FAUNAL AND FLORAL ASSESSMENT
FOR THE PROPOSED WEST WITS MINING PROJECT

Prepared for

SLR Consulting

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Section A: Background Information

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GLOSSARY OF TERMS

Alien and Invasive species	A species that is not an indigenous species; or an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention;
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the Ecosystems, ecological processes and landscape of which they are integral parts.
Biome	A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.
CBA (Critical Biodiversity Area)	A CBA is an area considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges.
Endangered	Organisms in danger of extinction if causal factors continue to operate.
Endemic species	Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.
ESA (Ecological Support Area)	An ESA provides connectivity and important ecological processes between CBAs and is therefore important in terms of habitat conservation.
Indigenous vegetation (as per the definition in (NEMA)	Vegetation occurring naturally within a defined area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years.

ACRONYMS

BGIS	Biodiversity GIS
CA	Conservation Area
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Area
CR	Critically Endangered
DMR	Department of Mineral Resources
EIA	Environmental Impact Assessment
ESA	Ecological Support Area
GDARD	Gauteng Department of Agriculture and Rural Development
GIS	Geographic Information System
IBA	Important Bird Area
IC	Infrastructure Complex
IUCN	International Union for Conservation of Nature
MAP	Mean Annual Precipitation
MAPE	Mean annual potential evaporation
MASMS	Mean annual soil moisture stress
MAT	Mean Annual Temperature
MFD	Mean Frost Days
MPRDA	Mineral and Petroleum Resources Development Act
MRA	Mining Right Area
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NPAES	National Protected Areas Expansion Strategy
PES	Present Ecological State
PRECIS	Pretoria Computer Information Systems
QDS	Quarter Degree Square
ROM	Run of Mine
SABAP 1 and 2	South African Bird Atlas Project 2
SACAD	South African Conservation Areas Database
SANBI	Southern African National Biodiversity Institute
SAPAD	South African Protected Areas Database
SCC	Species of Conservation Concern
STS	Scientific Terrestrial Services
TSP	Threatened Species Programme
VU	Vulnerable
WRD	Waste rock dumps

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct a terrestrial ecological assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA (Figure 1 and 2). The proposed MRA partly falls within Roodepoort (northern portion) and partly within Soweto (southern portion). A description of the project is provided in Section 1.2 below, which includes the locality of the proposed MRA relative to the surrounding areas.

The purpose of Section A of this report is to identify and describe the terrestrial ecology of the proposed MRA on a desktop basis. This was achieved by utilising all relevant desktop databases including, but not limited to, the Gauteng Conservation Plan v3.3 (2011), Important Bird and Biodiversity Areas Database (2015), National Biodiversity Assessment (2011), the Mining and Biodiversity Guidelines (2013) and Mucina and Rutherford (2006 & 2012). It is the objective of this study to provide detailed information to guide the fieldwork components (reported in Sections B and C) to ensure that all relevant ecological aspects were considered prior to performing the field assessments.

1.2 Project Description

In broad terms the proposed project entails:

- The development of five open-pit mining areas referred to as:
    - Mona Lisa Bird Reef Pit;
    - Roodepoort Main Reef Pit;
    - Rugby Club Main Reef Pit;
    - 11 Shaft Main Reef Pit; and
    - Kimberley Reef East Pit.
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings):
    - Bird Reef Central Infrastructure Complex; and

- Kimberley Reef East Infrastructure Complex.

The project would also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps (WRD) as well as supporting infrastructure including material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, wash bays, stores, change houses, lamprooms, vent fans and security facilities.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is three (3) to five (5) years and 20 years for the Kimberley Reef East underground operations and ten (10) years for the Bird Reef Central underground operations. The pits would be mined in a phased approach with each pit taking between six (6) and 16 months to be mined and rehabilitated.

The proposed location for the open pit mining areas and surface infrastructure complexes forming part of this project are depicted in Figure 1 and 2, with their approximate extent, presented in Table 1.

Table 1: Extent of the proposed infrastructure and open cast areas investigated pertaining to the proposed MRA.

Proposed Mining Right Area	Area (ha)
Proposed MRA	2076
Proposed Infrastructure Complexes Investigated	
Bird Reef Central	± 2.19
Kimberley Reef East	± 4.74
West Wits Opencast Areas Investigated (including open cast, topsoil stockpile and WRD footprint areas)	
11 Shaft Main Reef Pit	14
Kimberley Reef East Pit	9.92
Mona Liza Bird Reef Pit	19.2
Roodepoort Main Reef Pit	26.4
Rugby Club Reef East Pit	2.5

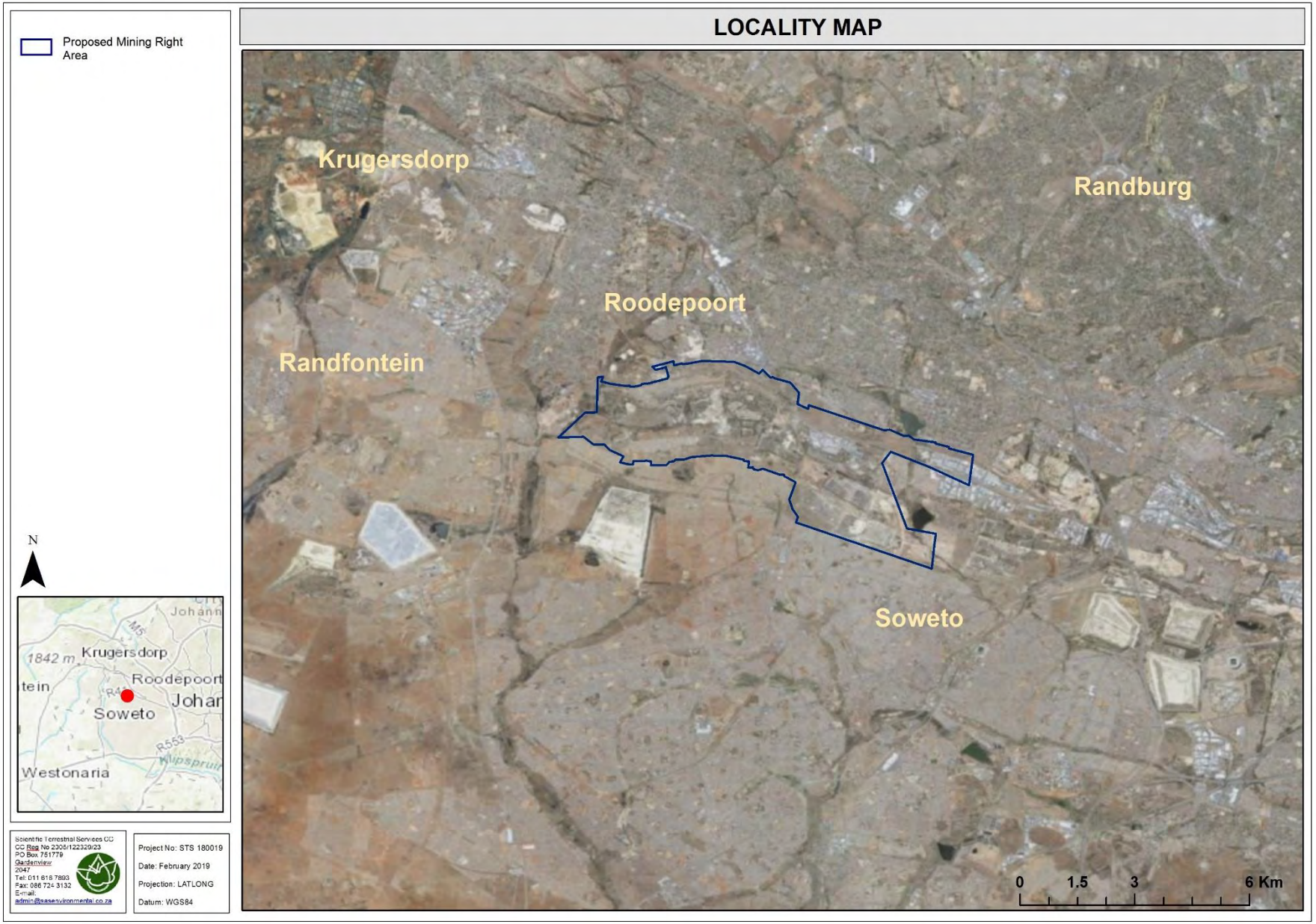

Figure 1: Digital Satellite image depicting the location of the proposed MRA in relation to surrounding areas.

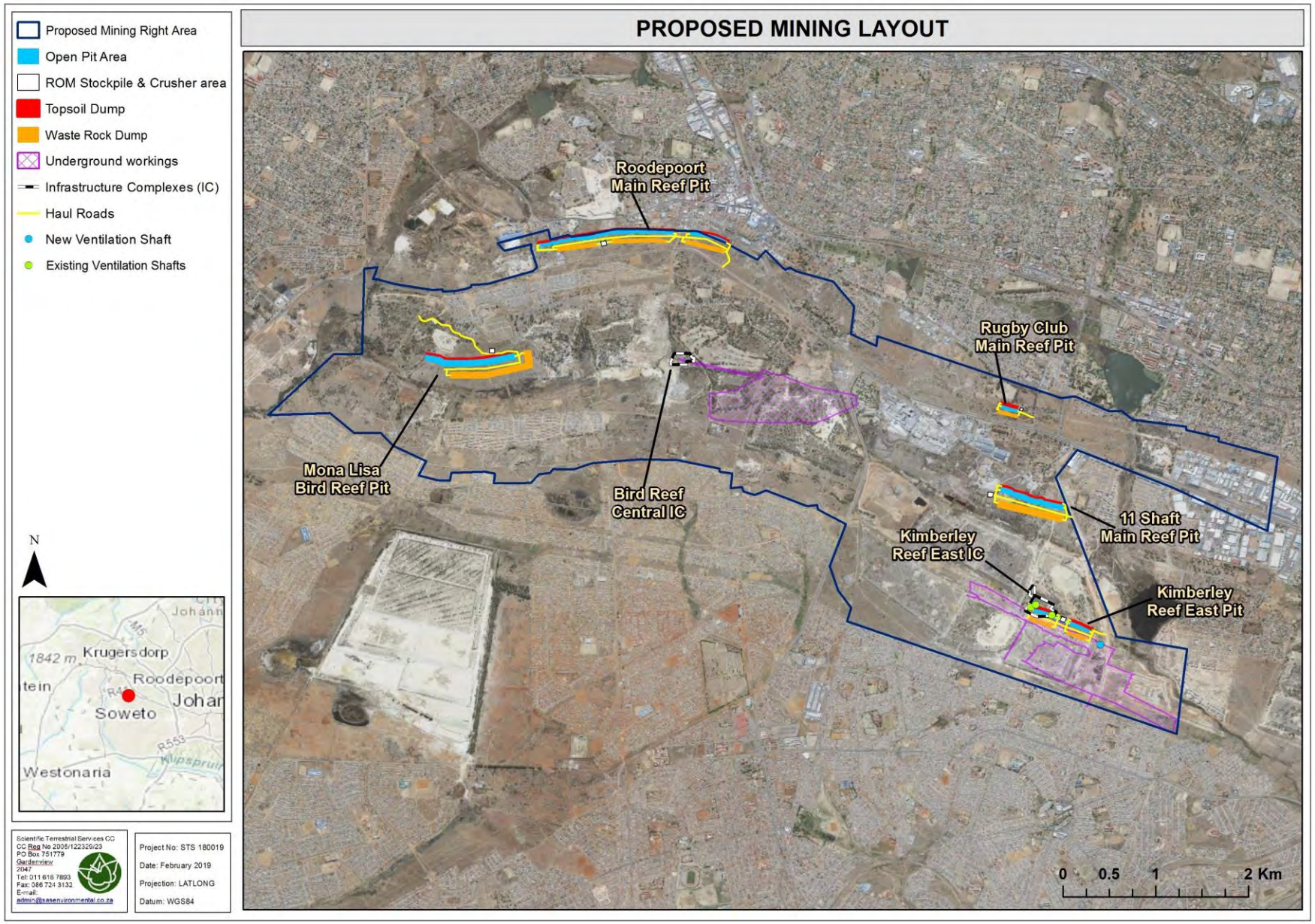

Figure 2: Proposed operations and infrastructure associated with the proposed MRA.

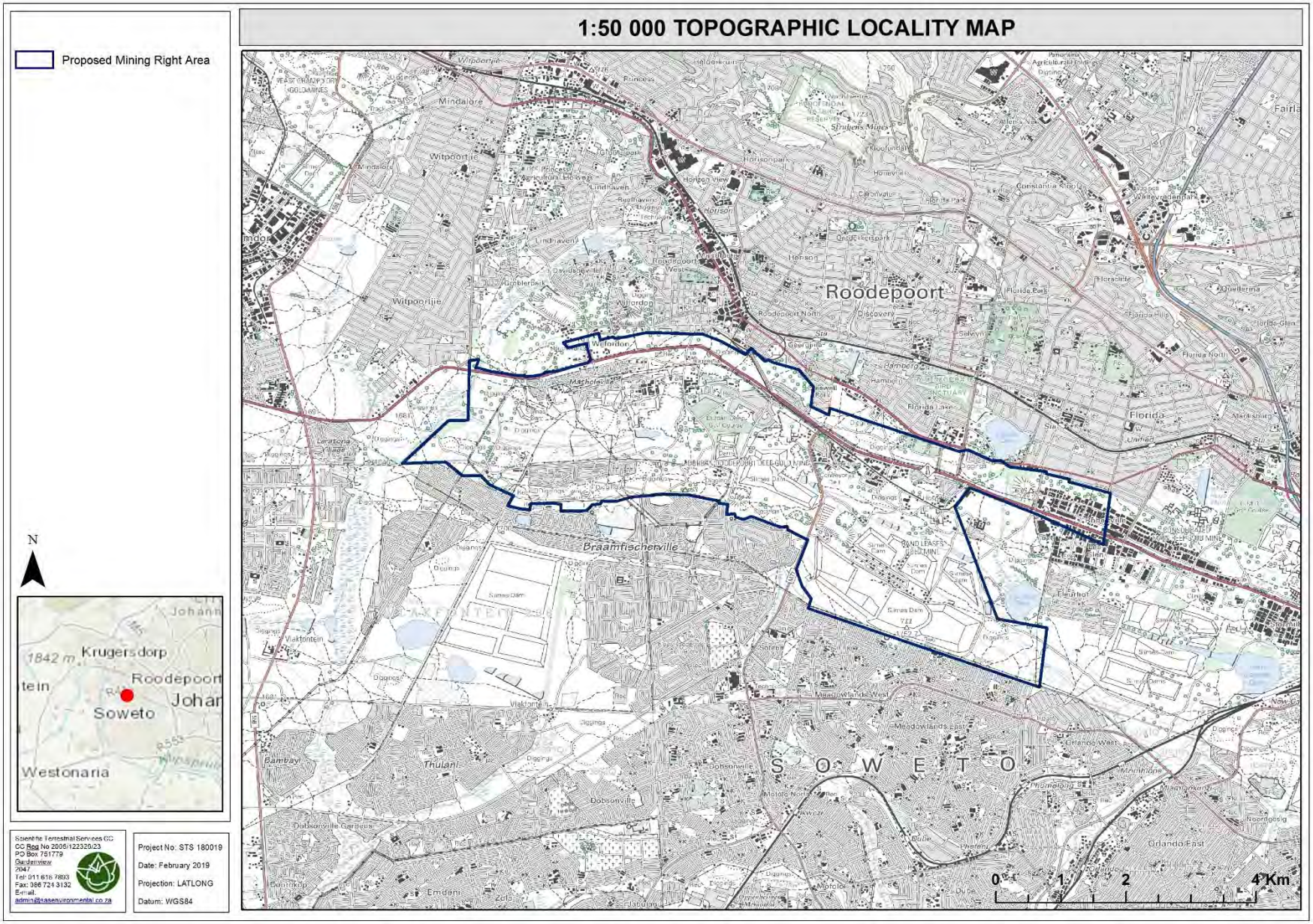

Figure 3: Proposed MRA depicted on a 1:50 000 topographical map in relation to its surrounding area.

1.3 Scope of Work

Specific outcomes of the study are as follows:

- Compile a desktop study with all relevant information as presented by SANBI's Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org), to gain background information on the physical habitat and potential floral and faunal biodiversity associated with the proposed MRA;
- To describe the spatial significance of the proposed MRA with regards to surrounding natural areas; and
- To identify and consider all sensitive landscapes including rocky ridges, wetlands and/ or any other special features.

1.4 Assumptions and Limitations

The following assumptions and limitations apply to this report:

- The terrestrial ecological assessment is confined to the proposed MRA and does not include the neighbouring and adjacent properties nor the entire proposed MRA; these were, however, considered as part of the desktop assessment; and
- It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the proposed MRA's actual site characteristics at the scale required to inform the Environmental Impact Assessment (EIA) process. However, this information is considered to be useful as background information to the study, and sufficient decision making can take place with regards to the mining activities based on the desktop results.

1.5 Legislative Requirements

The following legislative requirements were considered during the assessment:

- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA);
- National Environmental Management: Biodiversity Act: Alien and Invasive Species Regulations, Notice number 864 of 29 July 2016 in Government Gazette 40166);
- Mineral and Petroleum Resource and Development Act, 2002 (Act 28 of 2002) (MPRDA); and

- Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA).

The following documentation was also considered:

- The Gauteng Department of Agriculture and Rural Development (GDARD) Requirements for Biodiversity Assessments Version 3 (GDARD, 2014).

The details of each of the above, as they pertain to this study, are provided in **Appendix B** of this report.

2 ASSESSMENT APPROACH

2.1 General Approach

In order to capture comprehensive data with respect to faunal and floral taxa, the following methodology was used:

- Relevant databases considered during the assessment of the study area included the South African National Biodiversity Institute (SANBI) Threatened Species Programme (TSP), the Gauteng Conservation Plan v3.3 (2011), Mucina and Rutherford (2012), National Biodiversity Assessment (2011), Important Bird and Biodiversity Areas (2015) in conjunction with the South African Bird Atlas Project (SABAP 2) (2015), International Union for Conservation of Nature (IUCN), and Pretoria National Herbarium Computer Information Systems (PRECIS);

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 Conservation Characteristics of the Proposed MRA

The following table contains data accessed as part of the desktop assessment. It is important to note, that although all data sources used provide useful and often verifiable high-quality data, the various databases do not always provide an entirely accurate indication of the study area's actual biodiversity characteristics.

Table 2: Summary of the conservation characteristics for the MRA (Quarter Degree Square (QDS) 2627BB).

<table>
<tr><th colspan="3">DETAILS OF THE MRA IN TERMS OF MUCINA & RUTHERFORD (2012)</th><th colspan="2">GAUTENG CONSERVATION PLAN (C-PLAN v3.3, 2011) - Figure 4 & 5</th></tr>
<tr><td>Biome</td><td colspan="2">According to Mucina and Rutherford (2012), the MRA falls within two biomes. The proposed MRA is located in the Grassland Biome.</td><td rowspan="2">Critical Biodiversity Areas (CBAs)</td><td rowspan="2">The proposed MRA is located in, and surrounded by, numerous Critical Biodiversity Areas (CBAs, Figure 6). None of the Infrastructure Complexes falls within a CBA. The Mona Lisa Bird Reef Pit and the Rugby Club Main Reef Pit opencast and associated infrastructure areas fall within a CBA (Figure 7).
CBAs include natural or near-natural terrestrial and aquatic features that were selected based on an areas' biodiversity characteristics, spatial configuration and requirement for meeting both biodiversity pattern and ecological process targets.</td></tr>
<tr><td>Bioregion</td><td colspan="2">The proposed MRA within the Grassland Biome is located within the Mesic Highveld Grassland Bioregion.</td></tr>
<tr><td>Vegetation Type</td><td colspan="2">The proposed MRA within the Grassland Biome is situated within the Soweto Highveld Grassland.</td><td>Ecological Support Areas (ESA)</td><td>The proposed MRA is located in and surrounded by, numerous Ecological Support Areas (ESAs, Figure 6). None of the Infrastructure Complexes is located within an ESA. The 11 Shaft Main Reef Pit partly intersects an ESA (Figure 7).
ESAs are natural, near-natural, degraded or heavily modified areas required to be maintained in an ecologically functional state to support CBAs and/or Protected Areas.</td></tr>
<tr><th colspan="5">DESCRIPTION OF THE VEGETATION TYPE(S) RELEVANT TO THE PROPOSED MRA (MUCINA & RUTHERFORD 2012)</th></tr>
<tr><td>Vegetation Type</td><td colspan="4">Soweto Highveld Grassland (Gm 8)</td></tr>
<tr><td rowspan="6">Climate Information</td><td colspan="4">Summer-rainfall region</td></tr>
<tr><td>MAP* (mm)</td><td>662</td><td rowspan="5">Distribution</td><td rowspan="5">Mpumalanga, Gauteng (and to a very small extent also in neighbouring Free State and North-West) Provinces</td></tr>
<tr><td>MAT* (°C)</td><td>14.8</td></tr>
<tr><td>MFD* (Days)</td><td>41</td></tr>
<tr><td>MAPE* (mm)</td><td>2060</td></tr>
<tr><td>MASMS* (%)</td><td>75</td></tr>
<tr><td>Altitude (m)</td><td colspan="4">1 420–1 760 m</td></tr>
<tr><td>Geology, Soils & Hydrology</td><td colspan="4">Shale, sandstone or mudstone of the Madzaringwe Formation (Karoo Supergroup) or the intrusive Karoo Suite dolerites which feature prominently in the area. In the south, the Volksrust Formation (Karoo Supergroup) is found, and in the west, the rocks of the older Transvaal, Ventersdorp and Witwatersrand Supergroups are most significant. Soils are deep, reddish on flat plains and are typically Ea (soil with limited pedological development), Ba and Bb (soil with plintic catena) land types.</td></tr>
<tr><td>Conservation</td><td colspan="4">Endangered. Target 24%. Only a handful of patches statutorily conserved (Waldrift, Krugersdorp, Leeuwkuil, Suikerbosrand, and Rolfe's Pan Nature Reserves) or privately conserved (Johanna Jacobs, Tweefontein, Gert Jacobs, Nikolaas and Avalon Nature Reserves, Heidelberg Natural Heritage Site).</td></tr>
<tr><td>Vegetation & landscape features</td><td colspan="4">Gently to moderately undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland dominated almost entirely by Themeda triandra and accompanied by a variety of other grasses such as Elionurus muticus, Eragrostis racemosa, Heteropogon contortus and Tristachya leucothrix. In places not disturbed, only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover.</td></tr>
<tr><th colspan="5">CONSERVATION DETAILS PERTAINING TO THE PROPOSED MRA (VARIOUS DATABASES)</th></tr>
<tr><td>NBA (2011)</td><td colspan="4">The entire proposed MRA falls within an area that is currently not protected.</td></tr>
<tr><td>National Threatened</td><td colspan="4">The proposed MRA mainly falls within ecosystems classified as Critically Endangered (CR) and Vulnerable (VU) (Figure 6 & 7). More specifically, the Mona Lisa Bird Reef Pit completely falls within a CR area. A portion of 11 Shaft Main Reef Pit partly intersects a small part of a CR ecosystem on its eastern side with the majority of the western side falling within a VU area (Figure 7). Additionally, the Rugby Club Main Reef Pit and the Kimberley Reef East Pit are situated within VU ecosystem. Of the Infrastructure Complexes, the Bird Reef Central Infrastructure</td></tr>
</table>

Ecosystems (2011)	complex and the Kimberley Reef East Infrastructure complex falls within VU ecosystems (Figure 7). Areas within CR and VU ecosystems fall within the endangered Soweto Highveld Grassland vegetation and has been identified in the Gauteng C-Plan as Critical Biodiversity Areas and Ecological Support Areas. These areas have not been afforded any protection (NBA, 2011) and this adds to their threat status.
SACAD (2018)	The proposed MRA does not fall within a Conservation Area (CA). The Walter Sisulu National Botanical Garden is situated approximately 7.7 km north of the MRA and Magaliesberg Biosphere Reserve is approximately 11km north-west of the MRA (Figure 8).
SAPAD (2018)	The proposed MRA does not fall within a Nature Reserve (NR); however, it is located ± 8 km west of the Melville Koppies NR and ± 9.6 km north-west of the Olifantsvlei NR (Figure 8). No other Protected Area is within 10 km of the MRA.
NPAES	The MRA does not fall within a formally protected area; however, several formally protected reserves are within 10 km of the MRA (Figure 8). This includes Walter Sisulu National Botanical Garden (± 7.7 km north), Ruimsig Municipal Nature Reserve (± 9.2 km north), Kloofendal Municipal Nature Reserve (± 3.3 km north) and Melville Koppies Municipal Nature Reserve (± 9.6 km west).
IBA (2015)	The MRA does not fall within an Important Bird Area (IBA); however, the Magaliesberg IBA is approximately 11 km to the northwest of the MRA (Figure 9).
IMPORTANCE OF THE MRA ACCORDING TO THE MINING AND BIODIVERSITY GUIDELINES (2013) **–** Figure 10 & 11	
Moderate Biodiversity Importance	The central parts of the MRA fall within areas of Moderate Biodiversity Importance. The MRA is also surrounded by areas of Moderate Biodiversity Importance. The 11 Shaft Main Reef Pit, Kimberley Reef East Pit and the Kimberley Reef East Infrastructure complex are situated within areas of Moderate Biodiversity Importance (Figure 11). Biodiversity priority areas: Ecological support areas, vulnerable ecosystems, MRAs for protected area expansion (land-based and offshore protection). Risk for mining: Moderate risk for mining. Implications for mining: These areas are of moderate biodiversity value. EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, identifying features (e.g. threatened species) not included in the existing datasets, and on providing site-specific information to guide the application of the mitigation hierarchy. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.
High Biodiversity Importance	The northern-most portion of the MRA overlaps with a larger area of High Biodiversity Importance. The Bird Reef Central infrastructure complex and the Roodepoort Main Reef Pit fall within areas of High Biodiversity Importance (Figure 11). Biodiversity priority areas: Protected area buffers (including buffers around National Parks, World Heritage Sites* and Nature Reserves), Transfrontier Conservation Areas (remaining areas outside of formally proclaimed protected areas), other identified priorities from provincial spatial biodiversity plans, high water yield areas, Coastal Protection Zone, Estuarine functional zone. Risk for mining: High risk to mining Implications for mining: These areas are important for conserving biodiversity, for supporting or buffering other biodiversity priority areas, for maintaining important ecosystem services for particular communities or the country as a whole. An environmental impact assessment should include an assessment of optimum, sustainable land use for a particular area and will determine the significance of the impact on biodiversity. Mining options may be limited in these areas, and red flags for mining projects are possible. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.
Highest Biodiversity Importance	The Rugby Club Main Reef Pit, a small part on the eastern side of the 11 Shaft Main Reef Pit, and the entire Mona Lisa Bird Reef Pit are located within areas of Highest Biodiversity Importance (Figure 11). Biodiversity priority areas: Critically endangered and endangered ecosystems, Critical Biodiversity Areas (or equivalent areas) from provincial spatial biodiversity plans, River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and a 1km buffer around these FEPAs, Ramsar Sites. Risk for mining: Highest risk for mining. Implications for mining: Environmental screening, EIA's and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide a site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision making for mining, water use licences, and environmental authorisations. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure the protection of biodiversity, environmental sustainability, and human well-being.

CBA = Critical Biodiversity Areas; ESA = Ecological Support Area; IBA = Important Bird and Biodiversity Areas; MAP – Mean annual precipitation; MAT – Mean annual temperature; MAPE – Mean annual potential evaporation; MFD = Mean frost days; MASMS – Mean annual soil moisture stress (% of days when evaporative demand was more than double the soil moisture supply); NBA = National Biodiversity Assessment; NPAES = National Protected Areas Expansion Strategy; SACAD = South African Conservation Areas Database; SAPAD = South African Protected Areas Database.

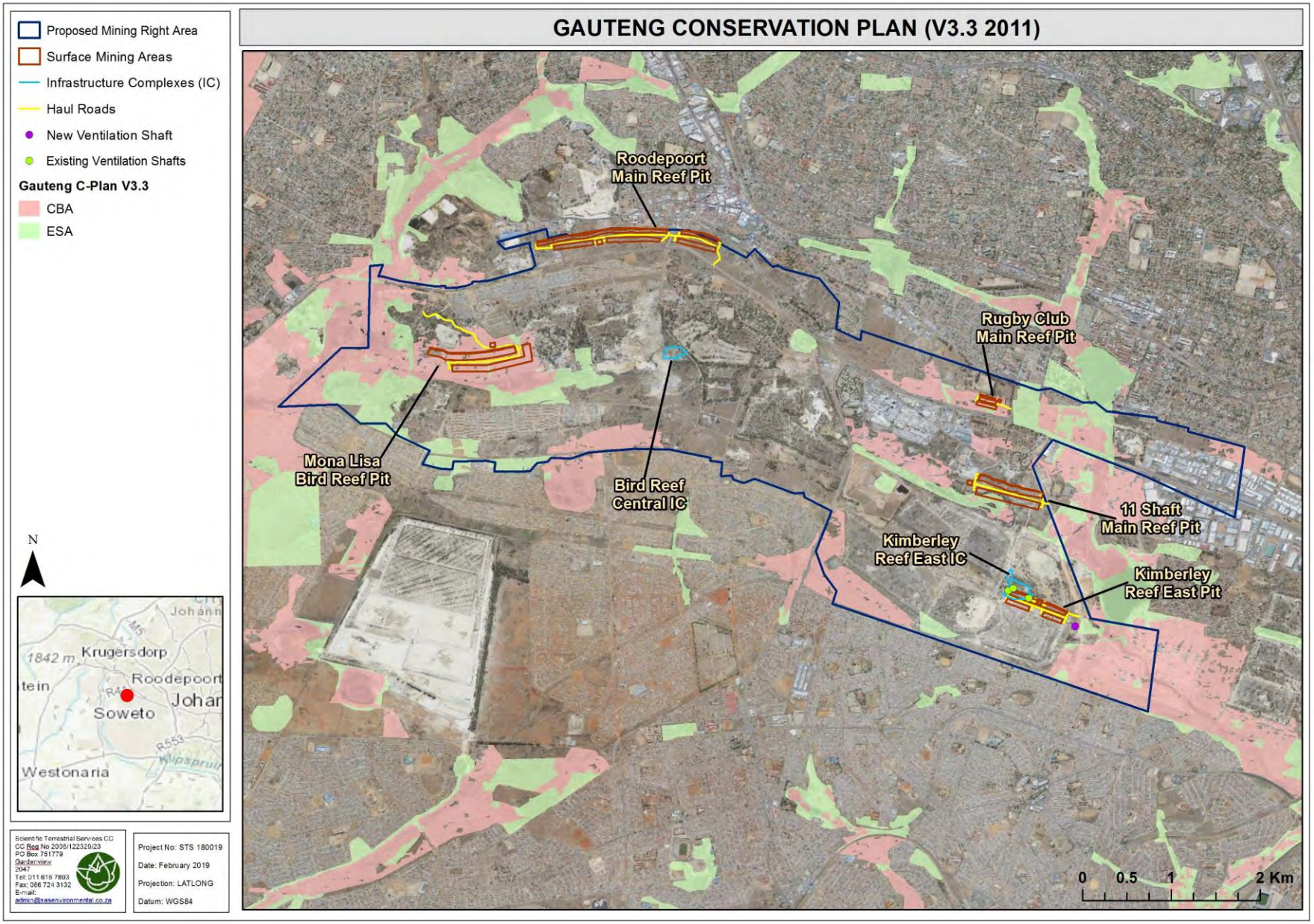

Figure 4: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are associated with the proposed MRA (Gauteng C-Plan v3.3).

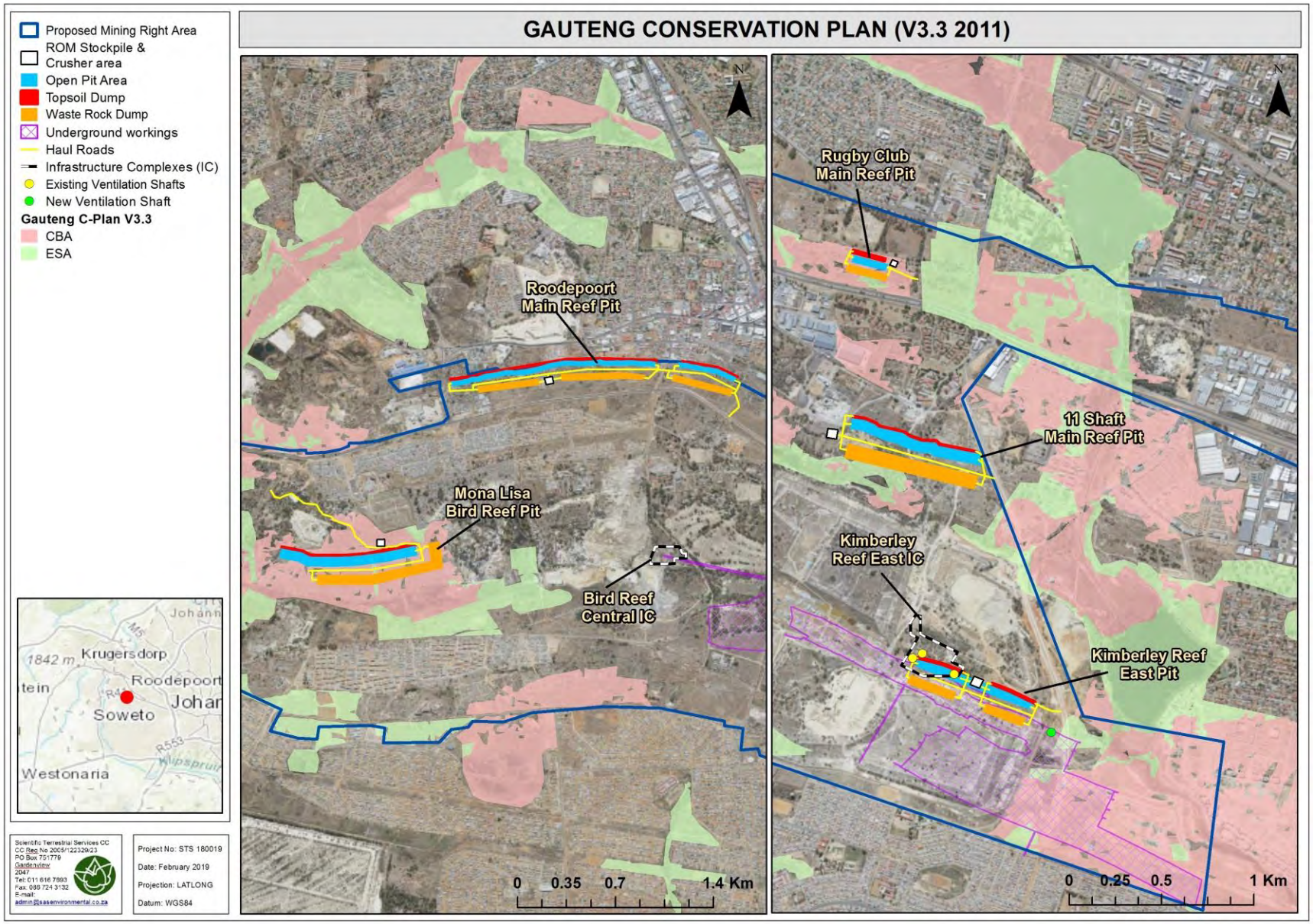

Figure 5: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are associated with the various open cast and infrastructure areas (Gauteng C-Plan v3.3).

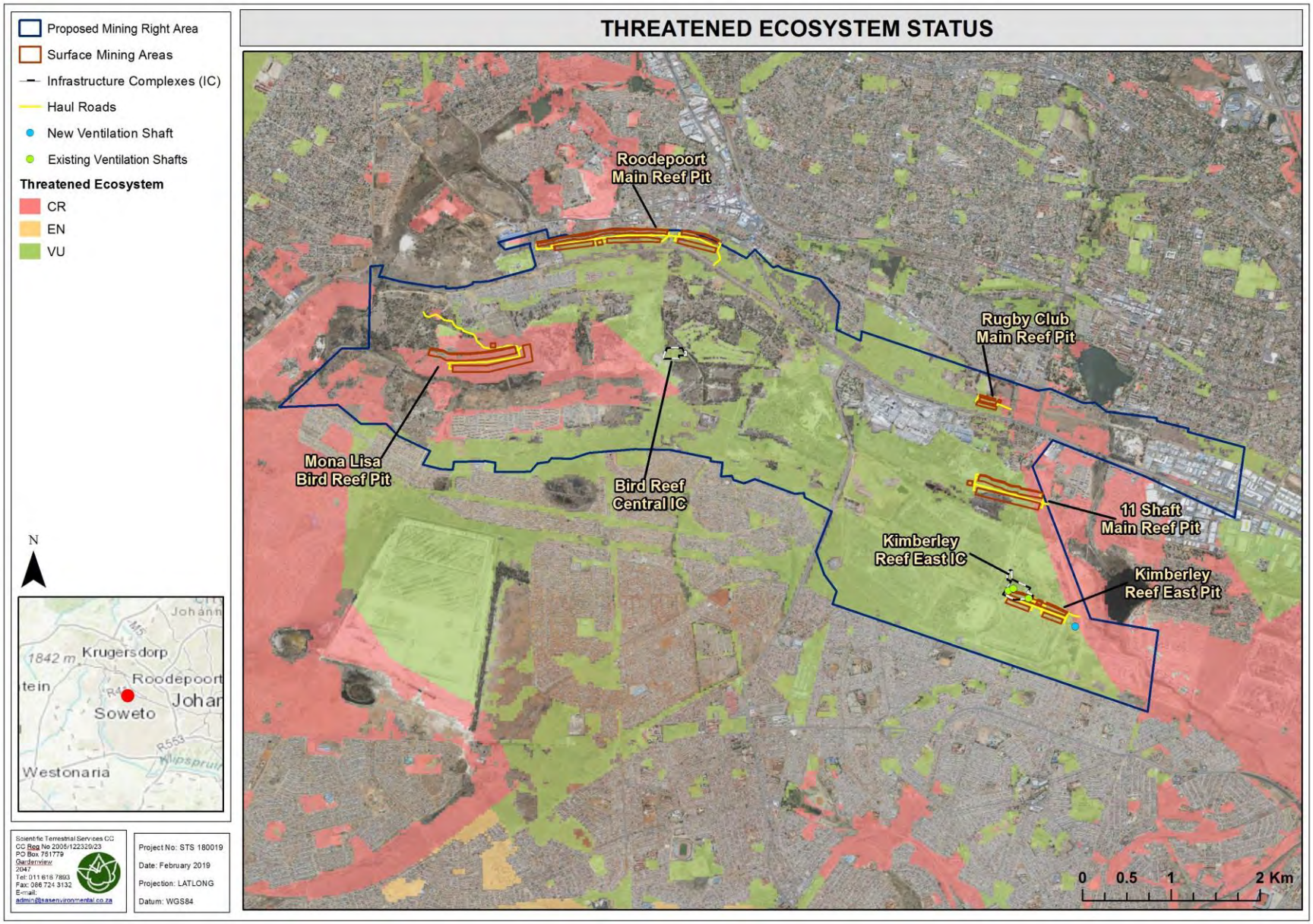

Figure 6: Ecosystem threat status for the proposed MRA.

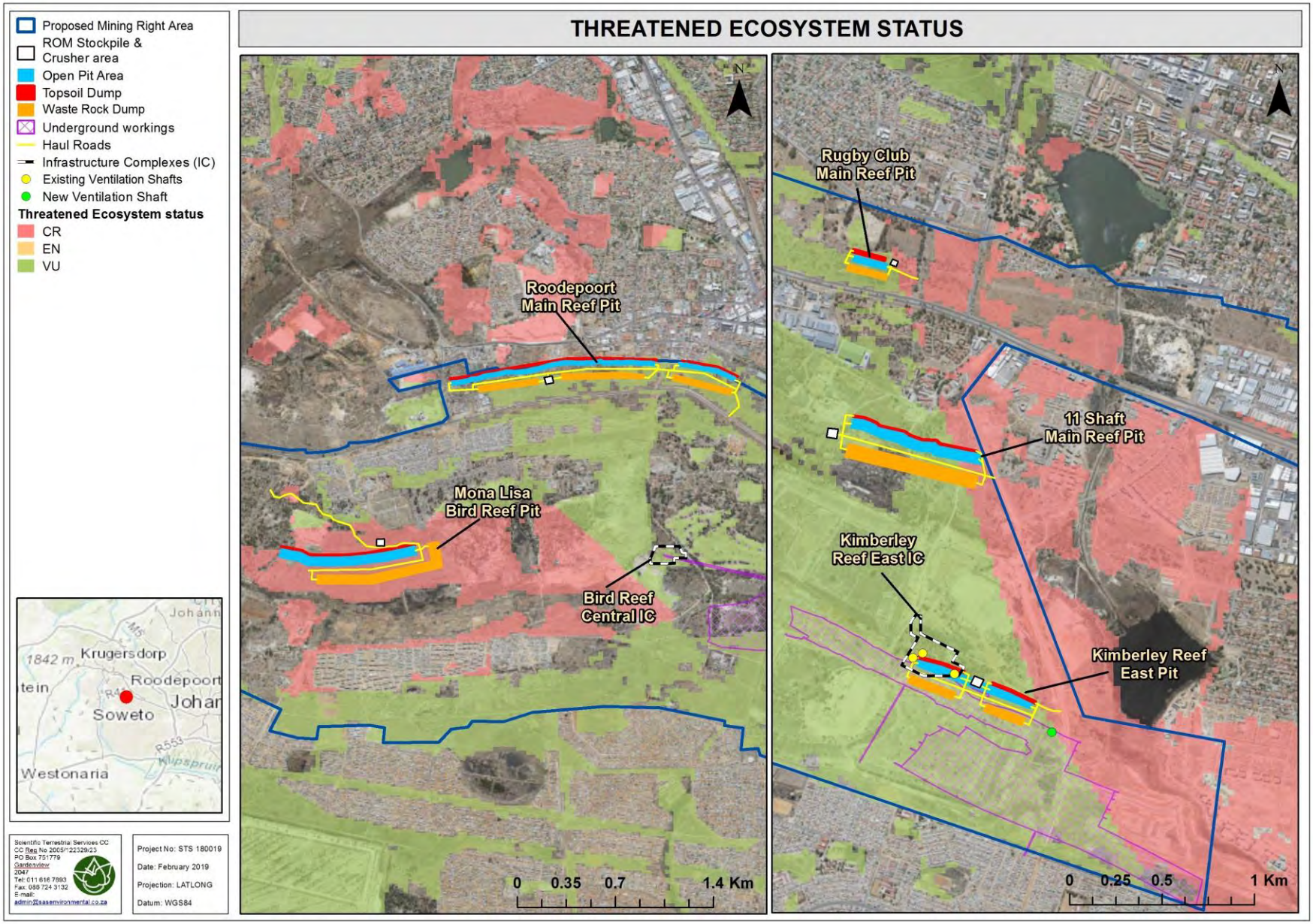

Figure 7: Ecosystem threat status that is associated with the various open cast and infrastructure areas.

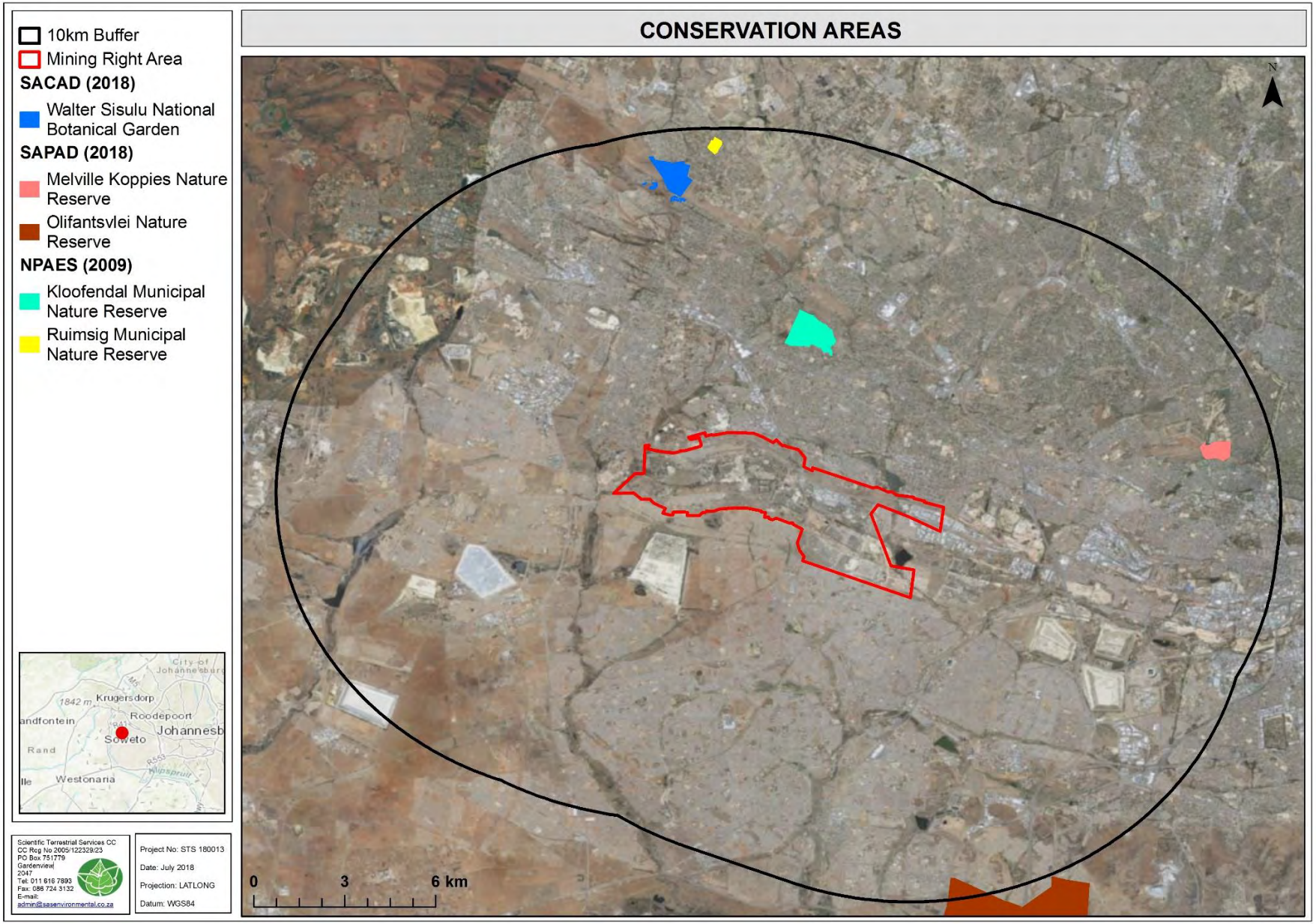

Figure 8: Conservation areas surrounding the proposed MRA within a 10 km radius.

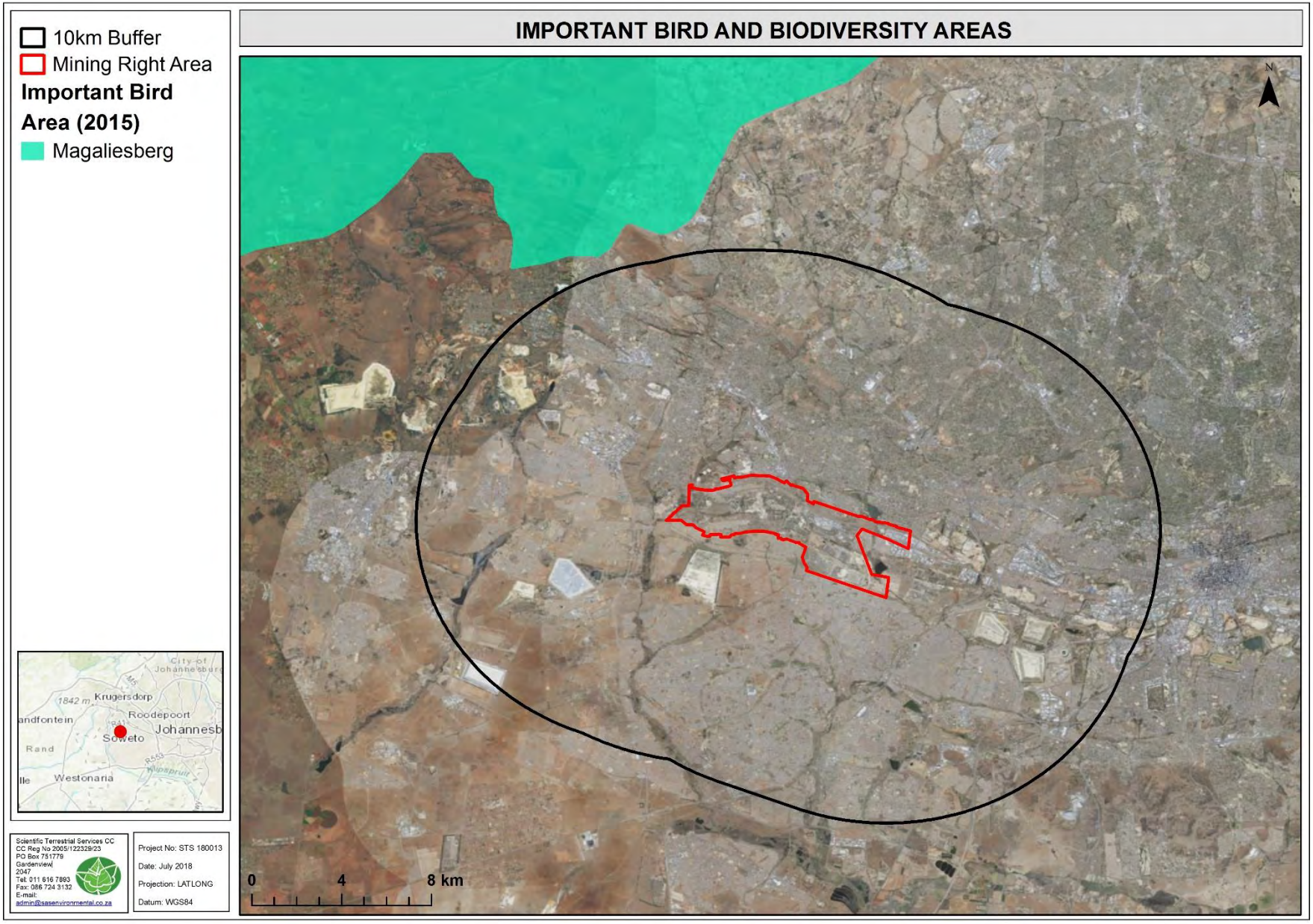

Figure 9: Magaliesberg Important Bird and Biodiversity Area (IBA) is approximately 11 km to the north of the proposed MRA.

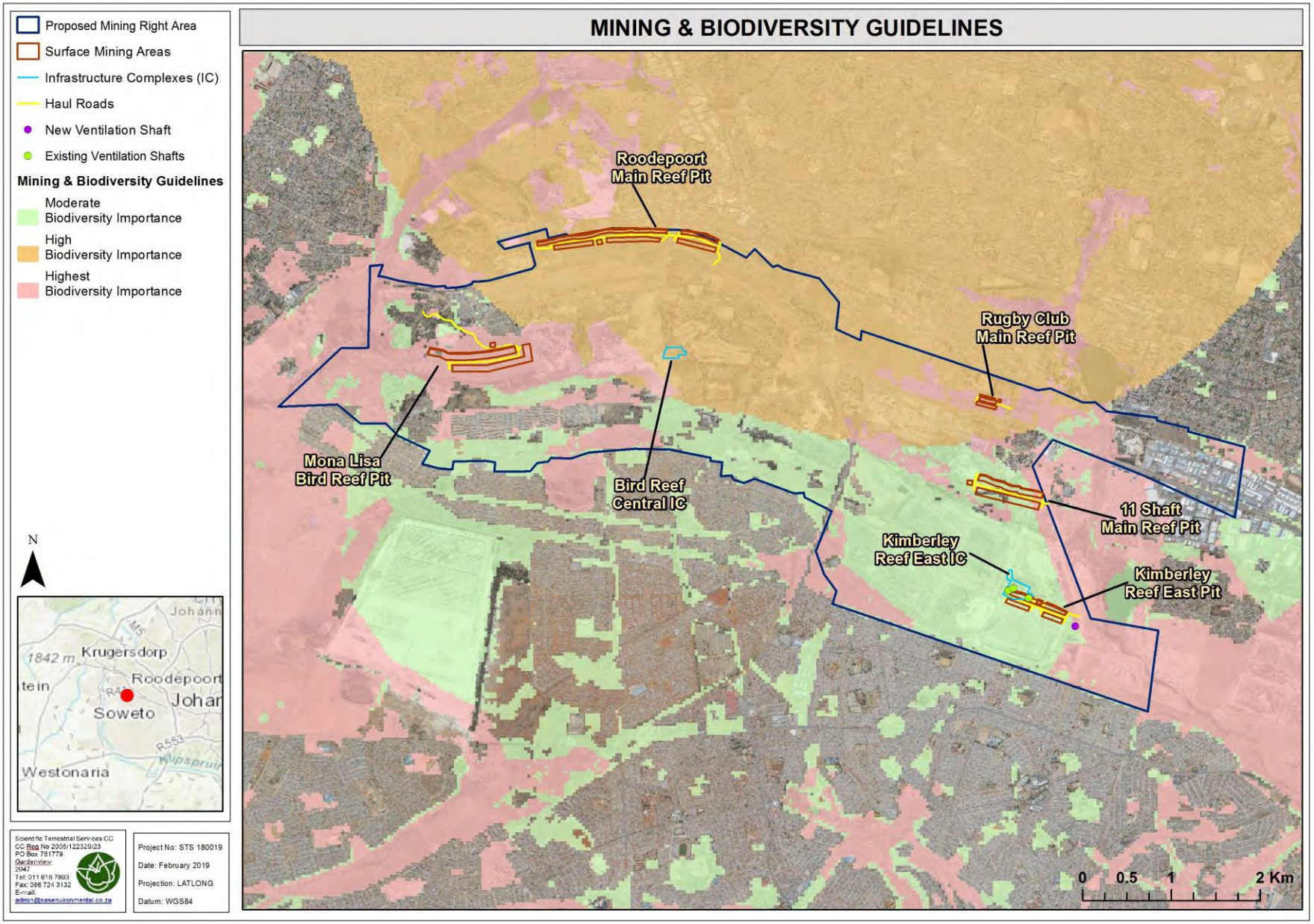

Figure 10: Areas of biodiversity importance associated with the proposed MRA (Mining Guidelines, 2013).

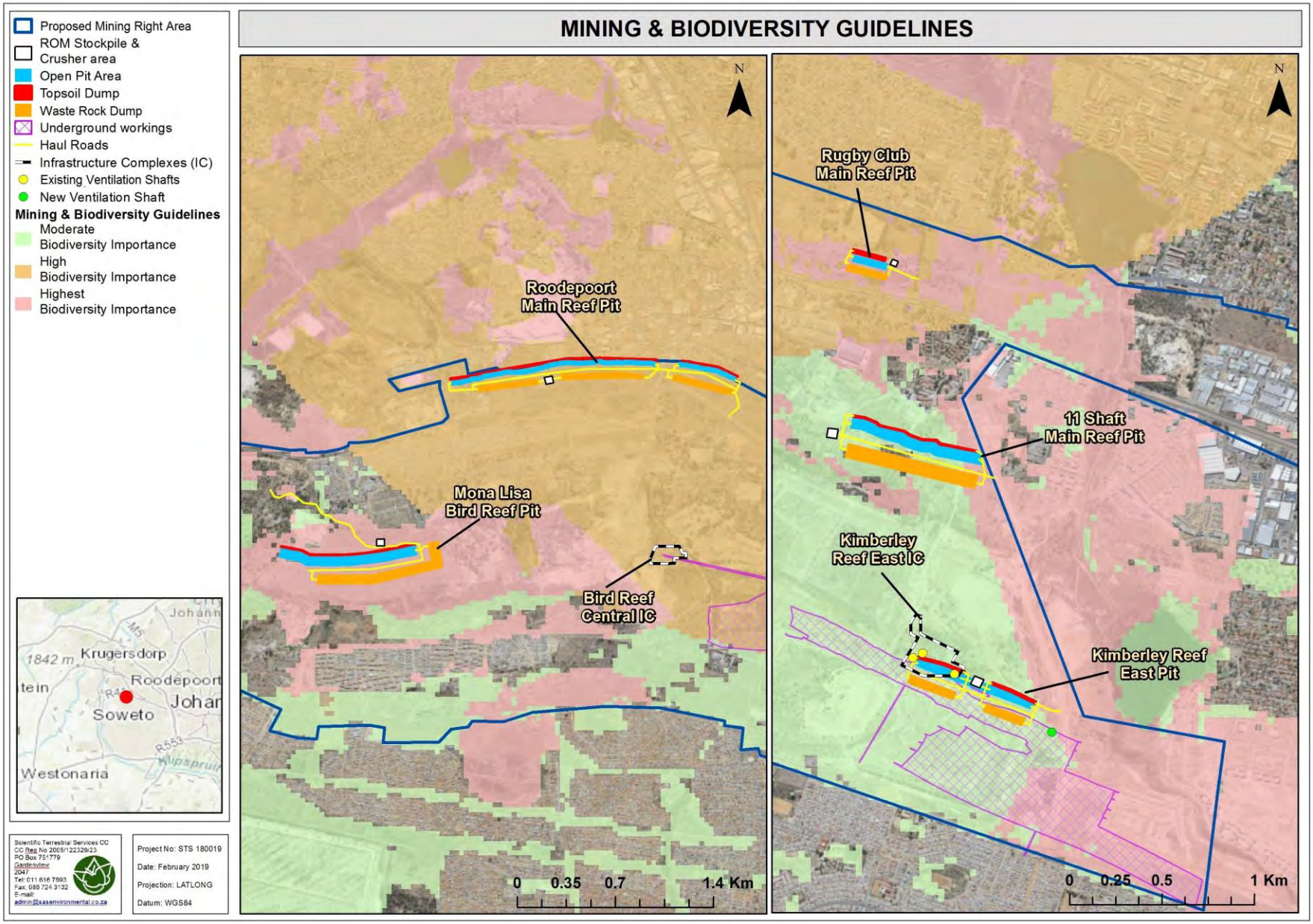

Figure 11: Areas of biodiversity importance that are associated with the various open cast and infrastructure areas (Mining Guidelines, 2013).

4 STRUCTURE OF THE REPORT

Section A of this report served to provide an introduction to the proposed MRA, as well as the general approach to the study. Section A also presents the results of general desktop information reviewed as part of the study including the information generated by the relevant authorities as well as the context of the site in relation to the surrounding anthropogenic activities and ecological character.

Section B addresses all the issues pertaining to the assessment of the floral ecology of the proposed MRA.

Section C addresses all the issues pertaining to the assessment of the faunal ecology of the proposed MRA.

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APPENDIX A: INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and STS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field or pertaining to this investigation.

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This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

APPENDIX B: LEGISLATIVE REQUIREMENTS

National Environmental Management Act, 1998 (Act 107 of 1998)

The National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) and the associated Environmental Impact Assessment (EIA) Regulations (GN R326 as amended in 2017 and well as listing notices 1, 2 and 3 (GN R327, R325 and R324 of 2017), state that prior to any development taking place which triggers any activity as listed within the abovementioned regulations, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment process depending on the nature of the activity and scale of the impact.

National Environmental Management Biodiversity Act, 2004 (Act 10 of 2004) (NEMBA)

The objectives of this act are (within the framework of NEMA) to provide for:

- The management and conservation of biological diversity within the Republic of South Africa and the components of such diversity;
- The use of indigenous biological resources in a sustainable manner;
- The fair and equitable sharing among stakeholders of the benefits arising from bioprospecting involving indigenous biological resources;
- To give effect to ratify international agreements relating to biodiversity which are binding to the Republic;
- To provide for cooperative governance in biodiversity management and conservation; and
- To provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

This act alludes to the fact that management of biodiversity must take place to ensure that the biodiversity of the surrounding areas is not negatively impacted upon, by any activity being undertaken, in order to ensure the fair and equitable sharing among stakeholders of the benefits arising from indigenous biological resources.

Furthermore, a person may not carry out a restricted activity involving either:

a) A specimen of a listed threatened or protected species;
b) Specimens of an alien species; or
c) A specimen of a listed invasive species without a permit.

National Environmental Management Biodiversity Act (NEMBA) (Alien and Invasive Species Regulations, Notice number 864 of 29 July 2016 in Government Gazette 40166)

NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. In terms of alien and invasive species. This act in terms of alien and invasive species aims to:

- Prevent the unauthorised introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur,
- Manage and control alien and invasive species, to prevent or minimise harm to the environment and biodiversity; and
- Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Alien species are defined, in terms of the National Environmental Management: Biodiversity Act, 2004 (Act no 10 of 2004) as:

(a) A species that is not an indigenous species; or
(b) An indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.

Categories according to NEMBA (Alien and Invasive Species Regulations, 2017):

- **Category 1a**: Invasive species that require compulsory control;
- **Category 1b**: Invasive species that require control by means of an invasive species management programme;
- **Category 2**: Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread; and
- **Category 3**: Ornamentally used plants that may no longer be planted.

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

Removal of the alien and weed species encountered in the application area must take place in order to comply with existing legislation (amendments to the regulations under the CARA, 1983 and Section 28 of the NEMA, 1998). Removal of species should take place throughout the construction and operation, phases.

Minerals and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA)

The obtaining of a New Order Mining Right (NOMR) is governed by the MPRDA. The MPRDA requires the applicant to apply to the Department of Mineral Resources (DMR) for a NOMR which triggers a process of compliance with the various applicable sections of the MPRDA. The NOMR process requires environmental authorisation in terms of the MPRDA Regulations and specifically requires the preparation of a Scoping Report, an Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP), and a Public Participation Process (PPP).

GDARD Requirements for Biodiversity Assessments Version 3 (GDARD, 2014b).

The biodiversity assessment must comply with the minimum requirements as stipulated by GDARD Version 3 of 2014 and must contain the following information:

- A location and description of the application site and proposed activities;
- Photographic record and description of the site characteristics and inventories of the faunal and floral species observed on site, with special mention to Red Listed species;
- Sensitivity map displaying all sensitive areas and associated buffers as listed in the Sensitivity Mapping Rules for Biodiversity Assessments section of GDARD V3 (2014); and
- A list of recommendations and mitigation measures to reduce the potential environmental impacts that the proposed development might have on the terrestrial ecology associated with the site.

APPENDIX C: VEGETATION TYPE

Soweto Highveld Grassland [Gm 8, Mucina and Rutherford (2012)]

Figure C1: Mucina and Rutherford (2012) page 397. Gm 8 Soweto Highveld Grassland: Typical mesic highveld grassland with *Themeda triandra* and several *Eragrostis* species still found in some parts of southern Gauteng in natural condition.

Dominant Floral Taxa - Important Taxa

- **Graminoids**: *Andropogon appendiculatus* (d), *Brachiaria serrata* (d), *Cymbopogon pospischilii* (d), *Cynodon dactylon* (d), *Elionurus muticus* (d), *Eragrostis capensis* (d), *E. chloromelas* (d), *E. curvula* (d), *E. plana* (d), *E. planiculmis* (d), *E. racemosa* (d), *Heteropogon contortus* (d), *Hyparrhenia hirta* (d), *Setaria nigrirostris* (d), *S. sphacelata* (d), *Themeda triandra* (d), *Tristachya leucothrix* (d), *Andropogon schirensis, Aristida adscensionis, A. bipartita, A. congesta, A. junciformis subsp. galpinii, Cymbopogon caesius, Digitaria diagonalis, Diheteropogon amplectens, Eragrostis micrantha, E. superba, Harpochloa falx, Microchloa caffra, Paspalum dilatatum.*
- **Herbs**: *Hermannia depressa* (d), *Acalypha angustata*, *Berkheya setifera*, *Dicoma anomala*, *Euryops gilfillanii*, *Geigeria aspera var. aspera*, Graderia subintegra, Haplocarpha scaposa, *Helichrysum miconiifolium, H. nudifolium var. nudifolium, H. rugulosum, Hibiscus pusillus, Justicia anagalloides, Lippia scaberrima, Rhynchosia effusa, Schistostephium crataegifolium, Selago densiflora, Senecio coronatus, Vernonia oligocephala, Wahlenbergia undulata*.
- **Geophytic Herbs**: *Haemanthus humilis subsp. hirsutus, H. montanus*.
- **Herbaceous Climber**: *Rhynchosia totta.*
- **Low Shrubs**: *Anthospermum hispidulum, A. rigidum subsp. pumilum, Berkheya annectens, Felicia muricata, Ziziphus zeyheriana*.

*(d = dominant species)

APPENDIX D: SPECIALIST DETAILS

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a)(i) Details of the specialist who prepared the report

Stephen van Staden	MSc Environmental Management (University of Johannesburg)
Nelanie Cloete	MSc (Botany and Environmental Management) (University of Johannesburg)
Hennie de Beer	National Diploma Nature Conservation (Tshwane University of Technology)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Terrestrial Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (STSSO) Member of the Gauteng Wetland Forum		

1.(b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, H. de Beer, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- 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 application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

I, N. Cloete, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- 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 application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- 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 application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

Signature of the Specialist

FAUNAL AND FLORAL ASSESSMENT
FOR THE PROPOSED WEST WITS MINING PROJECT

Prepared for

SLR Consulting

May 2019

Section B: Floral Assessment

Prepared by:	**Scientific Terrestrial Services**
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Report Reference:	**STS 180014**
Date:	**May 2019**

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DOCUMENT GUIDE

The Document Guide below is for reference to the procedural requirements for environmental authorisation applications in accordance to Government Notice 267 of 24 March 2017, as it pertains to the National Environmental Management Act (NEMA).

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Section A: Appendix E
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Section A: Appendix E
b)	A declaration that the specialist is independent	Section A: Appendix E
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section 2.1 and Section A: 3
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 2.1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Appendix A and B
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 3 and 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.2
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5
l)	Any conditions for inclusion in the environmental authorisation	Section 5
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 5
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5
(iA)	Regarding the acceptability of the proposed activity or activities	Section 5
(ii)	If the opinion is that the proposed activity, activities 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	Section 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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GLOSSARY OF TERMS

Alien and Invasive species	A species that is not an indigenous species; or an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention;
Biome	A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.
CBA (Critical Biodiversity Area)	A CBA is an area considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges.
Endangered	Organisms in danger of extinction if causal factors continue to operate.
Endemic species	Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.
ESA (Ecological Support Area)	An ESA provides connectivity and important ecological processes between CBAs and is therefore important in terms of habitat conservation.
Indigenous vegetation (as per the definition in (NEMA)	Vegetation occurring naturally within a defined area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years.
Invasive species	Means any species whose establishment and spread outside of its natural distribution range; they threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and may result in economic or environmental harm or harm to human health
Least Threatened	Least threatened ecosystems are still largely intact.
RDL (Red Data listed) species	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status.
SCC (Species of Conservation Concern)	The term SCC in the context of this report refers to all RDL (Red Data), and IUCN (International Union for the Conservation of Nature) listed threatened species as well as protected species of relevance to the project.

ACRONYMS

AIP	Alien and Invasive Plants
CR	Critically Endangered
EAP	Environmental Assessment Practitioner
EIS	Ecological Importance and Sensitivity
EN	Endangered
EW	Extinct in the Wild
GIS	Geographic Information System
GPS	Global Positioning System
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature and Natural Resources
NT	Near Threatened
P	Protected
PES	Present Ecological State
POC	Probability of Occurrence
PRECIS	Pretoria Computerised Information System
QDS	Quarter Degree Square
RE	Regionally Extinct
SANBI	South Africa National Biodiversity Institute
SP	Specially Protected
STS	Scientific Terrestrial Services
SCC	Species of Conservation Concern
TOPS	Threatened or Protected Species
VU	Vulnerable

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct a terrestrial ecological assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA. The proposed MRA partly falls within Roodepoort (northern portion) and partly within Soweto (southern portion). A description of the project is provided in Section 1.2 below, which includes the locality of the proposed MRA relative to the surrounding areas.

The purpose of this study was is to define the floral ecology of the proposed MRA on a higher level and specifically focus on mapping and defining areas of increased Ecological Importance and Sensitivity (EIS) and to define the Present Ecological State (PES) of the areas proposed for infrastructure and mining.

1.2 Project Description

In broad terms the proposed project entails:

- The development of five open-pit mining areas referred to as:
  - Mona Lisa Bird Reef Pit;
  - Roodepoort Main Reef Pit;
  - Rugby Club Main Reef Pit;
  - 11 Shaft Main Reef Pit; and
  - Kimberley Reef East Pit.
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings):
  - Bird Reef Central Infrastructure Complex; and
  - Kimberley Reef East Infrastructure Complex.

The site investigation for the floral assessment was focused on the infrastructure as mentioned above and mining areas and will collectively be referred to as the “focus areas”.

The project would also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps (WRD) as well as supporting infrastructure including material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, wash bays, stores, change houses, lamprooms, vent fans and security facilities.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is three (3) to five (5) years and 20 years for the Kimberley Reef East underground operations and ten (10) years for the Bird Reef Central underground operations. The pits would be mined in a phased approach with each pit taking between six (6) and 16 months to be mined and rehabilitated.

The proposed location for the open pit mining areas and surface infrastructure complexes forming part of this project are depicted in Figure 1 and 2 of the Report Section A: Background Information, with their approximate extent, presented in Table 1.

Table 1: Extent of the proposed infrastructure and open cast areas investigated pertaining to the proposed MRA.

Proposed Mining Right Area	Area (ha)
Proposed MRA	2076
Proposed Infrastructure Complexes Investigated	
Bird Reef Central	± 2.19
Kimberley Reef East	± 4.74
West Wits Opencast Areas Investigated (including opencast, topsoil stockpile and WRD footprint areas)	
11 Shaft Main Reef Pit	14
Kimberley Reef East Pit	9.92
Mona Lisa Bird Reef Pit	19.2
Roodepoort Main Reef Pit	26.4
Rugby Club Reef East Pit	2.5

It is the objective of this study:

- To provide inventories of floral species as encountered within the focus area;
- To determine and describe habitat types, communities and the ecological state of the focus area and to rank each habitat type based on conservation importance and ecological sensitivity;
- To identify and consider all sensitive landscapes including rocky ridges, wetlands and/ or any other special features;

- To conduct a Red Data Listed (RDL) species assessment as well as an assessment of other Species of Conservation Concern (SCC), including the potential for such species to occur within the focus area; and
- To ensure the ongoing functioning of the ecosystem in such a way as to support local and regional conservation requirements and the provision of ecological services in the local area.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The floral field assessment is confined to the focus areas. The proposed MRA was also assessed but on a high-level field assessment. This assessment does not include the neighbouring or adjacent properties; these were however considered as part of the desktop assessment (Section A). A high-level assessment of the proposed MRA will be performed to identify possible sensitive areas of influence by the proposed activities;
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. It is, however, expected that most floral communities had been accurately assessed and considered and the information provided is considered sufficient to allow informed decision making to take place and facilitate integrated environmental management;
- Sampling by its nature means that not all individuals are assessed and identified. Some species and taxa within the focus area may, therefore, have been missed during the assessment; and
- The data presented in this report are based on two site visits undertaken on the 6th and 7th of March 2018 (Summer) and the 14th of June 2018 (Winter). A more accurate assessment would require that assessments take place in all seasons of the year. However, on-site data was significantly augmented with all available desktop data and specialist experience in the area, and the findings of this assessment are considered to be an accurate reflection of the ecological characteristics of the focus areas.

2 ASSESSMENT APPROACH

Field assessments were undertaken to determine the ecological status of the focus areas. A reconnaissance ‘walkabout’ was undertaken to determine the general habitat types found

throughout the focus areas. Following the walkabout, specific study sites were selected that were considered to be representative of the habitats found within the area (where available), with special emphasis being placed on areas that may potentially support floral SCC. Sites were investigated on foot to identify the occurrence of the dominant floral species and habitat diversities. A detailed explanation of the method of assessment is provided in Appendix A of this report.

2.1 Sensitivity Mapping

All the ecological features of the focus area were considered, and sensitive areas were assessed. In addition, identified locations of floral SCC were marked using a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and final layout of the proposed mining activities.

3 RESULTS OF THE FLORAL ASSESSMENT

Following the assessment of the focus areas and the associated habitat, it has been concluded that the following habitat units can be associated with the focus areas:

- Secondary Grassland;
- Degraded Grassland;
- Freshwater features;
- Transformed habitat (associated with historic and current mining activities); and
- Built-up areas.

These habitat units are conceptualised in Figure 1 - 2 and their sensitivity described below. The Secondary Grassland and the Degraded Grassland will be discussed in more detail under Section 3.2 and 3.3.

The Transformed habitat and Built-up area will be briefly discussed due to their poor and degraded state and transformation. Although the freshwater features are not directly impacted by the footprint of the opencast areas and associated infrastructure, it is within the regulated zones according to the listing notices of the National Environmental Management Act, 1998 (NEMA) and Notice 509 of 2016 of the National Water Act, 1998 (NWA) Hence, these features will be briefly discussed from a terrestrial functionality and sensitivity.

3.1 Habitat Units

Secondary Grassland

The Secondary Grassland habitat unit comprises small pockets of modified grassland, dominated by alien and invasive plant species as a result of historic and current anthropogenic activities including edge effects from the surrounding residential developments, illegal dumping and ongoing illegal mining activities. Furthermore, the habitat unit has been largely transformed by historical mining activities and illegal disposal of waste material, with thickets of *Eucalyptus camaldulensis* (indicating historical disturbance). Due to the high levels of disturbance, only commonly occurring floral and faunal species were noted within proposed MRA. The majority of floral species present within the Secondary Grassland habitat unit are indicators of disturbed veld. In terms of faunal habitat availability, this habitat is considered to have a low habitat provision capability. In terms of faunal habitat, the habitat is considered to have a low habitat provision capability. The above-mentioned habitat disturbances have resulted in a low diversity and abundance of faunal SCC and low SCC probability.

Degraded Grassland

The Degraded Grassland habitat unit is considered to be in a significantly modified ecological condition, with a high abundance of alien and invasive flora species such as *Tagetes minuta, Eucalyptus camaldulensis, Acacia mearnsii* and *Melia azedarach*. The transformed areas also include existing illegal and historic mining activities. As a result of habitat degradation and alien and invasive plant proliferation, the habitat suitability for faunal and floral species has been significantly compromised and reduced, notably for SCC.

Freshwater features within the regulated zone

Several watercourses[1] were identified within the proposed MRA. A Channelled Valley Bottom Wetland feature (CVB2) was identified approximately 200 m from the proposed Mona Lisa Brid Reef Pit and another Channelled Valley Bottom Wetland feature (CVB3) was identified approximately 50 m from the proposed 11 Shaft Main Reef Pit. The CVB3 wetland features also extend approximately 400 m east of the Kimberley Reef East Pit and Kimberley Reef East Infrastructure Complex. The CVB3 wetland feature drains from the Florida Dam downstream

[1] Refer to the "Freshwater resource and Aquatic Ecological Assessment" Report compiled by Scientific Aquatic Services CC (2019) for detailed assessments on these watercourses.

into the Fleurhof Dam. The Klip River is located on the western boundary of the proposed MRA.

The watercourses located within the proposed MRA have all been impacted upon to some degree, with specific mention of the historical and ongoing surrounding agricultural and mining activities.

Table 2: Channelled Valley Bottom Wetland feature (CVB2) associated with the Mona Lisa Brid Reef Pit.

The vegetation component of these wetlands is dominated by reed species (*Phragmites australis* and *Typha capensis*). The excessive sediment substrate allowed for the invasion of a monoculture of *Phragmites australis*, dominating the largest extents of the wetlands, reducing the available substrate for other indigenous species to establish. Due to this monoculture, floral biodiversity is low, but the wetlands still have the potential to provide habitat for faunal species. The proliferation of alien and invasive floral species was also evidenced at the outer edges of the wetlands and where infrastructure (i.e. road crossings) has been constructed.	

Table 3: Channelled Valley Bottom Wetland feature (CVB3) associated with the 11 Shaft Main Reef Pit, Kimberley Reef East Pit and Kimberley Reef East IC:

A large degree of vegetation removal has occurred within and along this wetland system due to the development of road infrastructure and residential developments. Even though the permanent zone of the wetland could be considered well vegetated, the outer edges of the wetland have very little to no indigenous vegetation remaining, and thus no suitable buffer zone to aid in protecting the wetland from the surrounding activities. The western portion of this wetland system was however dominated by reed species (*Phragmites australis* and *Typha capensis*), which provides habitat and refugia for some less sensitive avifaunal and smaller faunal species.	

Transformed habitat

The Transformed habitat is associated with previous and current mining infrastructure such as slimes dams, derelict / abandoned buildings and water dams. The Kimberley Reef East Pit, Kimberley Reef East Infrastructure Complex and the Bird Reef Infrastructure Complex can be completely associated with this habitat unit. Small portions of the Transformed habitat can also be associated with the Roodepoort Main Reef Pit and the Mona Lisa Bird Reef Pit. The floral diversity and habitat suitability for SCC has been significantly modified, with a high

abundance of alien and invasive flora species such as *Tagetes minuta, Eucalyptus camaldulensis, Acacia mearnsii* and *Melia azedarach*.

Built-up areas

The built-up areas have been completely cleared of natural vegetation and replaced with urban residential dwellings, recreational areas, industrial areas and manufacturing and distribution facilities. Vegetation associated with this habitat unit includes garden ornamentals and landscape vegetation. None of the mining infrastructures, or operations is located within this habitat unit.

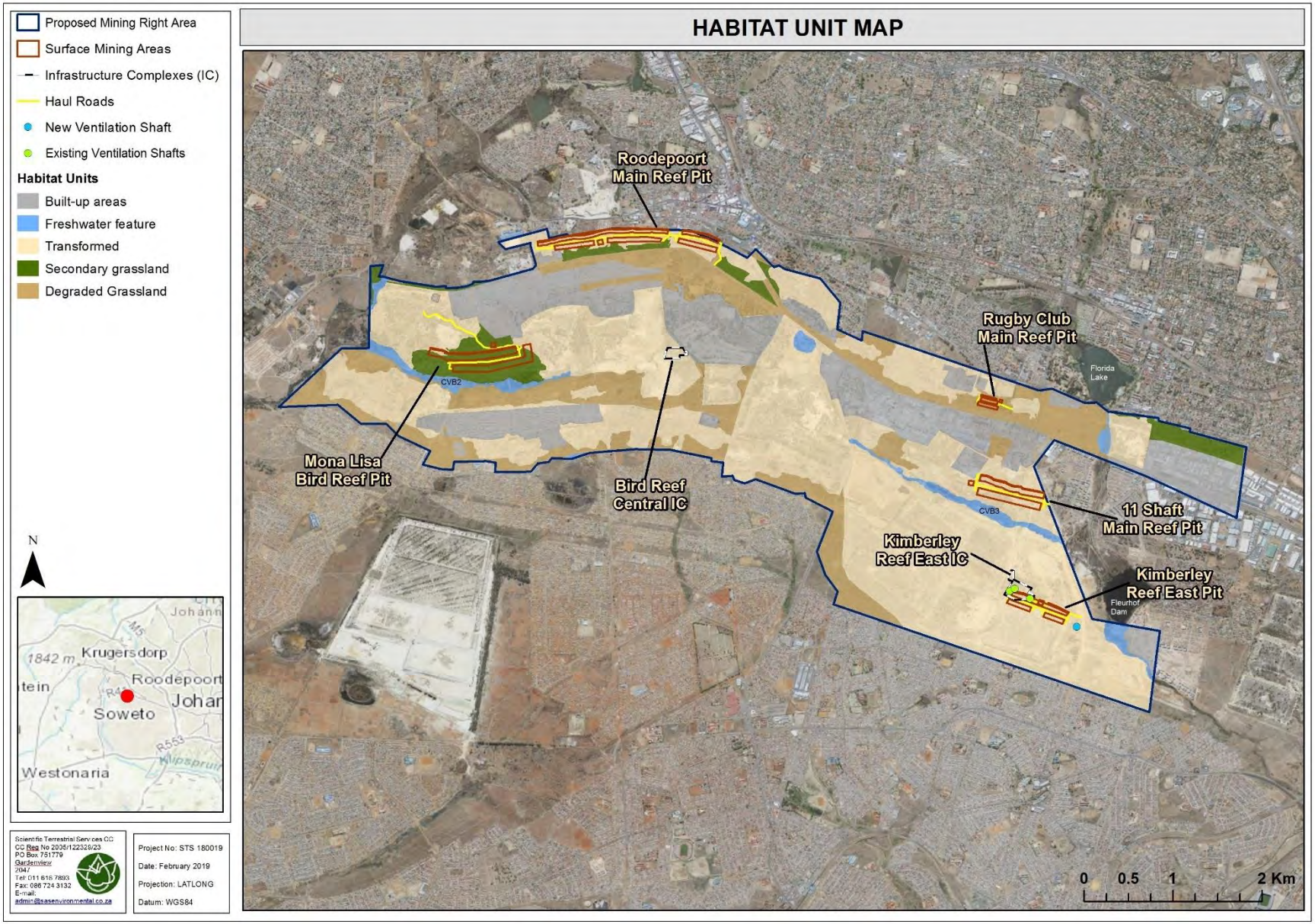


Figure 1: Conceptual illustration of the habitat units within the proposed MRA.

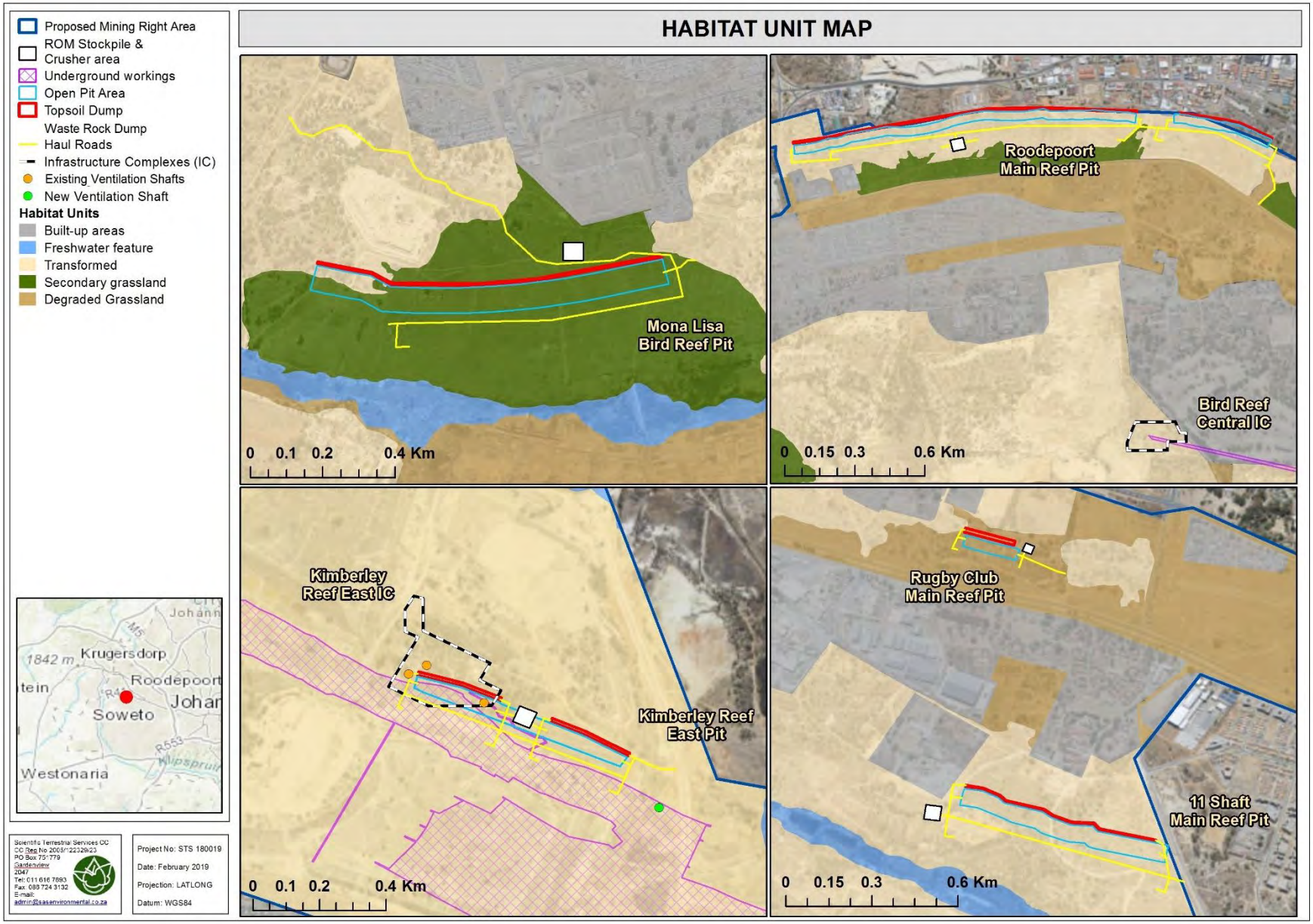
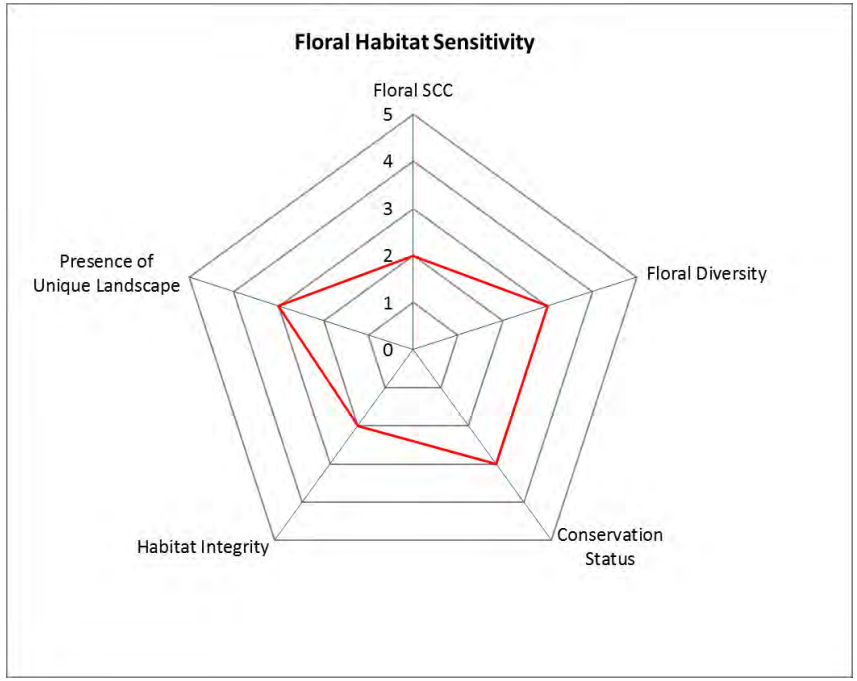


Figure 2: Conceptual illustration of the habitat units within the focus areas (Zoomed in).

3.2 Habitat Unit 1: Secondary Grassland Habitat Unit

Habitat Unit:	Floral Habitat Sensitivity	Moderately low
Secondary Grassland	**Notes on Photograph:** **Top**: Typical view of the Secondary Grassland that is present within the focus area. **Bottom:** Rocky patches that are present within the Secondary Grassland.	

Floral Habitat Sensitivity Graph

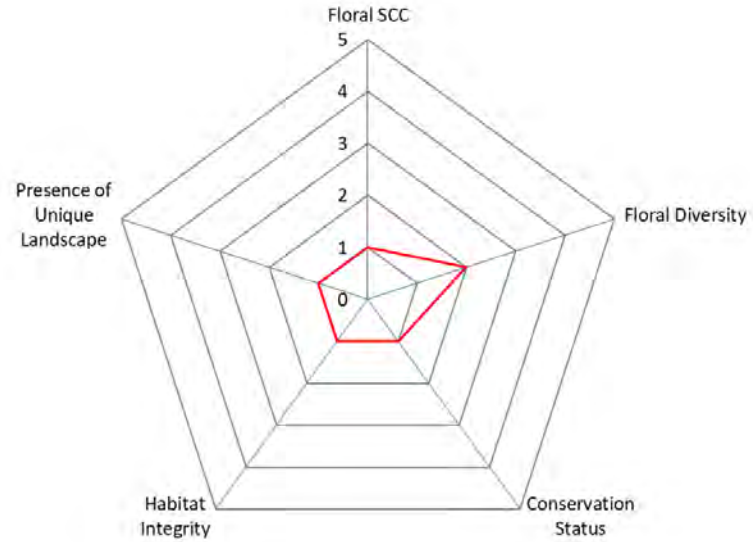


Floral Species of Conservation Concern (SCC)	No floral SCC were encountered during the winter and summer field assessments, however, based on distribution records, *Hypoxis hemerocallidea* (Declining) and *Boophone disticha* (Declining) may potentially occur within the focus area. These floral SCC species are harvested for traditional medicinal purposes, with overharvesting being a major contributing factor to the decline of many floral SCC in Gauteng. The Secondary Grassland habitat has been modified by historical and current anthropogenic activities. These activities include mining, housing development, indiscriminate disposal of rubble and the proliferation of alien and invasive plants. The likelihood of any floral SCC occurring within these habitat units is decreased by the close proximity to the surrounding communities.	**Presence of Unique Landscapes**	No unique landscapes are associated with the focus area. Activities causing degradation of the landscape include mining, housing development, indiscriminate disposal of rubble, and alien and invasive plant proliferation.
Floral Diversity	Floral species diversity associated with the Secondary Grassland Habitat Unit is considered to be intermediate, as the abundance of alien and invasive floral species and garden ornamentals such as *Eucalyptus camaldulensis*, *Acacia mearnsii*, *Tagetes minuta* and *Melia azedarach* were observed during the field assessment. Floral species such as *Aristida congesta*, *Eragrostis chloromelas, Cynodon dactylon, Melinis repens* and *Eragrostis curvula,* considered to be common and widespread, were present throughout the focus areas. The majority of the grass species present within the Secondary Grassland is classified as Increaser 2 species, which normally increase in density in over-utilized, trampled or disturbed veld. Refer to Appendix F for a more detailed floral species list.	Business Case, Conclusion and Mitigation Requirements: The secondary grassland habitat unit associated with the focus area is of moderately low ecological importance and sensitivity. The proposed mining activities would therefore have a moderately low impact on the floral component of the focus areas, as transformation has already occurred. No floral SCC were found during the summer and winter assessments. Taking into consideration the existing urban surroundings and edge effects thereof, it is recommended that an Alien and Invasive Plant Control Plan be developed and implemented to reduce the negative impact of alien and invasive plant species within the focus areas.	
Conservation Status of Vegetation Type / Ecosystem	The focus area falls within the Soweto Highveld Grassland vegetation type (Mucina and Rutherford, 2012), indicated to be an Endangered vegetation type. According to the Mining and Biodiversity Guidelines (2013) the Rugby Club Main Reef Pit, a small part on the eastern side of the 11 Shaft Main Reef Pit, and the entire Mona Lisa Bird Reef Pit are located within areas of Highest Biodiversity Importance. The northern-most portion of the proposed MRA overlaps with a larger area of High Biodiversity Importance. The Bird Reef Central infrastructure complex and the Roodepoort Main Reef Pit falls within areas of High Biodiversity Importance. The central parts of the proposed MRA fall within areas of Moderate Biodiversity Importance. The MRA is also surrounded by areas of Moderate Biodiversity Importance. The 11 Shaft Main Reef Pit, Kimberley Reef East Pit and the Kimberley Reef East Infrastructure complex are situated within areas of Moderate Biodiversity Importance. Due to historic mining activities and current anthropogenic activities within focus areas, it is no longer considered representative of this vegetation type, and it is thus considered to be of low conservation importance. According to the Gauteng Conservation Plan (C-Plan V3.3, 2011), none of the Infrastructure Complexes falls within a CBA. The Mona Lisa Bird Reef Pit and the Rugby Club Main Reef Pit opencast and associated infrastructure areas fall within a CBA. Although none of the Infrastructure Areas are located within an ESA, the 11 Shaft Main Reef Pit partly intersects an ESA. However, ecological conditions encountered on-site are not representative of conditions which define an ESA nor CBA as a result of the degraded floral ecology associated with the focus areas.		
Habitat integrity / Alien and Invasive species	The habitat has been modified by historic mining activities and invasion by indigenous species such as *Seriphium plumosum.* Stands of alien and invasive plants such as *Eucalyptus camaldulensis* were encountered throughout the focus area.		

3.3 Habitat Unit 2: Degraded Grassland Habitat Unit

Habitat Unit:	Floral Habitat Sensitivity	Low
Degraded Habitat	**Notes on Photograph:** Stands of *Eucalyptus* and *Pinus* species with weedy alien vegetation dominant in the forb layer as observed during the field assessments.	

Floral Habitat Sensitivity Graph



Floral Species of Conservation Concern (SCC)	No floral SCC were encountered during the summer and winter field assessments, which can be attributed to the extent of habitat degradation and transformation within the habitat unit. It is thus highly unlikely that any other floral SCC will occur within the habitat unit.	**Presence of Unique Landscapes**	No unique landscapes are associated with the focus areas. Activities causing degradation of the landscape include mining, housing development, indiscriminate disposal of rubble, and alien and invasive plant proliferation were noted.
Floral Diversity	Floral diversity is moderately low. *Eucalyptus camaldulensis, Eucalyptus sideroxylon, Melia azedarach* and *Pinus patula* forms the woody component of the tree stands. The herbaceous layer predominantly consists of a grass layer, interspersed with numerous weedy AIPs that are associated with disturbed places – most notably *Bidens pilosa* and *Tagetes minuta*. The grass layer is not representative of the Soweto Highveld Grassland and dominant species includes *Aristida congesta* subsp. *congesta, Chloris virgata, Cynodon dactylon, Digitaria eriantha* and *Urochloa mosambicensis.* The herbaceous species present within the Degraded Grassland habitat is a clear indication that the area is disturbed as the majority of the species are classified as Increaser 2 species.	**Business Case, Conclusion and Mitigation Requirements:**	The Degraded Grassland habitat units associated with the focus areas are of low ecological importance and sensitivity. The proposed mining activities would therefore have a low impact on the floral component of the focus areas, as transformation has already occurred. No floral SCC were observed during the summer and winter assessments, and none are likely to be present within the Degraded Grassland habitat unit. Taking into consideration the existing urban surroundings and edge effects thereof, it is recommended that an Alien and Invasive Plant Control Plan be developed and implemented to reduce the negative impact of alien and invasive plant species within the focus areas.
Conservation Status of Vegetation Type/Ecosystem	The focus area falls within the Soweto Highveld Grassland vegetation type (Mucina and Rutherford, 2012), indicated to be an Endangered vegetation type. According to the Mining and Biodiversity Guidelines (2013) the Rugby Club Main Reef Pit, a small part on the eastern side of the 11 Shaft Main Reef Pit, and the entire Mona Liza Bird Reef Pit are located within areas of Highest Biodiversity Importance. The northern-most portion of the MRA overlaps with a larger area of High Biodiversity Importance. The Bird Reef Central infrastructure complex and the Roodepoort Main Reef Pit falls within areas of High Biodiversity Importance. The central parts of the proposed MRA fall within areas of Moderate Biodiversity Importance. The proposed MRA is also surrounded by areas of Moderate Biodiversity Importance. The 11 Shaft Main Reef Pit, Kimberley Reef East Pit and the Kimberley Reef East Infrastructure complex are situated within areas of Moderate Biodiversity Importance. Due to historic mining activities and current anthropogenic activities within focus areas, it is no longer considered representative of this vegetation type, and it is thus considered to be of low conservation importance. According to the Gauteng Conservation Plan (C-Plan V3.3, 2011), none of the Infrastructure Complexes falls within a CBA. The Mona Lisa Bird Reef Pit and the Rugby Club Main Reef Pit opencast and associated infrastructure areas fall within a CBA. Although none of the Infrastructure Areas are located within an ESA, the 11 Shaft Main Reef Pit partly intersects an ESA. However, ecological conditions encountered on-site are not representative of conditions which define an ESA nor CBA as a result of the degraded floral ecology associated with the focus areas.		
Habitat integrity/Alien and Invasive species	The Degraded Grassland habitat unit is not representative of the Soweto Highveld Grassland. The vegetation is dominated by alien and invasive and ornamental plants with very few indigenous species remaining. Habitat integrity is classed as low because of the proliferation of alien and invasive plant species.		

3.4 Floral Species of Conservation Concern Assessment

Threatened species are those species facing a high risk of extinction for various reasons such as habitat loss, unsustainable use and so forth. Any species which is classified by the IUCN as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) is considered to be a threatened species. Floral Species of Conservation Concern (SCC) 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 and Declining.

An assessment considering the presence of any floral SCC, as well as suitable habitat to support any such species, was undertaken. The SANBI PRECIS Red Data Listed plants and GDARD conservation list was acquired for the Quarter Degree Square (QDS) 2627BB in order to ascertain which floral species may be expected to occur within the focus area, based on distribution records.

During the field assessment, no floral SCC was observed. Based on the results obtained *Hypoxis hemerocallidea* (Declining) and *Boophone disticha* (Declining) have the highest probability of occurrence within the focus area, but this is still below 60%. This is attributed to the level of habitat transformation already associated with the proposed MRA and immediate surrounds. However, should any floral SCC be encountered during any phase of the proposed mining activity, a suitably qualified specialist should be contacted in order to ascertain the best way forward. In some instances, it might be necessary to obtain rescue and relocation permits from the pertinent authorities.

3.5 Alien and Invasive Plant Species

Alien and invasive floral species are floral species that are of exotic origin and are invading previously pristine areas or ecological niches. Not all weeds are exotic in origin but, as these exotic plant species have very limited natural “check” mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem (Bromilow, 2001). Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process, however, takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the

disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;
- Ecological imbalance;
- Decreased productivity of grazing pastures; and
- Increased agricultural input costs.

During the floral assessment, dominant alien and invasive floral species were identified and are listed in the table below.

Of the alien species recorded during the field assessment (Table 4 below), sixteen are listed as NEMBA Category 1b, three as NEMBA Category 2 and one as NEMBA Category 3. The remainder are not considered invasive but are still considered problem plants in South Africa (Bromilow, 2001). The majority of alien species comprised forbs and woody species, with some areas being more invaded than others, e.g. areas with higher disturbance have both a higher abundance and density of AIP (roadsides, Transformed habitat unit).

Alien species located within the mining footprint areas need to be removed on a regular basis as part of maintenance activities according to the National Environmental Management: Biodiversity Act (Act 10 of 2004): Alien and Invasive Species Regulations, GN R864 of 2016 as it relates to the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004): Alien and Invasive Species Regulations.

Table 4: Dominant alien floral species identified during the summer and winter field assessments with their invasive status as per NEMBA: Alien and Invasive Species Lists, GN R598 of 2016.

WOODY SPECIES			
Scientific Name	Common Name	Category*	Habitat Unit
Acacia mearnsii	Black Wattle	2	Secondary Grassland and Degraded Grassland
Agave sisalana	Spreading century-plant	1b	Degraded Grassland
Ailanthus altissima	Tree-of-heaven	1b	Degraded Grassland
Eucalyptus camaldulensis	Red River Gum	a.) Category 1b within- (i) riparian areas; (ii) a Protected Area declared in terms of the Protected Areas Act; or, (iii) within a Listed Ecosystem or an ecosystem identified for conservation in terms of a Bioregional Plan or Biodiversity Management Plans published under the Act.	Secondary and Degraded Grassland and Transformed Habitat

		c.) Category 1b in Fynbos, Grassland, Savanna, Albany Thicket, Forest and Indian Ocean Coastal Belt biomes, but- (ii) Not listed within cultivated land that is at least 50 metres away from untransformed land, but excluding within any area in (a) above.	
Eucalyptus sideroxylon	Red ironbark	N/L	Degraded Grassland
Gleditsia triacanthos	Honey locust	1b	Degraded Grassland
Melia azedarach	Syringa	a. Category 1b b. Category 3 in urban areas.	Degraded Grassland and Secondary Grassland
Morus alba	White mulberry, Silkworm mulberry	3	Transformed Habitat and Freshwater Features
Pinus patula	Jelecote pine, Mexican weeping pine	2	Transformed Habitat and Degraded Grassland
Populus x canescens	Grey poplar	2	Transformed Habitat and Freshwater Features
Robinia pseudoacacia	Black locust	1b	Transformed Habitat
Solanum mauritianum	Bug weed	1b	Transformed Habitat
Ulmus parvifolia	Chinese elm	N/L	Transformed Habitat
FORBS			
Scientific Name	Common Name	Category*	Habitat Unit
Araujia sericifera	Moth Catcher	1b	Secondary and Degraded Grassland and Transformed Habitat
Bidens formosa	Cosmos	N/L	Secondary Grassland and Transformed Habitat
Bidens pilosa	Black Jack	N/L	Secondary and Degraded Grassland and Transformed Habitat
Canna indica	Canna	1b	Transformed Habitat
Campuloclinium macrocephalum	Pompom weed	1b	Secondary Grassland
Datura stramonium		1b	Transformed Habitat
Gomphrena celosioides	Bachelor's button, Prostrate globe-amaranth	N/L	Transformed Habitat
Ipomoea purpurea		1b	Degraded Grassland and Transformed Habitat
Opuntia ficus-indica		1b	Transformed Habitat
Solanum elaeagnifolium	Silverleaf nightshade	1b	Transformed Habitat
Tagetes minuta	Khaki bush, Khaki weed, African marigold	N/L	Secondary and Degraded Grassland and Transformed Habitat
Verbena aristigera	Maynes Pest	N/L	Transformed Habitat
Verbena bonariensis	Wild verbena, Tall verbena, Purple top	1b	Transformed Habitat and Freshwater Features
Zinnia peruviana	Peruvian zinnia	N/L	Transformed Habitat
GRASSES / SEDGES			
Scientific Name	Common Name	Category*	Habitat Unit
Arundo donax	Giant reed, Spanish reed	1b	Transformed Habitat and Freshwater Features
Bromus catharticus	Rescue Grass	N/L	Transformed Habitat
Cynodon dactylon	Couch grass, Quick grass	N/L	Secondary and Degraded Grassland and Transformed Habitat

Pennisetum cladestinum		a. 1b in Protected Areas and wetlands in which it does not already occur. b. Not listed elsewhere.	Transformed Habitat

1a: Category 1a – Invasive species that require compulsory control.
1b: Category 1b – Invasive species that require control by means of an invasive species management programme.
2: Category 2 – Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread.
3: Category 3 – Ornamentally used plants that may no longer be planted; existing plants may remain, except within the flood line of watercourses and wetlands, as long as all reasonable steps are taken to prevent their spread (Bromilow, 2001).

3.6 Medicinal Floral Species

Medicinal plant species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The table below presents a list of dominant plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment.

Table 5: Dominant traditional medicinal floral species identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Boophone disticha	Century plant, Poison bulb, Sore-eye flower	Bulb scales are used.	*B. disticha* has many medicinal uses. Traditional healers use it to treat pain and wounds. Parts of the plant are used by certain African tribes and also by some Europeans to cure various ailments: the outer covering of the bulb is applied to boils and abscesses; fresh leaves are used to stop bleeding of wounds.
Gomphocarpus fruticosus	Milkweed, Wild Cotton	Leaves mainly used, sometimes the roots.	Leaves are used as snuff and as a sedative in the treatment of headache and tuberculosis. Roots are used to relieve stomach pain and general aches in the body.
Hypoxis hemerocallidea	African star grass or African potato	Tuberous rootstock (corm).	Dizziness, bladder infections and insanity are treated by using the infusions of the corm as an emetic. Stems and leaves can be used with other ingredients to treat prostate problems. Within the past couple of years, *H. hemerocallidea* has become commercialised as a source of extracts used in prostate preparations, as well as in various tonics and so-called immune boosting preparations.
Leonotis ocymifolia var. *raineriana*	Wild dagga	Mainly leaves and stems used, sometimes roots are also utilised	The plant has been smoked for the relief of epilepsy. The use of wild dagga as a narcotic is not deemed plausible – only mildly narcotic. Leaves and roots used for bites and stings, though more common for snake bites. As a decoction for external use, the wild dagga can be applied to treat boils, eczema, skin diseases, itching and muscular cramps. Internal decoction uses for coughs, colds and influenza, bronchitis, high blood pressure and headaches. Leaf infusions have been used for asthma and viral hepatitis.
Tagetes minuta	Khaki bush, Khaki weed, African marigold	Leaves, stalks and flowers	It is also grown commercially in South Africa, France and North America for its essential oil. The oil is very effectively used for wounds and a wide variety of infections.

The species listed in the table above are common, widespread species and not confined to the focus area; nor are they unique within the region. However, *Hypoxis hemerocallidea* and *Boophone disticha* are classified as Declining in the Gauteng Province, mainly due to the rapid urbanisation in Gauteng, which has caused a decline in available natural habitat. These

species, if present, would need to be rescued and relocated to suitable habitat outside of the disturbance footprint area, which should be undertaken by a qualified specialist.

4 SENSITIVITY MAPPING

Figure 3 below conceptually illustrates the areas considered to be of increased ecological sensitivity with the proposed mining development areas overlaid. The areas are depicted according to their sensitivity in terms of the presence or potential for floral SCC, habitat integrity and levels of disturbance, threat status of the habitat type, the presence of unique landscapes and overall levels of diversity. The table below presents the sensitivity of each identified habitat unit along with an associated conservation objective and implications for development.

Table 6: A summary of sensitivity of each habitat unit and implications for the proposed mining development areas.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
Freshwater features	Intermediate	Preserve and enhance biodiversity of the habitat unit and surrounds while optimising development potential.	This habitat unit is of intermediate ecological sensitivity, predominantly due to the presence of this feature and the protection thereof. Several watercourses were identified within the proposed MRA. A Channelled Valley Bottom Wetland feature (CVB2) was identified approximately 200 m from the proposed Mona Lisa Brid Reef Pit and another Channelled Valley Bottom Wetland feature (CVB3) was identified approximately 50 m from the proposed 11 Shaft Main Reef Pit. The CVB3 wetland features also extend approximately 400 m east of the Kimberley Reef East Pit and Kimberley Reef East IC.
Secondary Grassland	Moderately Low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.	The floral composition present within the focus areas are considered to be in a transition between a pioneer and sub-climax state as a result of anthropogenic activities which have contributed to alien and invasive plant proliferation. This results in a moderately low ecological importance and sensitivity for the Secondary Grassland Habitat Unit. Therefore, it is highly unlikely to support any floral SCC. The proposed mining activities are therefore likely to have moderately low to low impact significance on the habitat unit, given the degree of historical disturbances, leading to the current transformed ecological state.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
Degraded Grassland Transformed Grassland Built-up areas	Low	Optimise development potential.	No floral SCC were found in these habitat units, as preferred habitat is not present. Taking into consideration the existing urban surroundings and edge effects thereof, and low diversity of indigenous floral species, proposed mining activities are therefore likely to have a low impact significance on the flora habitat.

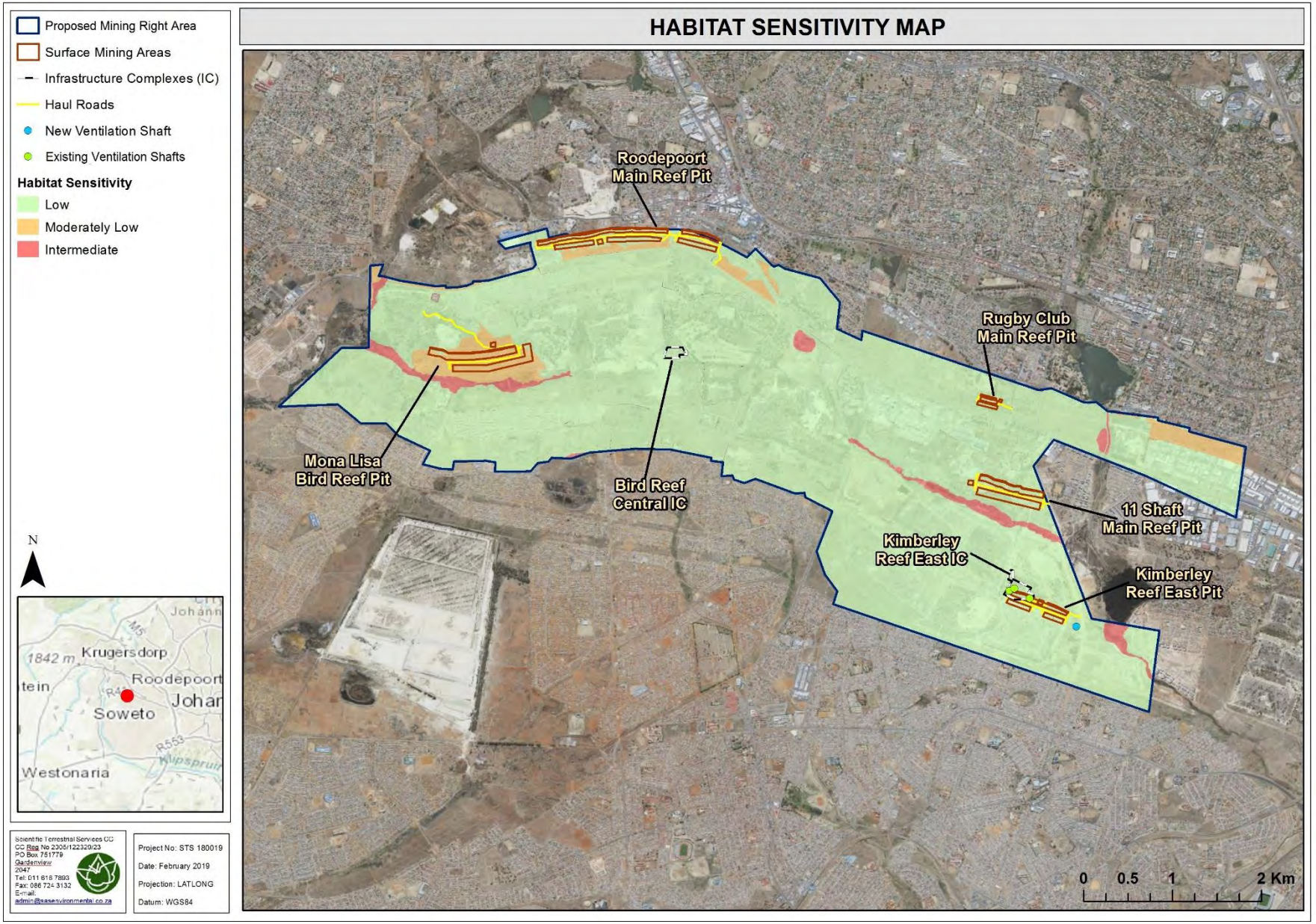


Figure 3: Sensitivity map for the proposed MRA.

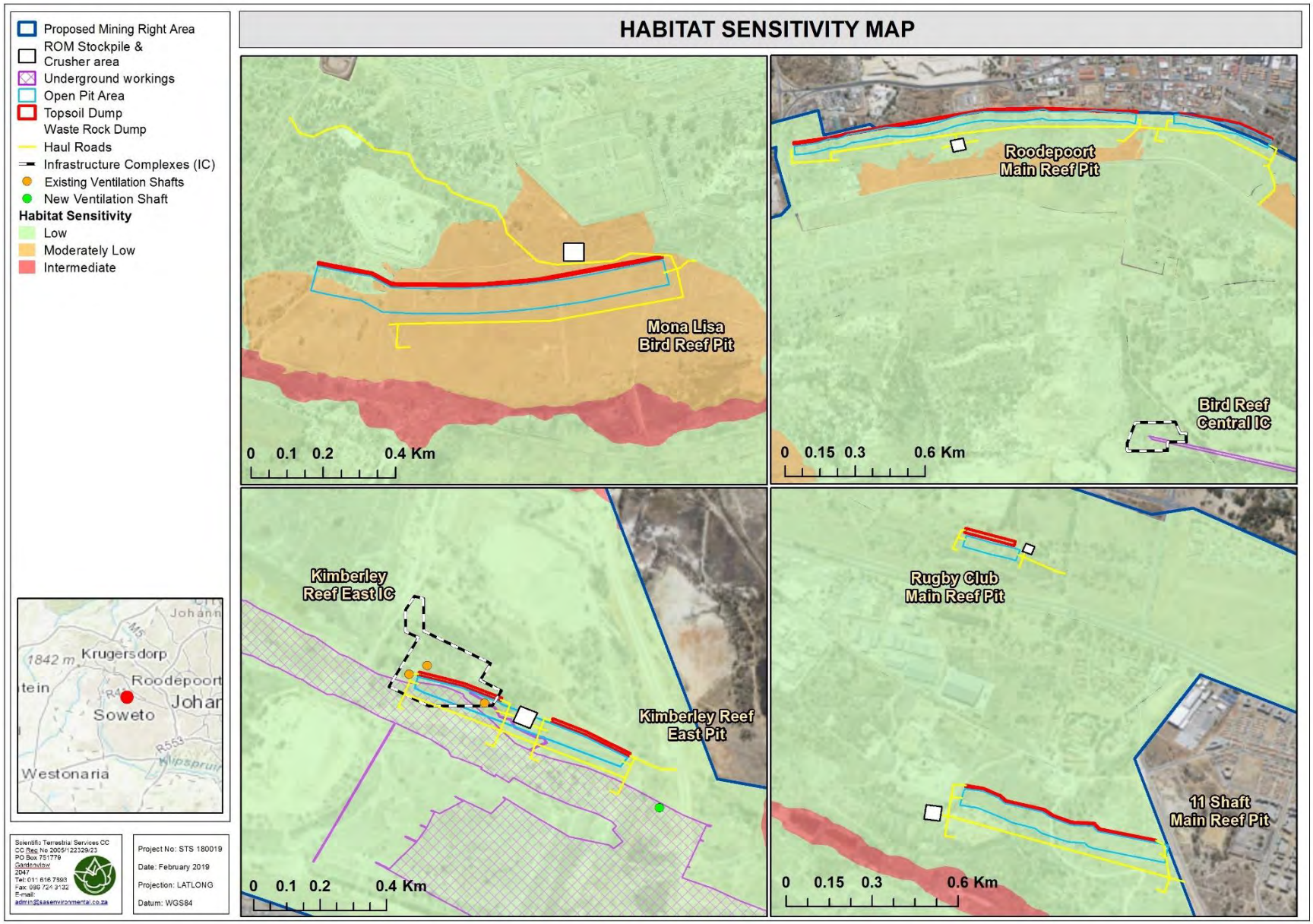


Figure 4: Conceptual illustration of the sensitivities within the focus areas (Zoomed in).

5 IMPACT ASSESSMENT

Tables 9 and 10 summarise the significance of perceived impacts on the terrestrial ecology of the focus area, according to the method described in Appendix C, with each impact identified presented in Section 5.1 and 5.2 of this report. All impacts are considered without mitigation taking place as well as with mitigation fully implemented. A summary of all potential construction, operational, as well as rehabilitation and maintenance impacts, are provided in Section 5.3. All the required mitigatory measures needed to minimise the impact is presented in Section 5.4.

The table below illustrates the anticipated timeline on the proposed mining activities. The duration of the proposed activities will also be incorporated and considered when assessing the impact and impact scoring.

Table 7: Timing associated with the implementation of the proposed mining activities [as per the EIA & EMP, March 2019 (SLR)].

Activity		Timeline												
		Year 1				Year 2				Year 3	Year 4	Year 5	Year 6 -25	year 26	Year 27 - 28
Opencast mining and concurrent rehabilitation															
Rugby Club Main Reef Pit	Mining														
	Rehabilitation														
Roodepoort Main Reef Pit	Mining														
	Rehabilitation														
11 Shaft Main Reef Pit	Mining														
	Rehabilitation														
Mona Lisa Bird Reef Pit	Mining														
	Rehabilitation														
Kimberley Reef East Pit	Mining														
	Rehabilitation														
Continued opencast rehabilitation and construction of infrastructure complexes															
Underground mining operations															
Steady state production achieved															
Decommissioning and closure															
Aftercare and maintenance															

Activities which are likely to negatively impact floral species within the focus area include, but are not limited to, the following:

- Clearing of vegetation during construction and operational activities;
- Alien and invasive floral proliferation and erosion in disturbed areas;
- Increased possibility of collection of medicinal plants; and
- Edge effects compromising habitat integrity through, e.g., enabling alien vegetation to proliferate, decreasing habitat connectivity and increasing the extent of transformed habitat with little chance of habitat restoration.

Activities and aspects register

Table 8 identifies potential activities that might take place during the various phases of the proposed development, which could impact on the floral ecology of the area. It should be noted that these activities listed in the table below were utilised during the impact assessment as pre-mitigated impacts to ascertain the significance of the perceived impacts prior to mitigation measures.

Table 8: Potential activities that might take place during the various phases of the proposed mining project.

Pre-Operational	Operational		Decommissioning, Rehabilitation & Closure
Design of infrastructure, leading to a larger than expected infrastructure footprint. This will result in loss of floral species and habitat.	Site clearing and the removal of vegetation due to the construction of haul roads, and IC's leading to a loss of floral habitat.	On-going disturbance of soils due to general operational activities leading to altered floral habitat.	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan.
Failure to initiate a biodiversity action plan, rehabilitation plan and alien floral control plan during the pre-operational phase.	Encroachment of operational activities beyond the extent of the proposed project footprint leading to loss of habitat and proliferation of alien and invasive flora species.	Increased introduction and proliferation of alien plant species and further transformation of natural habitat.	Ineffective repacking of soils during the backfilling activities, leading to altered soil profiles and poor establishment of indigenous flora.
	Site clearing and the disturbance and compaction of soils leading to loss of floral habitat.	Runoff and seepage from operational facilities such as the waste rock dump may lead to habitat loss.	Compacted soils limiting the re-establishment of natural vegetation.
	Movement of construction vehicles and access road construction beyond the project footprint leading to a loss of floral habitat.	Soil erosion as a result of operational activities leading to a loss of floral species diversity.	Failure to implement and manage biodiversity action plan, rehabilitation plan, alien and invasive control plan.

Pre-Operational	Operational		Decommissioning, Rehabilitation & Closure
	Dumping of material outside designated areas leading to loss of floral habitat.	Increased fire frequency and intensity, as well as uncontrolled fires during operational activities due to increased human activity impacting on floral.	Potential contamination from decommissioning of the project facilities.
	Edge effects such as erosion and alien species proliferation leading to loss of floral habitat in the surrounding areas.	Dust generation during operation leading to a loss of floral habitat.	
	Compaction of soils reducing the efficiency of floral re-establishment in surrounding areas	Removal or collection of medicinal floral species within the MRA.	
		Additional pressure on floral habitat by increased human populations associated with the proposed mine leading to a loss of floral habitat.	

5.1 IMPACT 1: Impact on Habitat and Diversity for Floral Species

5.1.1 Impact on the Floral Habitat Integrity and Species Diversity of the Secondary Grassland Habitat Unit

The Secondary Grassland habitat unit is considered to be of moderately low sensitivity in terms of floral ecology, this is due to the disturbed nature of the area as a result of historic and ongoing anthropogenic activities, resulting in floral species that could adapt to these conditions to be dominant. The impact associated with the loss of floral habitat is considered to be of medium significance during all phases of the proposed development prior to the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance may further be reduced to low levels.

Unmanaged						
	Severity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	M	L	M	H	Medium
Decommissioning, rehabilitation and closure phase	M	M	L	M	H	Medium
Managed						
	Severity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	L	L	L	M	Low
Decommissioning, rehabilitation and closure phase	M	L	L	L	L	Low
Mitigation Measures	The Mona Lisa Bird Reef Pit is the only mining infrastructure that is located within the Secondary Grassland Habitat unit. Areas adjacent to the Roodepoort Main Reef Pit is associated with the Secondary Grassland habitat unit. * Footprint and daily operations of these two infrastructure and mining areas must be strictly monitored to ensure edge effects from the operational facilities and activities does not affect the surrounding floral habitat that is located outside of the pit footprint. * The footprint area of all facilities must be clearly demarcated and minimised to what is essential to avoid unnecessary disturbance of floral habitat. * An effective dust management plan must be designed and implemented in order to mitigate the impact of dust on flora throughout all mining and development phases. * Adequate stormwater management must be incorporated into the design of the proposed mining activities throughout all phases in order to prevent erosion of topsoil and the loss of floral habitat. * Edge effects of all operational activities, such as erosion and alien and invasive plant species proliferation, which may affect adjacent Secondary Grassland habitat within surrounding areas, need to be strictly managed adjacent to the proposed infrastructure footprint areas. Specific mention in this regard is made to Category 1b species identified within the development footprint areas. * Ongoing alien and invasive plant monitoring and eradication/control should take place throughout the operational and closure/ decommissioning phases of the development, and the project perimeters should be regularly checked during the operational phase for alien and invasive plant proliferation to prevent spread into surrounding natural areas. *An alien and invasive floral control plan must be designed and implemented in order to monitor and control alien floral recruitment in disturbed areas. The alien floral control plan must be implemented for a period of 5 years after decommissioning and closure. * Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a suitable specialist. This rehabilitation plan should consider ongoing rehabilitation during the operational phase of the project as well as rehabilitation actions to be undertaken during mine closure. * All soils compacted as a result of operational activities falling outside of the proposed infrastructure areas should be ripped and profiled. Special attention should be paid to alien and invasive plant control within these areas. * Any post-mining re-vegetation exercise should use locally indigenous species, and as far as possible, indigenous plants naturally growing within the habitat unit where the mining infrastructure is situated must be used. * Concurrent/progressive rehabilitation must be implemented at all times, and disturbed areas must be rehabilitated as soon as such areas become available. This will not only reduce the total disturbance footprint but will also reduce the overall rehabilitation effort and cost. * Rehabilitation trials must be continuously undertaken from the commencement of construction in order to determine the efficiency of rehabilitation methods and the suitability of flora propagated in the nursery for rehabilitation. * As much vegetation growth as far possible should be promoted within the proposed surface infrastructure area in order to protect soils during the rehabilitation phase.						

	* Rehabilitation efforts and monitoring thereof must be implemented for a period of at least five years after decommissioning and closure.

5.1.2 Impact on the Floral Habitat Integrity and Species Diversity of the Degraded Grassland Habitat Unit

The integrity of the Degraded Grassland habitat unit, consisting of stands of AIP trees such as *Eucalyptus* and *Pinus patula* is high. No floral SCC was found in this habitat unit, as preferred habitat is not present, taking into consideration the existing urban surroundings and edge effects thereof, and low diversity of indigenous floral species.

The impact associated with the floral habitat integrity of the Degraded Grassland habitat unit is considered to be medium significance impacts during all phases of the proposed mining activities before the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance of the loss of important species may be even further reduced to low significance levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	M	L	L	M	Medium
Decommissioning, rehabilitation and closure phase	L	M	L	L	M	Medium
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	M	L	L	L	Low
Decommissioning, rehabilitation and closure phase	L	L	L	L	L	Low
Mitigation Measures	The Rugby Club Main Reef Pit is the only mining infrastructure that is located within the Degraded Grassland Habitat unit. The remainder of the pits and the infrastructure complexes are located within Transformed habitat. * The footprint area of all facilities must be clearly demarcated and minimised to what is essential to avoid unnecessary disturbance of floral habitat. * An effective dust management plan must be designed and implemented in order to mitigate the impact of dust on flora throughout all mining and development phases. * Adequate stormwater management must be incorporated into the design of the proposed mining activities throughout all phases in order to prevent erosion of topsoil and the loss of floral habitat. * Ongoing alien and invasive plant monitoring and eradication/control should take place throughout the operational and closure/ decommissioning phases of the development, and the project perimeters should be regularly checked during the operational phase for alien and invasive plant proliferation to prevent spread into surrounding natural areas. *An alien and invasive floral control plan must be designed and implemented in order to monitor and control alien floral recruitment in disturbed areas. The alien floral control plan must be implemented for a period of 5 years after decommissioning and closure. *All soils compacted as a result of operational activities falling outside of the proposed infrastructure areas should be ripped and profiled. Special attention should be paid to alien and invasive plant control within these areas.					

	* Any post-mining re-vegetation exercise should use locally indigenous species, and as far as possible, indigenous plants naturally growing within the habitat unit where the mining infrastructure is situated must be used. * Concurrent/progressive rehabilitation must be implemented at all times, and disturbed areas must be rehabilitated as soon as such areas become available. This will not only reduce the total disturbance footprint but will also reduce the overall rehabilitation effort and cost. * Rehabilitation trials must be continuously undertaken from the commencement of construction * Rehabilitation efforts must be implemented for a period of at least five years after decommissioning and closure.

5.2 IMPACT 2: Impact on Floral Species of Conservation Concern

5.2.1 Floral Species of Conservation Concern within the Secondary Grassland Habitat Unit

During the field assessment, no floral SCC was observed. Based on the results obtained *Hypoxis hemerocallidea* (Declining) and *Boophone disticha* (Declining) have the highest probability of occurrence within the Secondary Grassland habitat unit. The probability of any additional floral SCC to be present within the Secondary Grassland Habitat is deemed moderate, due to the current disturbances and the lack of suitable growing conditions for the evaluated species.

The impact associated with the loss of floral SCC is considered to be of medium significance during all phases of the proposed mining activities, before the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance of the loss of important species may be even further reduced to low significance levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	M	L	M	M	Medium
Decommissioning, rehabilitation and closure phase	M	M	L	M	M	Medium
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	L	L	L	L	Low
Decommissioning, rehabilitation and closure phase	M	L	L	L	L	Low

Mitigation Measures	* No collection of firewood, floral SCC (where applicable) or medicinal floral species must be allowed by construction or mining personnel. * During the surveying and site-pegging phase of surface infrastructure, a search and rescue for all floral SCC that will be affected by surface infrastructure must be done, marked and where possible, relocated to suitable habitat surrounding the disturbance footprint. The relevant permits (where necessary) must be applied for within the relevant province as indicated in the baseline floral assessment, prior to the construction phase. * Floral SCC is to be handled with care and the relocation of these plant species to nearby suitable similar habitat is to be overseen by a suitably qualified botanist. * Edge effect control needs to be implemented to ensure no further degradation and potential loss of floral SCC outside of the proposed project footprint area. * It must be ensured that operational related activities are kept strictly within the development footprint.

5.2.2 Floral Species of Conservation Concern within the Degraded Grassland Habitat Unit

No floral SCC was encountered within the Degraded Grassland habitat unit and, due to the disturbance and loss of suitable habitat therein, Probability of Occurrence (POC) of floral SCC is expected to be low. The impact associated with the loss of habitat and species diversity for floral SCC within this habitat unit is considered to be of medium to low significance during all phases of the proposed mining activities. With the implementation of mitigation measures, the impact significance of the loss of important species may be even further reduced to low significance levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	M	L	M	L	Low
Decommissioning, rehabilitation and closure phase	M	L	L	L	L	Low
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	L	L	L	L	Low
Decommissioning, rehabilitation and closure phase	L	L	L	L	L	Low
Mitigation Measures	* No collection of firewood, floral SCC (where applicable) or medicinal floral species must be allowed by construction or mining personnel. * Edge effect control needs to be implemented to ensure no further degradation and potential loss of floral SCC outside of the proposed project footprint area.					

5.3 Floral Assessment Summary

Tables 9 and 10 below summarise the findings indicating the significance of the impact before mitigation takes place and the likely impact if management and mitigation take place. In consideration of mitigation, it is assumed that a high level of mitigation takes place, but which does not lead to prohibitive costs.

Prior to mitigation, the impacts within the Secondary Grassland Habitat Unit on floral habitat integrity are of medium significance. If effective mitigation takes place, impacts on the floral habitat integrity and species diversity may be reduced to low significance impacts. Moreover, prior to mitigation the impacts within the Secondary Grassland Habitat Unit on floral SCC are medium significance, whereas if effective mitigation takes place, impacts on floral SCC can be reduced to low significance impacts.

For the Degraded Grassland habitat unit, the impacts on the floral habitat integrity and species diversity are of medium significance impacts and for Species of Conservational Concern are of low significance. If effective mitigation takes place, impacts on the floral habitat integrity and species diversity and the floral SCC may be reduced to low significance impacts.

Table 9: A summary of the results obtained from the impact assessment for the operational phase for the focus area.

Impact	Unmanaged	Managed
Secondary Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for floral Species	Medium	Low
Impact on floral Species of Conservation Concern	Medium	Low
Degraded Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for floral Species	Medium	Low
Impact on floral Species of Conservation Concern	Low	Low

Table 10: A summary of the results obtained from the impact assessment for the decommissioning and closure phase for the focus area.

Impact	Unmanaged	Managed
Secondary Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for floral Species	Medium	Low
Impact on floral Species of Conservation Concern	Medium	Low
Degraded Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for floral Species	Medium	Low
Impact on floral Species of Conservation Concern	Low	Low

5.4 Floral Resource Impact Mitigation

Based on the findings of the following general floral ecological recommendations are made in addition to those mentioned in the impact assessment summary in section 5.2, to minimise the impact on the floral ecology of the area, should the proposed mining development proceed:

- Any disturbance of floral habitat and flora SCC, should they be present must be actively avoided or rescue and relocation activities must be implemented.
- Sensitive freshwater resource habitat and associated buffer zones must be designated as No-Go areas, and no mining vehicles, personnel, or any other mining-related activities are to encroach upon these areas.
- All potentially affected wetland systems must be monitored for moisture stress and all potentially affected wetland areas must be monitored for changes in vegetation structure.
- Any natural areas, including freshwater feature areas, beyond the development footprint that have been affected by the operational activities must be rehabilitated using indigenous grass species and the addition of indigenous bushveld tree species. All rehabilitated areas should be rehabilitated to a point where natural processes will allow the pre-development ecological functioning and biodiversity of the area to be re-instated.

5.5 Cumulative Impacts

The proposed MRA is located within an area of increasing pressure from current and historic mining and residential / industrial development. Significant habitat loss has already occurred within the surrounding area as a result of historical mining activities and illegal disposal of waste material, with thickets of *Eucalyptus camaldulensis* (indicating historical disturbance). Due to the high levels of disturbance, only commonly occurring floral species were noted within proposed MRA. Mining activities and the associated infrastructure will result in a loss of floral habitat and species diversity and will thus contribute to the overall impact in the area. Therefore, it is vital that rehabilitation measures be implemented within a phased manner as opencast activities are completed to ensure that the habitat and species diversity of the area is restored or reinstated.

6 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to conduct a terrestrial ecological assessment as part of the Environmental Impact Assessment process for an application for a

Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The objective of this study was to provide sufficient information on the floral ecology of the area, together with other studies on the physical and socio-cultural environment for the Environmental Assessment Practitioner (EAP) and the relevant authorities to apply the principles of Integrated Environmental Management (IEM) and the concept of sustainable development. The needs for conservation as well as the risks to other spheres of the physical and socio-cultural environment need to be compared and considered along with the need to ensure economic development of the country.

Based on the findings of the ecological assessment, from a floral ecological perspective, the proposed mining activity poses minimal risk to the floral resource management and conservation initiatives for the area, due to the significantly decreased ecological integrity and transformation of the area. However, in order that the significance of perceived impacts remain low, all essential mitigation measures and recommendations presented in this report must be adhered to so as to ensure that the ecology within the proposed Mining Right Area, along with the surrounding zone of influence is protected or adequately rehabilitated where necessary, in order to ensure that the intended post-closure land use objectives are met.

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APPENDIX A: Floral Method of Assessment

Floral Species of Conservation Concern Assessment

Prior to the field assessment, a record of floral SCC and their habitat requirements was acquired from SANBI for the QDS in which the focus area is situated, as well as from relevant national, provincial and regional conservation lists. Throughout the floral assessment, special attention was paid to the identification of any of these SCC as well as the identification of suitable habitat that could potentially support these species.

The Probability of Occurrence (POC) for each floral SCC was determined using the following calculations wherein the distribution range for the species, specific habitat requirements and level of habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research.

Each factor contributes an equal value to the calculation.

Distribution						
	Outside of known distribution range					Inside known distribution range
Site score	0	1	2	3	4	5
Habitat availability						
	No habitat available					Habitat available
Site score	0	1	2	3	4	5
Habitat disturbance						
	0	Very low	Low	Moderate	High	Very high
Site score	5	4	3	2	1	0

[Distribution + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition that was recorded during detailed floral assessments using the step point vegetation assessment methodology. Different transect lines were chosen throughout the entire focus area within areas that were perceived to best represent the various plant communities. Floral species were recorded, and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation types as described in Appendix C of Section A, which serves to provide an accurate indication of the ecological integrity and conservation value of each habitat unit (Evans & Love, 1957; Owensby, 1973).

Floral Habitat Sensitivity

The floral habitat sensitivity of each habitat unit was determined by calculating the mean of five different parameters which influence floral communities and provide an indication of the overall floristic ecological integrity, importance and sensitivity of the habitat unit. Each of the following parameters are subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Floral SCC:** The confirmed presence or potential for floral SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Unique Landscapes:** The presence of unique landscapes or the presence of an ecologically intact habitat unit in a transformed region;
- **Conservation Status:** The conservation status of the ecosystem or vegetation type in which the habitat unit is situated based on local, regional and national databases;
- **Floral Diversity:** The recorded floral diversity compared to a suitable reference condition such as surrounding natural areas or available floristic databases; and
- **Habitat Integrity:** The degree to which the habitat unit is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contribute equally to the mean score, which determines the floral habitat sensitivity class in which each habitat unit falls. A conservation and land-use objective are also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the habitat unit in question. In order to present the results use is made of spider diagrams to depict the significance of each aspect of floral ecology for each habitat unit. The different classes and land-use objectives are presented in the table below:

Table A1: Floral habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Conserve and enhance biodiversity of the habitat unit and surrounds while optimising development potential.
4> and <5	Moderately high	Conserve and enhance the biodiversity of the habitat unit, limit development and disturbance.
5	High	Conserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.

APPENDIX B: Impact Assessment Methodology

Impacts are assessed based on consideration of the impact severity, spatial scale and duration of impacts, which together determine the impact consequence. The impact consequence together with the probability of the impact occurring determine the overall impact significance.

The criteria for determining the severity, spatial scale and duration of potential impacts are presented in Table 1. The criteria are based on the criteria detailed in *DEAT (2002) Specialist Studies, Integrated Environmental Management Information Series 4, Department of Environmental Affairs and Tourism (DEAT), Pretoria*; *DEAT (2002) Impact Significance, Integrated Environmental Management Information Series 5, Department of Environmental Affairs and Tourism (DEAT)* and the criteria and methodology developed by Theo Hacking[2]. Table D1 also provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact).

Table B1: Criteria for the assessment of impacts

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE		Significance = consequence x probability
Definition of CONSEQUENCE		Consequence is a function of severity, spatial extent and duration
Criteria for ranking of the SEVERITY of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

Impact consequence and significance are determined from Table B2 and Table B3. The interpretation of the impact significance is presented in Table B4.

[2] Hacking, Theo (1999) An innovative approach to structuring environmental impact assessment reports. Anglo American Corporation-Envirolink. Unpublished.

Table B2: Method of determining impact consequence

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	H	Medium	Medium	Medium
	Medium term	M	Low	Low	Medium
	Short term	L	Low	Low	Medium
SEVERITY = M					
DURATION	Long term	H	Medium	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Low	Medium	Medium
SEVERITY = H					
DURATION	Long term	H	High	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Medium	Medium	High
			L	M	H
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

Table B3: Method of determining impact and significance

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	H	Medium	Medium	High
	Possible/ frequent	M	Medium	Medium	High
	Unlikely/ seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

Table B4: Interpretation impact significance

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
High	Influences the decision regardless of any possible mitigation.
Medium	Should have an influence on the decision unless it is mitigated.
Low	Will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed project:

- Mitigation and performance improvement measures and actions that address the risks and impacts[3] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and

[3] Mitigation measures should address both positive and negative impacts

- Offsetting.

- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the terrestrial ecology of the resources traversed by or in close proximity of the proposed infrastructure.

APPENDIX C: Floral SCC

Table C1: PRECIS plant list and status for the QDS 2627BB (Raimondo *et al*., 2009; SANBI, www.sanbi.org), with additional information on their threat status as defined in the SANBI Red List Plant status (http://redlist.sanbi.org/index.php), the NEMBA Threatened and Protected Species (TOPS, 2015) of Gauteng, as well as their threat status according to the Gauteng Conservation Plan (C-Plan) V3.3. Information on their distribution and preferred habitat were gathered from The Red List of South African Plants (http://redlist.sanbi.org/index.php). The Potential of Occurrence (POC) of these floral SCC within the focus area is also provided.

Species	Distribution	Habitat	2009 Threat Status (PRECIS)	SANBI Red List Status (2016)	Gauteng TOPS (2015)	POC (%)
Adromischus umbraticola subsp. *umbraticola*	Endemism: South African endemic Provincial distribution: Gauteng, North West Range: Potchefstroom and Zeerust to Cullinan.	Major habitats: Savanna Description: South-facing rock crevices on ridges, restricted to Gold Reef Mountain Bushveld in the northern parts of its range, and Andesite Mountain Bushveld in the south.	N/L	NT	N/L	0%
Alepidea attenuata	Endemism: Not endemic to South Africa Provincial distribution: Gauteng, Limpopo, Mpumalanga Range: Dullstroom, Lydenburg, Machadodorp, Swaziland, Gauteng, Wolkberg Mountains and Sasolburg.	Major system: Terrestrial Major habitats: Grassland Description: Wetlands in grassland up to 2 200 m.	N/L	NT	N/L	0%
Aloe peglerae	Endemism: South African endemic Provincial distribution: Gauteng, North West Range: Magaliesberg and Witwatersberg.	Major system: Terrestrial Major habitats: Gold Reef Mountain Bushveld, Waterberg-Magaliesberg Summit Sourveld, Rand Highveld Grassland Description: Grassland, in shallow, gravely quartzitic soils on rocky, north-facing slopes or summits of ridges.	N/L	CR	EN	0%
Boophone disticha	Endemism: South African endemic Provincial distribution: Gauteng, North West Range: Krugersdorp to Pretoria.	Major habitats: Carletonville Dolomite Grassland, Soweto Highveld Grassland, Egoli Granite Grassland Description: Grassland.	Declining	LC	N/L	33%
Bowiea volubilis subsp. volubilis	Endemism: Not endemic to South Africa Provincial distribution: Eastern Cape, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga Range: Eastern Cape to Limpopo Province. Widespread elsewhere in southern and eastern Africa.	Major system: Terrestrial Major habitats: Gamtoos Thicket, Ohrigstad Mountain Bushveld, Poung Dolomite Mountain Bushveld, Southern Mistbelt Forest, Andesite Mountain Bushveld, Gauteng Shale Mountain Bushveld, Northern Mistbelt Forest, Great Fish Thicket, East Griqualand Grassland, Carletonville Dolomite Grassland, Drakensberg Foothill Moist Grassland, Thukela Thornveld, Queenstown Thornveld, Midlands Mistbelt Grassland, Soutpansberg Mountain Bushveld, Egoli Granite Grassland, Zastron Moist Grassland, Amathole Montane Grassland, Pondoland-Ugu Sandstone Coastal Sourveld, Gabbro Grassy Bushveld, Groot Thicket	N/L	VU	VU	0%

Species	Distribution	Habitat	2009 Threat Status (PRECIS)	SANBI Red List Status (2016)	Gauteng TOPS (2015)	POC (%)
		Description: Low and medium altitudes, usually along mountain ranges and in thickly vegetated river valleys, often under bush clumps and in boulder screes, sometimes found scrambling at the margins of karroid, succulent bush in the Eastern Cape. Occurs in bushy kloofs at the coast and inland in KwaZulu-Natal. In Gauteng, Mpumalanga and North West Province it is often found in open woodland or on steep rocky hills usually in well-shaded situations. Tolerates wet and dry conditions, growing predominantly in summer rainfall areas with an annual rainfall of 200-800 mm.				
Brachycorythis conica subsp. *transvaalensis*	Endemism: South African endemic Provincial distribution: Gauteng, Limpopo, Mpumalanga Range: Waterberg to Balfour.	Major habitats: Rand Highveld Grassland, Gold Reef Mountain Bushveld, Eastern Highveld Grassland, Waterberg Mountain Bushveld, Central Sandy Bushveld, Waterberg-Magaliesberg Summit Sourveld, Carletonville Dolomite Grassland Description: Short, open grassland and wooded grassland, on sandy gravel overlying dolomite, sometimes also on quartzite, 1 000-1 705 m.	EN	CR	N/L	13%
Callilepis leptophylla	Endemism: Not endemic to South Africa Provincial distribution: Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga Range: Widespread in eastern half of South Africa. Also, in Swaziland.	Major habitats: Grassland, Savanna Description: Grassland or open woodland, often on rocky outcrops or rocky hill slopes.	Declining	LC	N/L	13%
Cineraria austrotransvaalensis	Endemism: South African endemic Provincial distribution: Gauteng, Mpumalanga, North West Range: Scattered throughout Gauteng and the North West Province and at Standerton in southern Mpumalanga.	Major habitats: Grassland, Savanna Description: Amongst rocks on steep hills and ridges, at the edge of thick bush or under trees on a range of rock types: quartzite, dolomite and shale, 1 400-1 700 m.	NT	NT	N/L	13%
Delosperma leendertziae	Endemism: South African endemic Provincial distribution: Gauteng, Mpumalanga, North West Range: Magaliesberg.	Major system: Terrestrial Major habitats: Savanna Description: Steep, south-facing slopes of quartzite in mountain grassland.	N/L	NT	N/L	7%
Eucomis autumnalis	Endemism: Not endemic to South Africa Provincial distribution: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West Range: South Africa, Swaziland, Lesotho, Botswana, Zimbabwe and Malawi.	Major system: Terrestrial Major habitats: Grassland Description: Damp, open grassland and sheltered places from the coast to 2 450 m.	Not evaluated	LC	N/L	7%
Habenaria barbertoni	Endemism: South African endemic	Major habitats: Savanna	NT	NT	N/L	7%

Species	Distribution	Habitat	2009 Threat Status (PRECIS)	SANBI Red List Status (2016)	Gauteng TOPS (2015)	POC (%)
	Provincial distribution: Gauteng, Mpumalanga Range: Gauteng and Mpumalanga.	Description: Rocky hillsides, in bushveld in association with acacias, 1 000-1 500 m.				
Habenaria mossii	Endemism: South African endemic Provincial distribution: Gauteng, North West Range: Johannesburg, Pretoria and Krugersdorp.	Major system: Terrestrial Major habitats: Carletonville Dolomite Grassland, Andesite Mountain Bushveld Description: Open grassland on dolomite or in black, sandy soil.	N/L	EN	N/L	20%
Holothrix randii	Endemism: Not endemic to South Africa Provincial distribution: Gauteng, Limpopo Range: Gauteng and Limpopo Province, Zimbabwe, Tanzania and Kenya.	Major system: Terrestrial Major habitats: Grassland Description: Grassy slopes and rock ledges, usually southern aspects.	N/L	NT	N/L	0%
Hypoxis hemerocallidea	Endemism: Not endemic to South Africa Provincial distribution: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North West Range: Widespread in the eastern part of southern Africa from the Eastern Cape to Botswana and Mozambique.	Major habitats: Albany Thicket, Grassland, Indian Ocean Coastal Belt, Savanna Description: Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant.	Declining	LC	N/L	33%
Ilex mitis var. *mitis*	Endemism: Not endemic to South Africa Provincial distribution: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North West, Western Cape Range: Widespread from Table Mountain in the Western Cape to Ethiopia and also Madagascar.	Major habitats: Albany Thicket, Forest, Fynbos, Grassland, Indian Ocean Coastal Belt, Savanna Description: Along rivers and streams in forest and thickets, sometimes in the open. Found from sea level to inland mountain slopes.	Declining	LC	N/L	7%
Melolobium subspicatum	Endemism: South African endemic Provincial distribution: Gauteng, North West Range: Krugersdorp to Pretoria.	Major habitats: Carletonville Dolomite Grassland, Soweto Highveld Grassland, Egoli Granite Grassland Description: Grassland.	VU	VU	N/L	27%
Pearsonia bracteata	Endemism: South African endemic Provincial distribution: Gauteng, Limpopo, North West Range: Wolkberg and Pretoria to Klerksdorp.	Major habitats: Grassland, Savanna Description: Plateau grassland.	NT	NT	N/L	7%

CR= Critically Endangered, EN= Endangered, EW = Extinct in the Wild, NT = Near Threatened, VU= Vulnerable, P= Protected, N/L = Not Listed.

Table C2: Additional floral SCC for the QDS 2627BB as obtained from GDARD.

Family	Species	Threat Status	Habitat	POC (%)
Recorded from the farm on which the study site is situated / within 5 km of the study site				
Aizoaceae	*Delosperma leendertziae*	NT	Major system: Terrestrial. Major habitats: Savanna. Description: Steep, south-facing slopes of quartzite in mountain grassland.	7%

APPENDIX D: Observed Floral Species

Table D1: Dominant floral species encountered in the Transformed and Secondary Grassland Habitat Units identified within the proposed MRA. Alien species are indicated with an asterisk (*). Also indicated are species falling within an alien invasive category as per the National Environmental Management: Biodiversity Act (Act 10 of 2004): Alien and Invasive Species Regulations, 2016.

Species *Alien	Habitat Units	
	Secondary Grassland	Degraded Grassland / Transformed Habitat
TREES AND SHRUBS		
**Agave sisalana* 1b		X
**Acacia mearnsii* 2	X	X
**Ailanthus altissima*		X
**Eucalyptus camaldulensis* 1b		X
**Eucalyptus sideroxylon*		X
**Gleditsia triacanthos*		X
**Melia azedarach* 3 (Urban areas)	X	X
**Morus alba* 3		X
**Pinus patula* 2		X
**Populus x canescens* 2		X
**Robinia pseudoacacia* 1b		X
**Ulmus parvifolia*		X
Elephantorrhiza elephantina	X	
Gomphocarpus fruticosus	X	
Seriphium plumosum	X	
Solanum mauritianum 1b	X	X
FORBS AND GROUNDCOVERS		
**Araujia sericifera* 1b	X	X
**Bidens formosa*		X
**Bidens pilosa*	X	X
**Canna indica*		X
**Campuloclinium macrocephalum* 1b	X	X
**Conyza bonariensis*		X
**Cirsium vulgare*	X	
**Datura stramonium* 1b	X	X
**Gomphrena celosioides*		X
**Ipomoea purpurea* 1b		X
**Opuntia ficus-indica* 1b		X
**Solanum elaeagnifolium* 1b		X
**Tagetes minuta*		X
**Taraxacum officinale*	X	
**Verbena aristigera*		X
**Verbena bonariensis* 1b	X	
**Zinnia peruviana*		X
Acalypha angustata	X	
Bulbine abyssinica	X	
Commelina africana	X	
Graderia subintegra	X	
Helichrysum cephaloideum	X	
Helichrysum nudifolium	X	
Hibiscus trionum	X	
Ledebouria ovatifolia	X	
Senecio venosus		
Turbina oblongata	X	
GRASSES/ REEDS AND SEDGES		
** Arundo donax* 1b		X
** Bromus catharticus*		X
**Pennisetum clandestinum*		X
Aristida adscensionis	X	X
Aristida bipertuda	X	X
Aristida congesta	X	X

Species *Alien	Habitat Units	
	Secondary Grassland	Degraded Grassland / Transformed Habitat
Aristida junciformis	X	
Aristida transvaalensis	X	
Cymbopogon plurinodis	X	
Cynodon dactylon	X	
Digitaria eriantha	X	
Elionurus muticus	X	
Enneapogon cenchroides	X	X
Eragrostis chloromelas	X	
Eragrostis curvula	X	
Eragrostis gummiflua	X	X
Eragrostis racemosa	X	
Eragrostis superba	X	
Heteropogon contortus	X	X
Hyparrhenia hirta	X	X
Hyparrhenia tamba	X	X
Melinis repens	X	X
Melinis nerviglumis	X	
Setaria sphacelata var. *sphacelata*	X	
Sporobolus fimbriatus	X	
Themeda triandra	X	
Urochloa mosambicensis	X	X

1a: Category 1a – Invasive species that require compulsory control.

1b: Category 1b – Invasive species that require control by means of an invasive species management programme.

2: Category 2 – Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread.

3: Category 3 – Ornamentally used plants that may no longer be planted; existing plants may remain, except within the flood line of watercourses and wetlands, as long as all reasonable steps are taken to prevent their spread (Bromilow, 2001).

FAUNAL AND FLORAL ASSESSMENT
FOR THE PROPOSED WEST WITS MINING PROJECT

Prepared for

SLR Consulting

May 2019

Section C: Faunal Assessment

Prepared by: **Scientific Terrestrial Services**
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Report Reference: **STS 180014**
Date: **May 2019**

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DOCUMENT GUIDE

The Document Guide below is for reference to the procedural requirements for environmental authorisation applications in accordance to Government Notice 267 of 24 March 2017, as it pertains to the National Environmental Management Act (NEMA).

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Section A: Appendix E
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Section A: Appendix E
b)	A declaration that the specialist is independent	Section A: Appendix E
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section A
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 2.1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Appendix A and B
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 3 and 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.2
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5
l)	Any conditions for inclusion in the environmental authorisation	Section 5
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 5
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5
(iA)	Regarding the acceptability of the proposed activity or activities	Section 5
(ii)	If the opinion is that the proposed activity, activities 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	Section 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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ACRONYMS

BLSA	Bird Life South Africa
CR	Critically Endangered
EAP	Environmental Assessment Practitioner
EIS	Ecological Importance and Sensitivity
EN	Endangered
GIS	Geographic Information System
GPS	Global Positioning System
IBA	Important Bird Area
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature
LC	Least Concern
NE	Near Evaluated
NT	Near Threatened
NYBA	Not Yet Been Assessed
P	Protected
PES	Present Ecological State
POC	Probability of Occurrence
QDS	Quarter Degree Squares
SABAP	Southern African Bird Atlas
SCC	Species of Conservation Concern
STS	Scientific Terrestrial Services
VU	Vulnerable

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct a terrestrial ecological assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA. The proposed MRA partly falls within Roodepoort (northern portion) and partly within Soweto (southern portion). A description of the project is provided in Section 1.2 below, which includes the locality of the proposed MRA relative to the surrounding areas.

The purpose of this study is to define the faunal ecology of the focus area as well as mapping and defining areas of Ecological Importance and Sensitivity (EIS) and to define the Present Ecological State (PES) of the focus area.

1.2 Project Description

In broad terms the proposed project entails:

- The development of five open-pit mining areas referred to as:
  - Mona Lisa Bird Reef Pit;
  - Roodepoort Main Reef Pit;
  - Rugby Club Main Reef Pit;
  - 11 Shaft Main Reef Pit; and
  - Kimberley Reef East Pit.
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings):
  - Bird Reef Central Infrastructure Complex; and
  - Kimberley Reef East Infrastructure Complex.

The site investigation for the faunal assessment was focused on the infrastructure as mentioned above and mining areas and will collectively be referred to as the “focus areas”.

The project would also include the establishment of Run of Mine (ROM) ore stockpiles, topsoil stockpiles and Waste Rock Dumps (WRD) as well as supporting infrastructure including

material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, wash bays, stores, change houses, lamprooms, vent fans and security facilities.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is three (3) to five (5) years and 20 years for the Kimberley Reef East underground operations and ten (10) years for the Bird Reef Central underground operations. The pits would be mined in a phased approach with each pit taking between six (6) and 16 months to be mined and rehabilitated.

The proposed location for the open pit mining areas and surface infrastructure complexes forming part of this project are depicted in Figure 1 and 2 of the Report Section A: Background Information, with their approximate extent, presented in Table 1.

Table 1: Extent of the proposed infrastructure and open cast areas investigated pertaining to the proposed MRA.

Proposed Mining Right Area	Area (ha)
Proposed MRA	2076
Proposed Infrastructure Complexes Investigated	
Bird Reef Central	± 2.19
Kimberley Reef East	± 4.74
West Wits Opencast Areas Investigated (including opencast, topsoil stockpile and WRD footprint areas)	
11 Shaft Main Reef Pit	14
Kimberley Reef East Pit	9.92
Mona Lisa Bird Reef Pit	19.2
Roodepoort Main Reef Pit	26.4
Rugby Club Reef East Pit	2.5

It is the objective of this study:

- To provide inventories of faunal species as encountered within the focus area;
- To determine and describe habitat types, communities and the ecological state of the focus area and to rank each habitat type based on conservation importance and ecological sensitivity;
- To identify and consider all sensitive landscapes including rocky ridges, wetlands and/ or any other special features;
- To conduct a Red Data Listed (RDL) species assessment as well as an assessment of other Species of Conservation Concern (SCC), including the potential for such species to occur within the focus area;

- To provide detailed information to guide the activities associated with the proposed mining activities associated within the focus area; and
- To ensure the ongoing functioning of the ecosystem in such a way as to support local and regional conservation requirements and the provision of ecological services in the local area.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The faunal assessment is confined to the MRA development and does not include the neighbouring and adjacent properties; these were however considered as part of the desktop assessment;
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. It is, however, expected that most faunal communities have been accurately assessed and considered and the information provided is considered sufficient to allow informed decision making to take place and facilitate integrated environmental management;
- Sampling by its nature means that not all individuals are assessed and identified. Some species and taxa within the MRA development area may, therefore, have been missed during the assessment; and
- The data presented in this report are based on two site visits undertaken on the 6th and 7th of March 2018 (Summer) and 14th of June 2018 (Winter). A more accurate assessment would require that assessments take place in all seasons of the year. However, on-site data was significantly augmented with all available desktop data and specialist experience in the area, and the findings of this assessment are considered to be an accurate reflection of the ecological characteristics of the MRA development.

2 ASSESSMENT APPROACH

Field assessments were to determine the ecological status of the focus area. A reconnaissance ‘walkabout’ was initially undertaken to determine the general habitat types found throughout the focus area. Following this, specific study sites that were selected were considered to be representative of the habitats found within the area, with special emphasis being placed on areas that may potentially support faunal SCC. These sites were further investigated on foot to identify the occurrence of fauna within the focus area. For further details on the methodologies used for this assessment please refer to Appendix A.

2.1 Sensitivity Mapping

All the ecological features of the focus area were considered, and sensitive areas were assessed. In addition, identified locations of protected species were marked using a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed mining development.

3 FAUNAL ASSESSMENT RESULTS

Following the floral assessment of the focus areas (Please refer to Section B:Floral Assessment) and the associated habitat, it has been concluded that the following habitat units can be associated with the focus areas:

- Secondary Grassland;
- Degraded Grassland;
- Freshwater features;
- Transformed habitat (associated with historic and current mining activities); and
- Built-up areas.

These habitat units are conceptualised in Figure 4 - 5 and their sensitivity briefly described below. For a more detailed description and discussion of these habitat units see Section B (Floral Report).

The Transformed habitat and Built-up area will be briefly discussed due to their poor and degraded state and transformation. Although the Freshwater features are not directly impacted by the footprint of the opencast areas and associated infrastructure, it is within the regulated zones according to the listing notices of the National Environmental Management Act, 1998 (NEMA) and Government Notice 509 of 2016 of the National Water Act, 1998 (NWA) Hence, these features will be briefly discussed from a terrestrial functionality and sensitivity. For additional information on the Freshwater resources please refer to the Freshwater Assessment as compiled by SAS (report reference 218025, 2019).

3.1 Faunal Habitat Description

Secondary Grassland

The Secondary Grassland habitat unit comprises small pockets of modified grassland, dominated by alien and invasive plant species as a result of historic and current anthropogenic activities. This includes edge effects from the surrounding residential developments, illegal dumping and ongoing illegal mining activities. Furthermore, the habitat unit has been largely transformed by historical mining activities and illegal disposal of waste material, unplanned veld fires and thickets of *Eucalyptus camaldulensis* (indicating historical disturbance) were present throughout. Due to the high levels of disturbance, only commonly occurring floral and faunal species were noted within the focus areas. The majority of floral species present within the Secondary Grassland habitat unit are indicators of disturbed veld. In terms of faunal habitat availability, this habitat is considered to have a low habitat provision capability. The above-mentioned habitat disturbances have resulted in a low diversity and abundance of faunal SCC and low SCC probability.

Figure 1: Representative photograph of the Secondary Grassland habitat unit.

Degraded Grassland

The Degraded Grassland habitat unit is considered to be in a significantly modified ecological condition, with a high abundance of alien and invasive flora species such as *Tagetes minuta, Eucalyptus camaldulensis, Acacia mearnsii* and *Melia azedarach*. Transformed areas were identified within this habitat unit as a result of existing illegal and historic mining activities. As a result of habitat degradation and alien and invasive plant proliferation, the habitat suitability for faunal and floral species has been significantly compromised and reduced, notably for SCC.

Figure 2: Representative photograph of the Secondary Grassland habitat unit.

Freshwater Features within the Regulated Zone

Several watercourses[1] were identified within the proposed MRA. A Channelled Valley Bottom Wetland feature (CVB2) was identified approximately 200 m from the proposed Mona Lisa Brid Reef Pit and another Channelled Valley Bottom Wetland feature (CVB3) was identified approximately 50 m from the proposed 11 Shaft Main Reef Pit. The CVB3 wetland features also extend approximately 400 m east of the Kimberley Reef East Pit and Kimberley Reef East Infrastructure Complex. The CVB3 wetland feature drains from the Florida Dam downstream into the Fleurhof Dam. The Klip River is located on the western boundary of the proposed MRA.

The watercourses located within the MRA have all been impacted upon to some degree, with specific mention of the historical and ongoing surrounding agricultural and mining activities. The following tables provides a summary of the findings for CVB2 and CVB3.

[1] Refer to the "Freshwater resource and Aquatic Ecological Assessment" Report compiled by Scientific Aquatic Services CC (2019) for detailed assessments on these watercourses.

Table 2: Channelled Valley Bottom Wetland feature (CVB2) associated with the Mona Lisa Bird Reef Pit.

The vegetation component of this wetland system is dominated by reed species (*Phragmites australis* and *Typha capensis*). The excessive sediment substrate allowed for the invasion of a monoculture of *Phragmites australis*, dominating the largest extents of the wetland, reduces the available substrate for other indigenous species to establish. Due to this monoculture, floral biodiversity is low, but the wetland still has the potential to provide habitat for faunal species. The proliferation of alien and invasive floral species was also noted at the outer edges of the wetland and where infrastructure (i.e. road crossings) have been constructed.	

Table 3: Channelled Valley Bottom Wetland feature (CVB3) associated with the 11 Shaft Main Reef Pit, Kimberley Reef East Pit and Kimberley Reef East IC:

A large degree of vegetation removal has occurred within and along this wetland system due to the development of road infrastructure and residential development. Even though the permanent zone of the wetland could be considered well vegetated, the outer edges of the wetland have very little to no indigenous vegetation remaining, and thus no suitable buffer zone to aid in protecting the wetland from the surrounding activities. The western portion of this wetland system was however dominated by reed species (*Phragmites australis* and *Typha capensis*), which provides habitat and refugia for some less sensitive avifaunal and smaller faunal species.	

Transformed Habitat

The Transformed habitat is associated with previous and current mining infrastructure such as slimes dams, derelict / abandoned buildings and water dams. The Kimberley Reef East Pit, Kimberley Reef East Infrastructure Complex and the Bird Reef Infrastructure Complex can be completely associated with this habitat unit. Small portions of the Transformed habitat are also associated with the Roodepoort Main Reef Pit and the Mona Lisa Bird Reef Pit. The floral diversity and habitat suitability for SCC has been significantly modified, with a high abundance of alien and invasive flora species such as *Tagetes minuta, Eucalyptus camaldulensis, Acacia mearnsii* and *Melia azedarach*.

Figure 3: Representative photograph of the Secondary Grassland habitat unit.

Built-up Areas

The built-up areas have been completely cleared of natural vegetation and replaced with urban residential dwellings, recreational areas, industrial areas and manufacturing and distribution facilities. Vegetation associated with this habitat unit includes garden ornamentals and landscape vegetation. None of the mining infrastructures, or operations is located within this habitat unit.

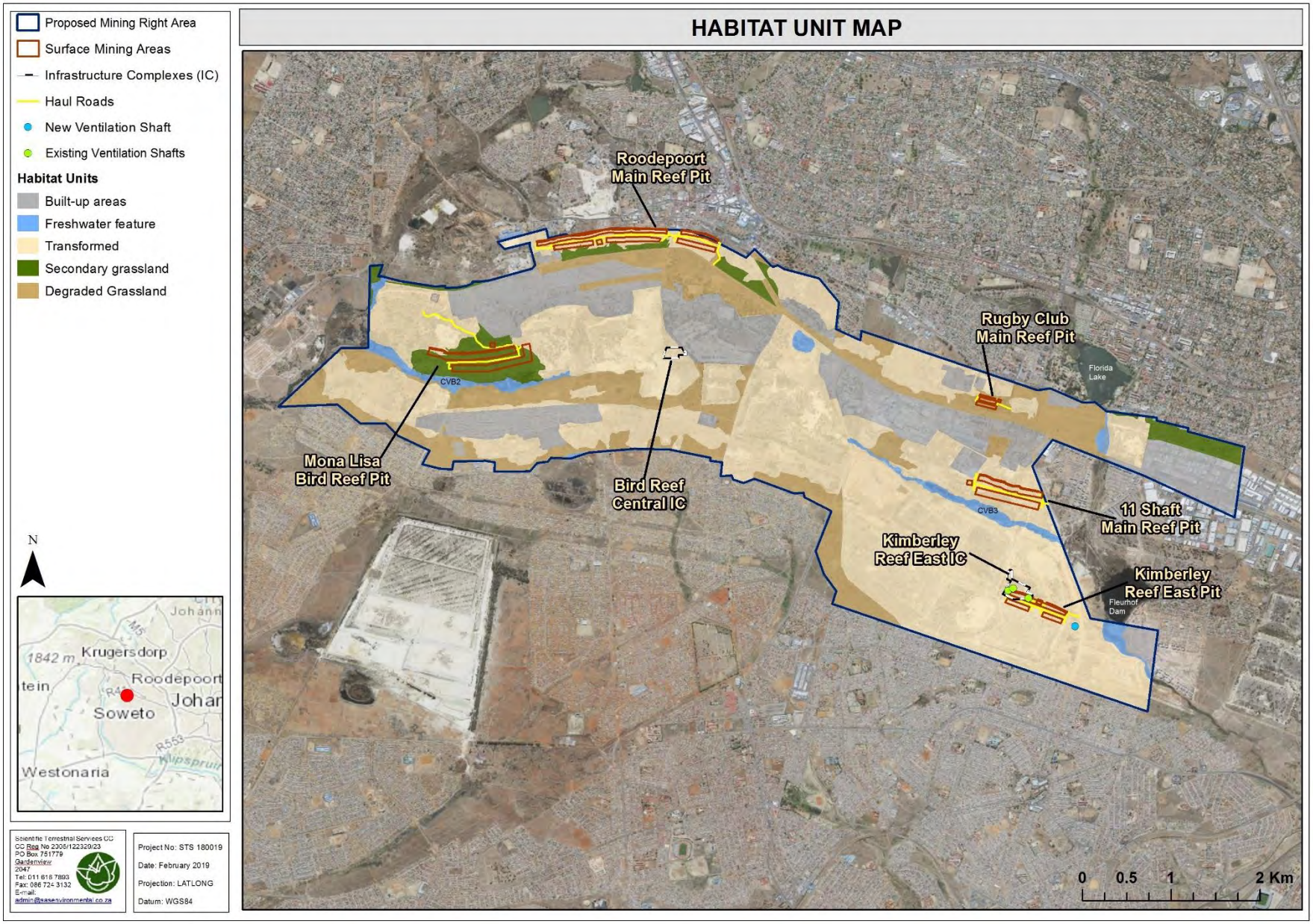


Figure 4: Conceptual illustration of the habitat units within the proposed MRA area.

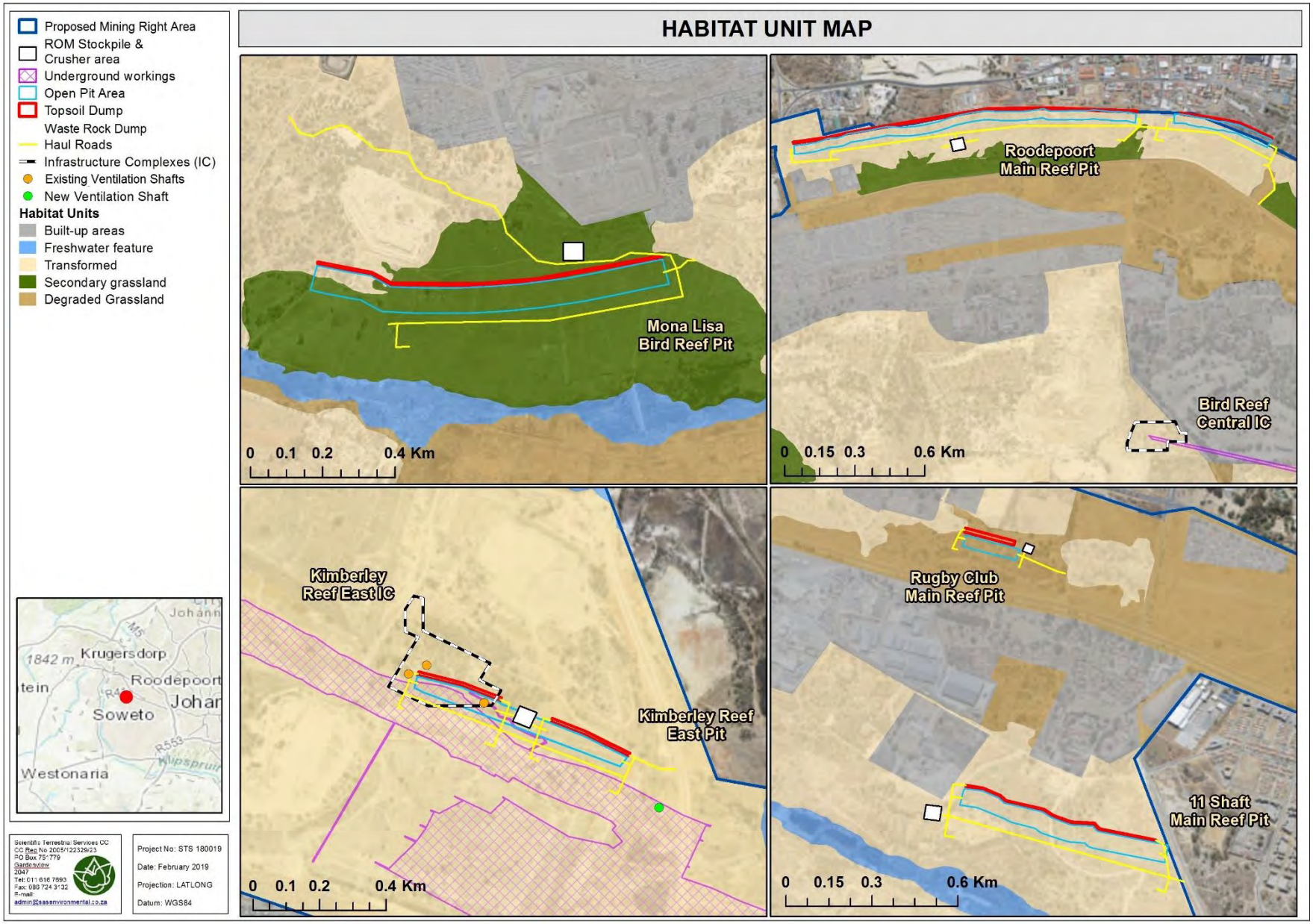
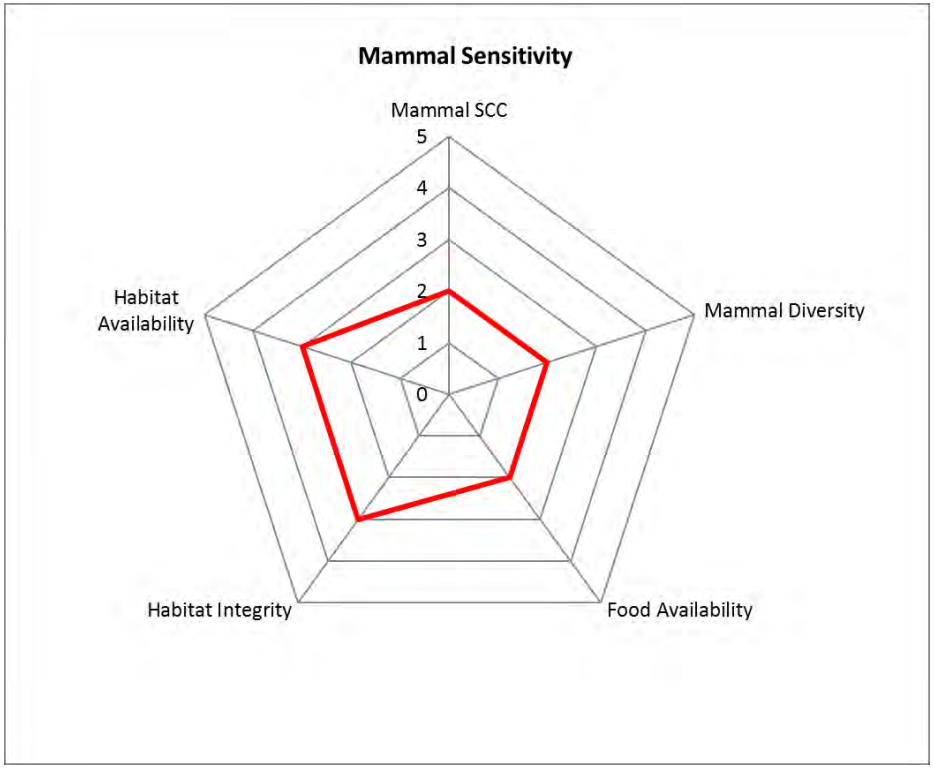


Figure 5: Conceptual illustration of the habitat units within the focus area (Zoomed in).

3.2 Mammals

Table 4: Field assessment results pertaining to mammal species within the focus area.

Faunal Class: Mammal	Mammal Habitat Sensitivity	Moderately Low
	Notes on photograph: Top: Domestic dogs were observed within the Transformed habitat unit. Bottom: Grazing activities by cattle from the local residents were observed throughout the focus area, utilising the Secondary Grassland Habitat.	
Mammal Sensitivity Graph:		



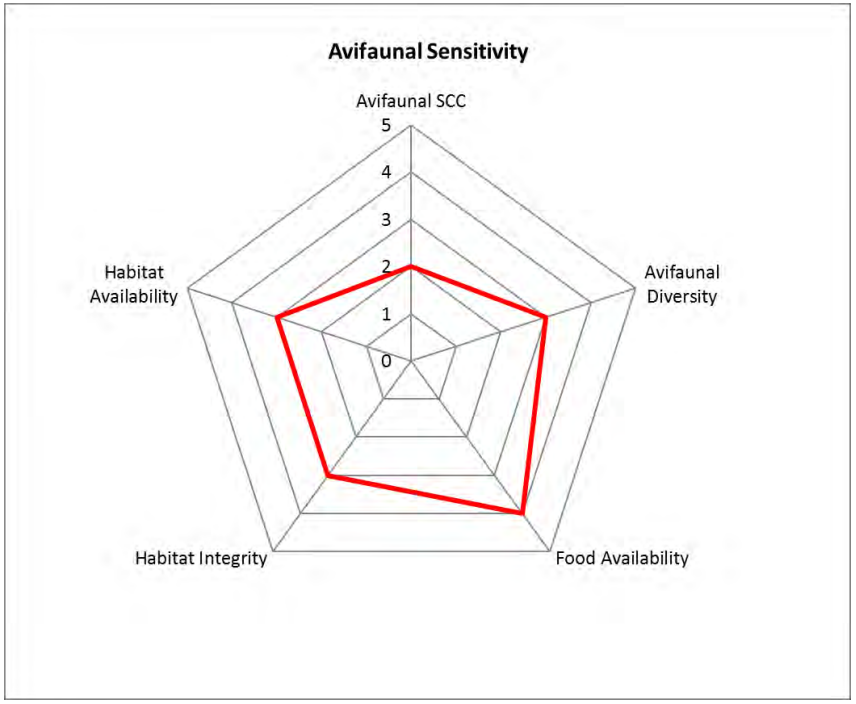
Photograph:

Faunal SCC/Endemics/TOPS/	No mammal SCC were encountered during the summer and winter field assessments. Preferred mammal SCC habitat has been negatively affected by historic and current anthropogenic activities, such as mining activities, urban development, alien and invasive plant proliferation, dumping of rubble and unplanned burning of the veld. Alien and invasive plant proliferation present within the focus area has altered preferred habitat for *Atelerix frontalis* (Southern African Hedgehog, NT) and it is deemed unlikely that this species will be present within the focus area. The Freshwater habitat unit within the proposed MRA is associated with increased alien and invasive plant species proliferation that negatively affects preferred habitat for faunal SSC. The Freshwater habitat and associated buffer, including the Secondary Grassland may serve as a corridor for mammal species to move between open areas within the surrounding areas.	Business Case, Conclusion and Mitigation Requirements: The Freshwater and Secondary Grassland habitat units will be utilised by mammal species as a corridor to move between open space areas within the surrounding areas. The mammal habitat sensitivity of the focus area is considered to be moderately low. Development related activities are unlikely to have a significant impact on mammal habitat, species and diversity, as the habitat integrity is already considered to be disturbed and unlikely to support any mammal SCC. In order to limit negative impacts on the Freshwater habitat unit, the proposed development and related edge effects must not negatively affect the Freshwater habitat unit. Strict enforcement of mitigation measures must be implemented to ensure no further Freshwater habitat degradation occurs during all phases of the proposed mining activities. All phases of development must be monitored, to ensure edge effects from these areas do not affect the Freshwater habitat.
Faunal Diversity	Mammal diversity has been negatively affected within the focus area as a result of anthropogenic activities that have transformed faunal habitat. Only signs (I.e. spoor and faeces) of common mammal species, e.g. *Cryptomys hottentotus* (Common Mole Rat) and *Canis mesomelas* (Black Backed Jackal) were observed within the focus area during the site assessments. These species have the ability to adapt to areas that have been impacted by anthropogenic activities and urban encroachment.	
Food Availability	Due to the historical and current anthropogenic activities in the focus area, only mammal species capable of adapting to these changes would be able to obtain sufficient food resources for survival. The Secondary Grassland area within the focus area will have the biggest potential to provide foraging habitat for mammal species. Transformed habitat also provide foraging habitat for species that are able to adapt to anthropogenic activities, e.g. *Cryptomys hottentotus* (Common Mole Rat).	
Habitat Integrity	The majority of the mammal habitat available in the focus area has been affected negatively due to historical and ongoing anthropogenic activities, especially mining activities, the proliferation of alien and invasive plant species and uncontrolled fires within the focus area. The Secondary Grassland habitat unit within the focus area provides the most intact habitat for foraging and breeding purposes for common mammal species.	
Habitat Availability	Habitat availability is considered intermediate. Although habitat degradation and transformation has occurred, and alien floral species were present, the secondary grassland habitat unit within the focus area is still capable of providing habitat to a number of small mammal species (such as the *Muridae* family), although it is expected to be limited to common and widespread species.	

3.3 Avifauna

Table 5: Field assessment results pertaining to avifaunal species within the focus area.

Faunal Class: Avifaunal	Avifaunal Habitat Sensitivity	Intermediate
	Notes on the photograph, top left and right: Common avifaunal species observed during the field assessment. Top: *Saxicola torquatus* (African Stonechat), Bottom: *Calandrella cinerea* (Red-capped Lark)	
Avifaunal Sensitivity Graph:		



Photograph:

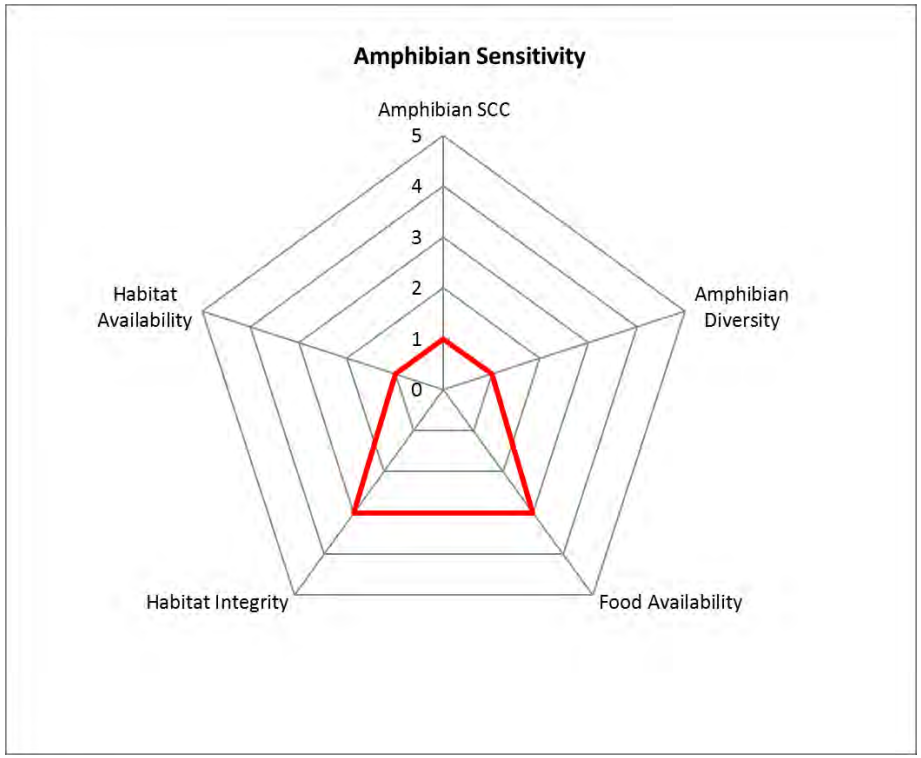
Faunal SCC/Endemics/TOPS/	No avifaunal SCC were encountered during the summer and winter field assessments. Preferred avifaunal SCC habitat has been negatively affected by historic and current anthropogenic activities, such as alien and invasive plant proliferation, burning of veld and the expansion of the surrounding urbanised area. It is unlikely that avifaunal SCC will utilise the focus area for breeding purposes as the preferred breeding habitat is altered by alien and invasive plant proliferation. Although no avifaunal SCC was observed during the field assessment, it is considered likely that birds of prey may utilise the focus area during foraging forays.	Business Case, Conclusion and Mitigation Requirements: The overall avifaunal habitat sensitivity for the focus area is considered to be intermediate. Currently the focus area provides habitat and food resources to an abundance and diversity of commonly occurring avifaunal species associated with urbanized areas. Mining activities within the proposed MRA will lead to the loss of habitat and food resources, forcing avifaunal species into surrounding areas which in turn will increase the level of habitat and resource utilisation in the surrounding area. Mitigation measures as stipulated in Section 4.4 must be adhered to in order to manage threats to avifaunal species.
Faunal Diversity	The avifaunal diversity associated with the focus area was intermediate and comprised mainly of common faunal species adapted to high levels of anthropogenic activities/change. Species encountered during the field assessment include common avifaunal species such as *Streptopelia capicola* (Cape Turtle Dove), *Ardea melanocephala* (Black-headed Heron) and *Ploceus velatus* (Southern Masked-weaver).	
Food Availability	The Freshwater and Secondary Grassland habitat units provide the most intact habitat for foraging and breeding purposes for common avifaunal species as most of the food source for avifaunal species will be present within these habitat units.	
Habitat Integrity	The Degraded Grassland and Transformed habitat were noted to have a low level of habitat integrity, while the Secondary Grassland habitat provided suitable habitat for common avifaunal species to utilise for breeding and feeding purposes. The habitat within the immediate surrounding area has been impacted upon by mining activities, urban development and alien and invasive plant proliferation.	
Habitat Availability	The Secondary Grassland habitat unit provides suitable avifaunal habitat within the focus area, while the transformed habitat can be considered secondary habitat and is mostly used for roosting purposes by common avifaunal species.	

3.4 Amphibians

Table 6: Field assessment results pertaining to amphibian species within the focus area.

Faunal Class: Amphibians	Amphibian Habitat Sensitivity	Moderately low
	Notes on Photograph: Potential amphibian habitat present within the Degraded Grassland and Freshwater habitat unit.	

Amphibian Sensitivity Graph:



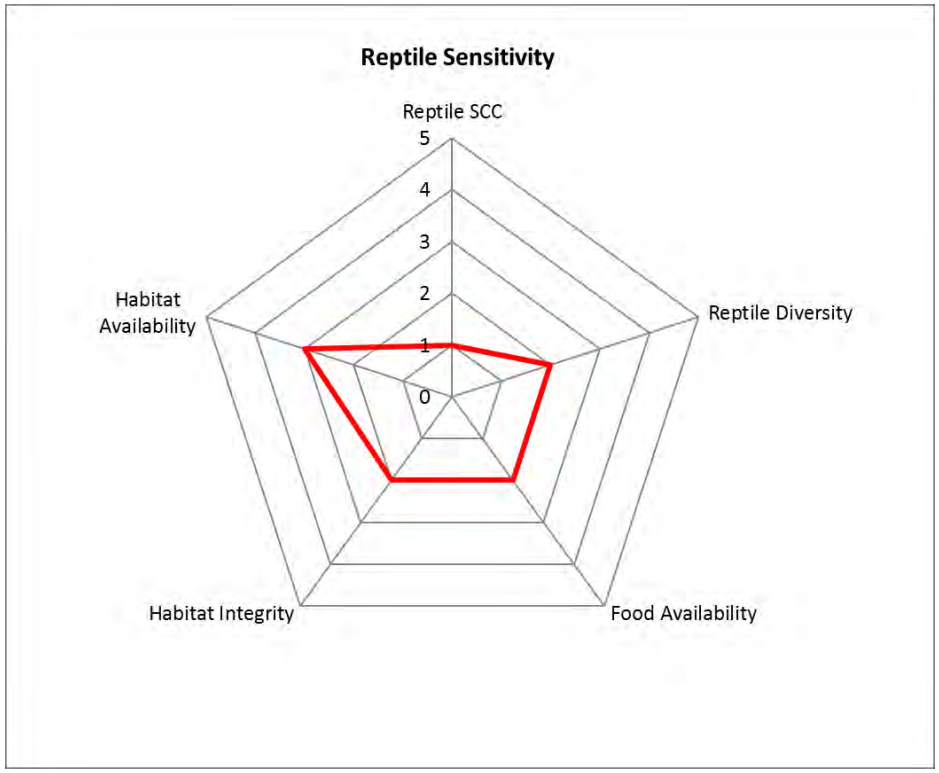
Photograph:

Faunal SCC/Endemics/TOPS/	No amphibian SCC was observed during the field summer and winter field assessments and are unlikely to be present within the focus area. Anthropogenic activities within the focus area and immediate surroundings have had a negative impact on preferred habitat requirements of such species.	Business Case, Conclusion and Mitigation Requirements: The amphibian habitat sensitivity within the focus area is considered to be moderately low. The Freshwater habitat unit and the recommended buffer provides preferred amphibian habitat, and as such, impacts as a result of the proposed development activities need to be effectively managed to limit disturbances to these areas.
Faunal Diversity	No amphibians were observed within the focus area during the field assessment. Availability of habitat and breeding areas within the Freshwater habitat unit and immediate surrounding area allows an inference of a higher amphibian diversity than that which was observed during the field assessment. Species likely to inhabitant these areas include *Cacosternum boettgeri* (Common Caco) and *Schismaderma carens* (Red Toad).	
Food Availability	Small invertebrates form the primary food source of many amphibian species. The focus area provides habitat to a number of insect species, although in moderate numbers - as observed during the field assessment (see table 7 below). Food availability is highest within the Secondary Grassland and Freshwater habitat units.	
Habitat Integrity	Habitat integrity was observed to be the highest within the Freshwater and Secondary Grassland habitat units, as these are in a more natural state and encompassed all the requirements for amphibian survival. Furthermore, the Freshwater habitat unit provides connectivity corridors between the various habitats and landscape units.	
Habitat Availability	The Freshwater habitat unit provides primary habitat for amphibian species, while the secondary grassland habitat unit is suitable for amphibian species that are less water dependent. Habitat availability is considered to be lower in the transformed habitat, due to a decreased level of food provision and the transformed state of the habitat.	

3.5 Reptiles

Table 7: Field assessment results pertaining to reptile species within the focus area.

Faunal Class: Reptiles	Reptile Habitat Sensitivity	Moderately low	Photograph:
	Notes on Photograph: Old building structures and building rubble creates habitat for common reptile species such as *Trachylepsis punctatissima* (Montane Speckled Skink).		
Reptile Sensitivity Graph:			

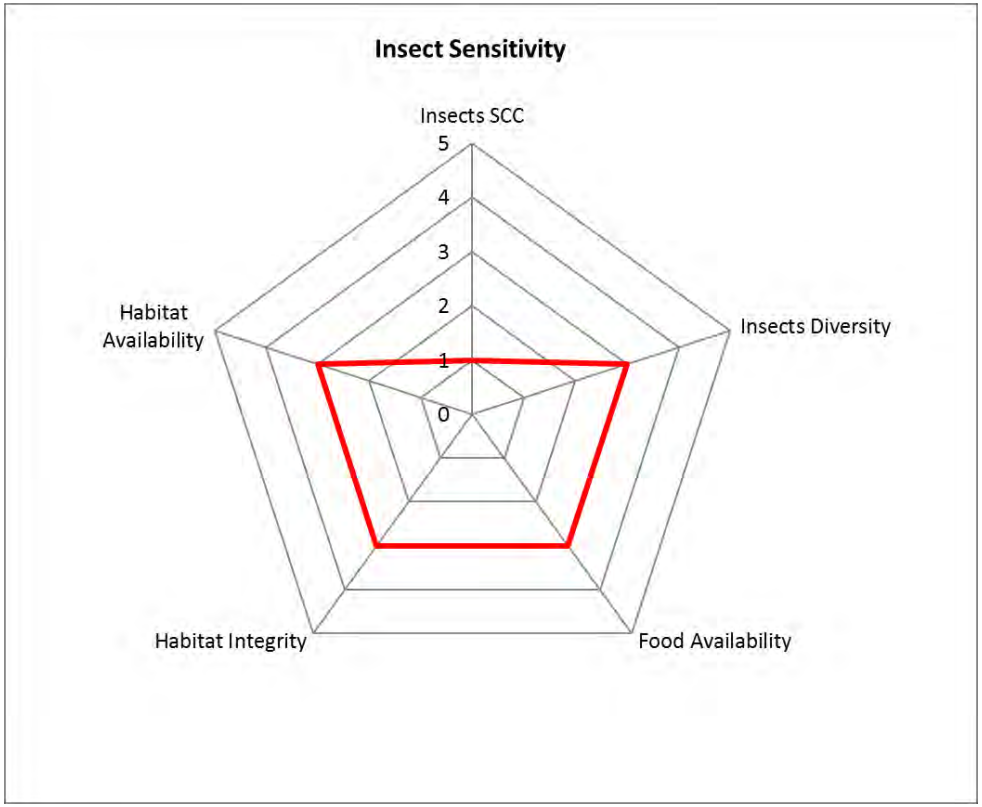


Faunal SCC/Endemics/TOPS/	No reptile SCC was observed during the summer and winter field assessments and are unlikely to be present within the focus area. Anthropogenic activities within the focus area and immediate surroundings have had a negative impact on food sources and preferred habitat requirements of such species.	Business Case, Conclusion and Mitigation Requirements: Although a limited reptile assemblage is expected to be present and it is unlikely that reptile SCC will occur within the focus area, it is still important to ensure that the proposed mining development does not negatively affect the Freshwater habitat unit and areas outside of the development footprint areas. This will be achieved by avoiding unnecessary disturbance and minimising construction footprints. It must also be ensured that all disturbed areas are rehabilitated by the mine to prevent the proliferation of alien and invasive plant species. This action will form part of the rehabilitation plan and measure to be implemented during the operational and decommissioning phase
Faunal Diversity	A low reptile diversity was observed during the field assessment. However, this is likely due to the secretive nature of many reptile species. It is likely that the focus area will have a moderately low reptile diversity. Only common species, e.g. *Trachylepsis punctatissima* (Montane Speckled Skink) was observed during the summer and winter field assessments. For a full list of species observed see Appendix C.	
Food Availability	High levels of anthropogenic activities and alien floral species proliferation have resulted in moderately low levels of food availability within the focus area. However, a number of seed-bearing floral species are present within the focus area, resulting in food resources for various invertebrates and small mammal species which are considered an important food resource for reptile species.	
Habitat Integrity	The Secondary Grassland habitat unit is the most intact habitat present within the focus area and may, therefore, provide improved habitat conditions for common reptile species. Buildings and areas where rubble have been disposed of may provide additional habitat for common reptile species within the focus area.	
Habitat Availability	The Secondary Grassland habitat unit provides suitable reptile habitat for common reptiles. Abandoned burrows and warrens provide suitable habitat for reptile species to seek refuge.	

3.6 Insecta

Table 8: Field assessment results pertaining to insect species within the focus area.

Faunal Class: Insects	Insect Habitat Sensitivity	Intermediate
	Notes on Photograph: Common insects observed during the field assessment. Top: *Danaus chrysippus* (African Monarch), *Junonia hierta* (Yellow Pansy) and Bottom: *Musca domestica* (House Fly), *Trinervitermis* sp (Snouted Harvester Termites).	
Insect Sensitivity Graph:		

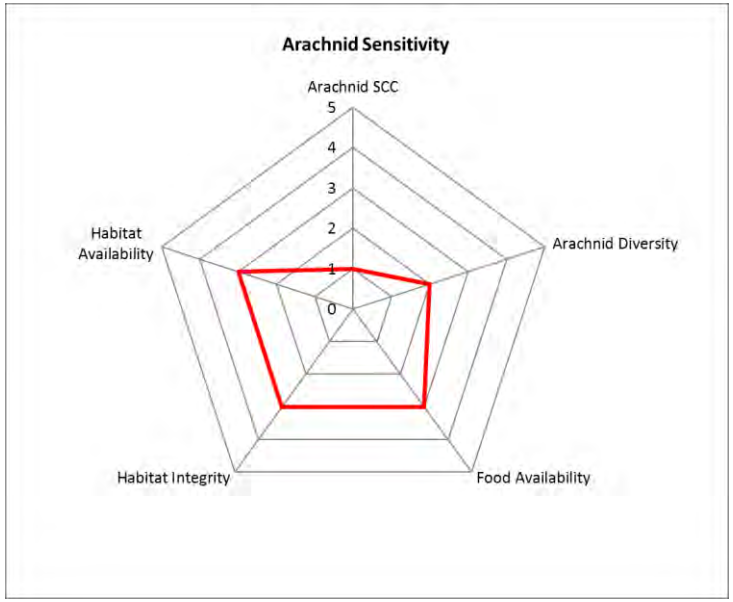


Photograph:

Faunal SCC/Endemics/TOPS/	No insect SCC were observed, and it is unlikely that any insect SCC will be present, as preferred habitat is not present within the focus area.	Business Case, Conclusion and Mitigation Requirements: The insect habitat sensitivity is considered to be intermediate. The varying floral characteristics of the secondary grassland and Freshwater habitat units provide a broad range of suitable habitat for a variety of common insect species. These species, in turn, are utilised as a food source by numerous other faunal species. As such, mitigation measures set out within this report must be adhered to.
Faunal Diversity	Overall, insect diversity of the focus area is considered to be intermediate. This may be attributed to the anthropogenic activities within the focus area such as alien and invasive plant proliferation and uncontrolled veld fires. Only common insect species of the area were observed, with the highest invertebrate population density being present within the secondary grassland habitat unit. For a full list of species observed see Appendix D.	
Food Availability	High levels of anthropogenic activities and alien floral species proliferation have resulted in intermediate levels of food availability within the focus area. However, a number of seed-bearing and flowering floral species are present within the focus area, resulting in food resources for various invertebrates' species, therefore it is expected that common insect species will be encountered within the focus area.	
Habitat Integrity	The most intact habitat for insects is present within the Secondary Grassland habitat unit. This habitat types have been affected to varying degrees by anthropogenic activities associated with uncontrolled veld fires and the presence of alien and invasive plant species.	
Habitat Availability	The Secondary Grassland habitat unit provides suitable habitat to a number of insect species that are common to the area. The varying landscape ensured that a range of habitat types are afforded to insect species, ensuring continued insect diversity and abundance levels. The grasslands and freshwater resources were particularly well utilised by insect species and are considered important in terms of continued food, water and habitat provision.	

3.7 Arachnids

Table 9: Field assessment results pertaining to arachnid species within the focus area.

<table>
<tr><td rowspan="2">Faunal Class:
Arachnids</td><td>Arachnid Habitat Sensitivity</td><td>Moderately Low</td><td rowspan="2">Photograph:
  </td></tr>
<tr><td colspan="2">Notes on Photograph:
The following common species were observed. Top: Argiope trifasciata (Banded Garden Orb-web spider) and Bottom: Olurunia ocellate (Grass Funnel-web Spider).</td></tr>
<tr><td colspan="3">Arachnid Sensitivity Graph:
 
</td></tr>
<tr><td>Faunal SCC/Endemics/TOPS/</td><td colspan="2">No arachnid SCC was observed within the focus area, nor are any expected to be present within the focus area.</td><td>Business Case, Conclusion and Mitigation Requirements:

The focus area is considered to be of moderately low habitat sensitivity for arachnids. No arachnid SCC was observed within the focus area. It is recommended that the proposed mining development activities do not negatively affect the Freshwater and Secondary Grassland habitat units by avoiding unnecessary disturbance, minimising construction footprints and ensuring that all disturbed areas are rehabilitated.</td></tr>
</table>

Faunal Diversity	While very few arachnid species were observed, this is likely due to the secretive nature of many arachnid species. It is expected that the Secondary Grassland habitat unit is likely to be inhabited by a number of common arachnid species, such as *Olurunia ocellate* (Grass Funnel-web Spider). For a full list of species observed see Appendix D.
Food Availability	The moderate abundance and diversity of insects within the focus area provide a suitable food source for many of the arachnid species.
Habitat Integrity	The most intact habitat for arachnids is in the Secondary Grassland habitat unit. While the Degraded Grassland and Transformed areas have suffered varying degrees of transformation, it still provides habitat for common species that are able to adapt to these conditions.
Habitat Availability	The focus area is considered to have an intermediate level of habitat availability for arachnid species, predominantly within the Secondary Grassland habitat unit.

3.8 Faunal Species of Conservation Concern Assessment

During field assessments, it is not always feasible to identify or observe all species within an area, largely due to the secretive nature of many faunal species, possible low population numbers or varying habits of species. As such, and to specifically assess an area for faunal SCC, a Probability of Occurrence (POC) matrix is used, utilising a number of factors to determine the probability of faunal SCC occurrence within the focus area. Species listed in Appendix C whose known distribution ranges and habitat preferences include the focus area were taken into consideration.

None of the faunal SCC listed in Appendix C was observed during the summer and winter field assessments within the focus area and the immediate surrounding area. In addition, no faunal SCC are considered to have a POC of 60% or higher within the focus area, due to the severe habitat transformation associated with the area. *Atelerix frontalis* (Southern African Hedgehog) is listed as Protected (GDARD, 2014b) and as Near Threatened by the Red Data Book of the Mammals of South Africa (EWT, 2012). Thus, habitat for this species still needs protection as it is facing increasing threats due to habitat degradation and collection for the illegal pet trade. This species is likely to use the Freshwater habitat unit and surrounding grassland areas including Secondary Grassland that acts as a corridor linkage to more favourable habitat within the immediate surrounding areas.

Due to the fact that no faunal SCC or signs thereof were identified, and the lack of suitable habitat or known occurrences of faunal SCC within the focus area, it can be concluded that the proposed mining activities will unlikely affect faunal SCC conservation in the region. Should any faunal SCC listed in Appendix C of this report, however, be encountered, all operations must be stopped immediately, and a biodiversity specialist must be consulted, and rescue and a management plans should be implemented.

4 SENSITIVITY MAPPING

Figures 6 and 7 and Table 10 below conceptually describes and illustrate the areas considered to be of increased faunal ecological sensitivity. The areas are depicted according to their sensitivity in terms of the presence or potential for faunal SCC, habitat integrity, levels of disturbance and overall levels of diversity. The table below presents the sensitivity of each area along with an associated conservation objective and implications for development.

Table 10: A summary of the sensitivity of each habitat unit and implications for proposed mining development.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
Freshwater features	Intermediate	Preserve and enhance biodiversity of the habitat unit and surrounds while optimising development potential.	This habitat unit is of intermediate ecological sensitivity, due to its function and ecological state. In this regard, maintaining migratory corridors and connectivity along the Freshwater system is deemed essential. Several watercourses were identified within the MRA. A Channelled Valley Bottom Wetland feature (CVB2) was identified approximately 200 m from the proposed Mona Lisa Brid Reef Pit and another Channelled Valley Bottom Wetland feature (CVB3) was identified approximately 50 m from the proposed 11 Shaft Main Reef Pit. The CVB3 wetland features also extend approximately 400 m east of the Kimberley Reef East Pit and Kimberley Reef East IC.
Secondary Grassland	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.	The Secondary Grassland habitat unit provides food resources to several faunal species. Activities in this habitat unit are unlikely to significantly impact on faunal species within the study area. Care must be taken to limit edge effects on the surrounding natural areas.
Degraded Grassland Transformed Grassland Built-up areas	Low	Optimise development potential.	Activities in this habitat unit are unlikely to impact on faunal species within the focus area. Care must be taken to limit edge effects on the surrounding natural areas.

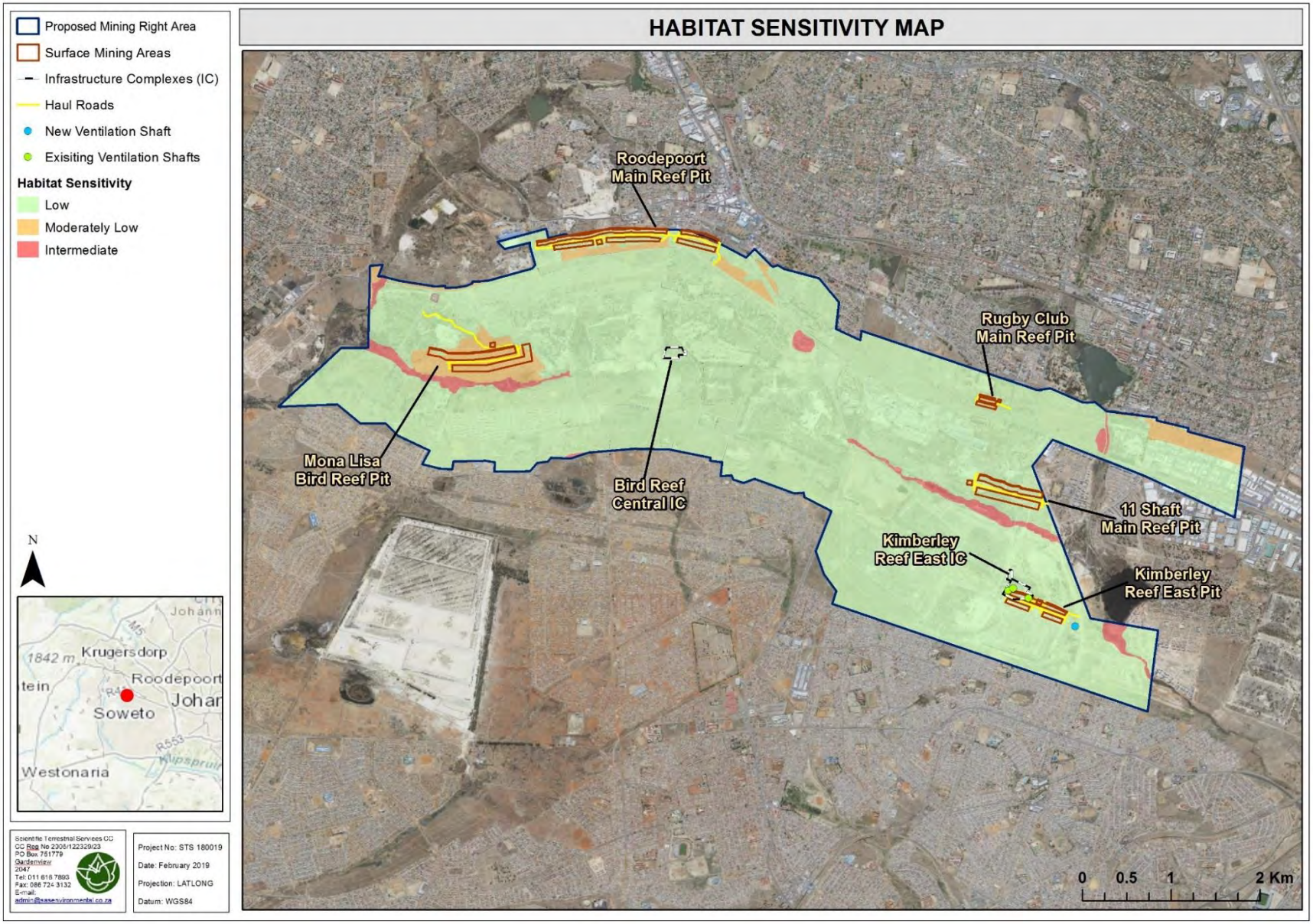


Figure 6: Sensitivity map for the proposed MRA.

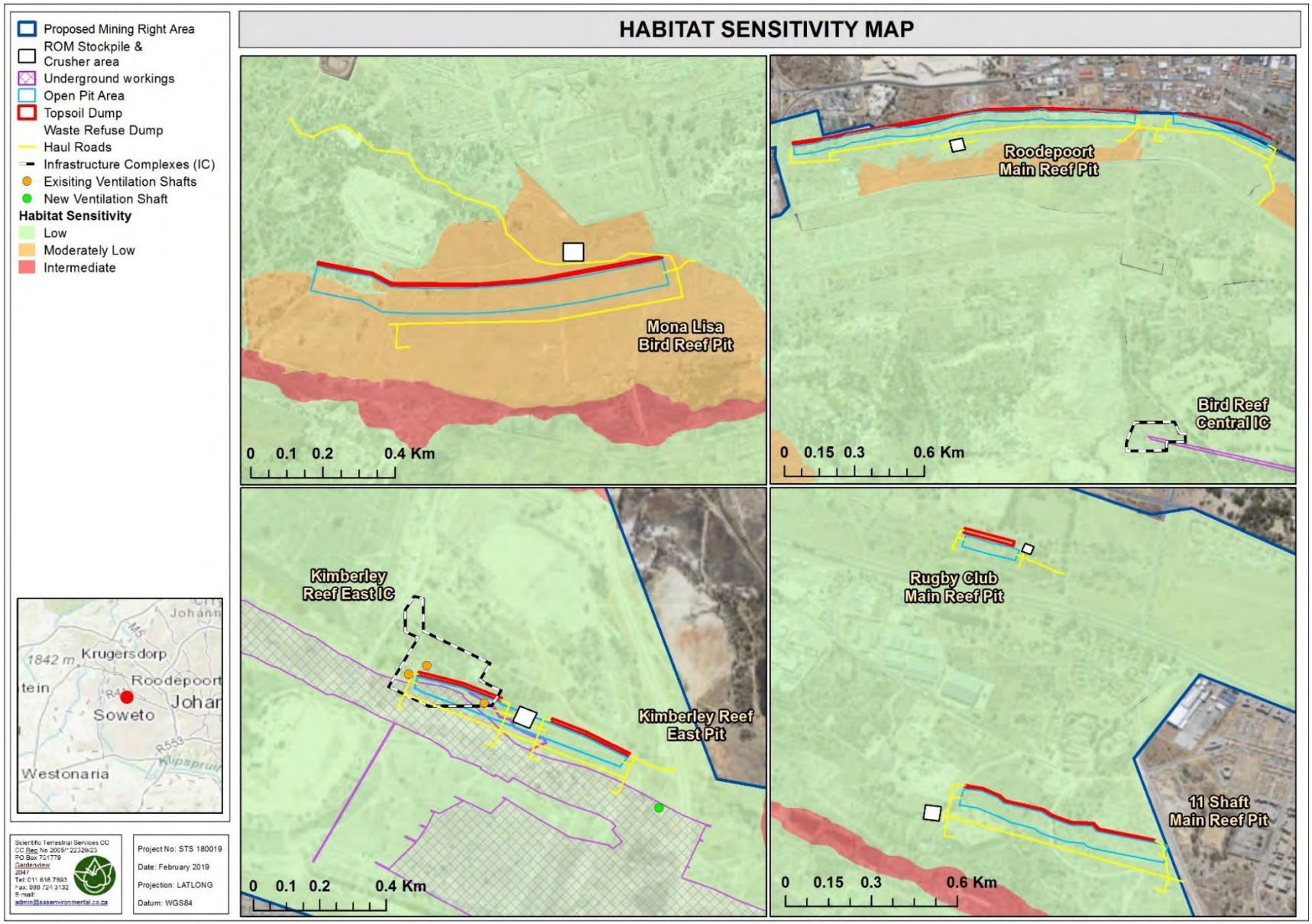


Figure 7: Conceptual illustration of the sensitivities within the focus areas (Zoomed in).

5 IMPACT ASSESSMENT

Tables 13 and 14 summarise the significance of perceived impacts on the faunal and floral ecology of the focus area, with each individual impact identified presented in Section 5.1 and 5.2 of this report. A summary of all potential pre-construction, construction, operational and decommissioning & closure (and rehabilitation) impacts is provided in Section 5.3.

The table below illustrates the anticipated timeline on the proposed mining activities. The duration of the proposed activities will also be incorporated and considered when assessing the impact and impact scoring.

Table 11: Timing associated with the implementation of the proposed mining activities [as per the EIA & EMP, March 2019 (SLR)].

Activity		Timeline													
		Year 1				Year 2				Year 3	Year 4	Year 5	Year 6 -25	year 26	Year 27 - 28
Opencast mining and concurrent rehabilitation		■	■	■	■	■	■	■	■	■					
Rugby Club Main Reef Pit	Mining	■	■	■											
	Rehabilitation		■	■	■										
Roodepoort Main Reef Pit	Mining			■	■	■									
	Rehabilitation				■	■	■								
11 Shaft Main Reef Pit	Mining				■	■									
	Rehabilitation					■	■								
Mona Lisa Bird Reef Pit	Mining					■	■								
	Rehabilitation						■	■							
Kimberley Reef East Pit	Mining						■	■							
	Rehabilitation							■	■						
Continued opencast rehabilitation and construction of infrastructure complexes										■	■	■			
Underground mining operations											■	■	■		
Steady state production achieved												■			
Decommissioning and closure														■	
Aftercare and maintenance															■

Activities which are likely to negatively impact faunal species within the focus area include, but are not limited to, the following:

- Clearing of vegetation during construction and operational activities leading to a loss of faunal habitat;
- Alien and invasive floral proliferation and erosion in disturbed areas; and

- Edge effects compromising habitat integrity throughout, e.g., enabling alien vegetation to proliferate, decreasing habitat connectivity and increasing the extent of transformed habitat with little chance of habitat restoration.

Activities and aspects register

Table 12 presents the impact assessment according to the method described in Appendix D. Impacts are considered without mitigation taking place, as well as with mitigation fully implemented. The required mitigatory measures needed to minimise the impact is presented in Section 5.4.

Table 12: Potential activities that might take place during the various phases of the proposed mining project.

Pre-Operational	Operational		Decommissioning & Closure (Rehabilitation)
Identification of laydown areas and access routes, leading to a larger than expected infrastructure footprint. This will result in loss of faunal habitat.	Site clearing and the removal of vegetation for surface infrastructure, access roads and mining footprint areas leading to increased habitat loss for faunal species.	On-going disturbance of soils due to general operational activities leading to altered faunal habitat.	Potential ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan.
	Loss of faunal diversity through invasion of alien and invasive plant species.	Potential increased incidence of fire during operations leading to a loss of sensitive floral and faunal habitat and diversity.	Failure to implement a well-conceived biodiversity action plan, rehabilitation plan and alien and invasive floral control plan during the decommissioning and closure phase leading to soil compaction, contamination or poor habitat re-establishment.
	Movement of construction vehicles, increasing the possible risk of collision with faunal species and destruction of vegetation.	On-going disturbance may lead to erosion and sedimentation resulting in a loss of floral and faunal habitat and diversity.	
	Potential indiscriminate disposal of operational related waste material in the surrounding habitat.	Potential failure to implement a biodiversity action plan, rehabilitation plan and alien floral control plan during the operational phase leading to further decreased ecological integrity of the terrestrial habitat.	
	Compaction of soils reducing floral re-establishment.	Dust generation during operational activities leading to smothering of biota and associated loss of faunal and floral habitat.	

Pre-Operational	Operational		Decommissioning & Closure (Rehabilitation)
	Increased anthropogenic activity within the proposed mining area, which may lead to an increase in the collection and/or poaching of faunal species and pressure on faunal communities.		

5.1 Impact on Habitat and Diversity for Faunal Species

5.1.1 Impact on the Faunal Habitat Integrity and Species Diversity of the Secondary Grassland Habitat Unit

The Secondary Grassland habitat unit is considered to be of moderately low sensitivity in terms of faunal ecology, this is due to the disturbed nature of the area as a result of historic and ongoing anthropogenic activities, limiting faunal habitat and food availability for common faunal species. The impact associated with the loss of faunal habitat is considered to be of medium significance during the operational phase and the decommisdioning and closure (rehabilitation) phase of the proposed mining activity prior to the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance may further be reduced to low levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	M	M	M	M	Medium
Decommissioning and closure (rehabilitation) phase	M	H	L	M	H	Medium
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	L	L	L	L	Low
Decommissioning and closure (rehabilitation) phase	M	L	L	L	L	Low
Mitigation Measures	* No trapping, collecting or hunting of faunal species must be allowed during any phases of the proposed mining development. * Sensitive faunal habitat and associated buffer zones adjacent to footprint areas must be designated as No-Go areas, and no mining vehicles, personnel, or any other mining-related activities are to encroach upon these areas. * Road margins close to telephone lines and power lines must be burned and/or mowed regularly to prevent microhabitat for small mammals that could be hunted by raptors. By keeping the grass height low, it lowers the possibility of raptors colliding with vehicles. *Haul roads used by mining vehicles must be treated in such a way as to lower dust pollution within the surrounding areas. * Edge effects of all operational activities, such as erosion and alien and invasive plant species proliferation, which may affect adjacent Secondary Grassland habitat providing habitat for faunal					

	species within surrounding areas, need to be strictly managed adjacent to the proposed infrastructure footprint areas. Specific mention in this regard is made to Category 1b species identified within the development footprint areas. * Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a suitable specialist. This rehabilitation plan should consider ongoing rehabilitation during the operational phase of the project as well as rehabilitation actions to be undertaken during mine closure. This could improve the habitat availability and species diversity of faunal species within the surrounding area. * Lighting pollution and its effect on fauna (with special mention of invertebrates, bats and avifauna) must be effectively mitigated with the following guidelines in mind: • Downward facing lights must be installed and limited to essential areas; and • Covers/light diffusers must be installed to lessen the intensity of illumination if at all possible.

5.1.2 Impact on the Faunal Habitat Integrity and Species Diversity of the Degraded Grassland Habitat Unit

This habitat unit is considered of low sensitivity in terms of faunal ecology. This is due to current and historical anthropogenic activities, disposal of building rubble and the proliferation of alien and invasive plant species. Only common faunal species that are able to adapt to urban development will utilise the Degraded Grassland habitat unit for breeding and foraging purposes. The impact associated with the loss of faunal habitat is considered to be of medium significance during all phases of the proposed development prior to the implementation of mitigation measures. The impact score is due to loss of habitat, even if common faunal species occurred within this habitat unit and due to poor or no rehabilitation measures. Should mitigation measures not be fully implemented faunal habitat could possibly be reinstated to some degree. With the implementation of mitigation measures, the impact significance may further be reduced to low levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	L	L	L	M	Medium
Decommissioning and closure (rehabilitation) phase	M	M	L	M	H	Medium
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	L	L	L	L	Low
Decommissioning and closure (rehabilitation) phase	M	L	L	L	L	Low
Mitigation Measures	* No trapping, collecting or hunting of faunal species must be allowed during any phases of the proposed mining development. * Road margins close to telephone lines and power lines must be burned and/or mowed regularly to prevent microhabitat for small mammals that could be hunted by raptors. By keeping the grass height low, it lowers the possibility of raptors colliding with vehicles. * Edge effects of all operational activities, such as erosion and alien and invasive plant species proliferation, which may affect adjacent Secondary Grassland habitat providing habitat for faunal					

	species within surrounding areas, need to be strictly managed adjacent to the proposed infrastructure footprint areas. Specific mention in this regard is made to Category 1b species identified within the development footprint areas. * Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a suitable specialist. This rehabilitation plan should consider ongoing rehabilitation during the operational phase of the project as well as rehabilitation actions to be undertaken during mine closure. This could improve the habitat availability and species diversity of faunal species within the surrounding area. * Lighting pollution and its effect on fauna (with special mention of invertebrates, bats and avifauna) must be effectively mitigated with the following guidelines in mind: • Downward facing lights must be installed and limited to essential areas; and • Covers/light diffusers must be installed to lessen the intensity of illumination if at all possible.

5.2 IMPACT 2: Impact on Important Faunal Species and Species of Conservation Concern

Impacts associated with the Transformed habitat and Built-up area were not assessed due to their poor and degraded state, habitat transformation and very little to no potential to house faunal SCC. The freshwater features are not directly impacted by the footprint of the opencast areas and associated infrastructure. The impacts for the Freshwater features from a freshwater function and sensitivity were discussed in detail in the Freshwater Report (SAS, 2019).

5.2.1 Impact on Important Faunal Species and Species of Conservation Concern within the Secondary Grassland Habitat Unit

No faunal SCC was identified within the Secondary Grassland habitat unit. The only faunal SCC that will likely utilise the Secondary Grassland Habitat for occasional foraging purposes will be *Atelerix frontalis* (Southern African Hedgehog, NT). No other faunal SCC will utilise this area due to the anthropogenic activities, including uncontrolled burning of veld and mowing of extended areas. The impact associated with the loss of faunal SCC is considered to be of medium significance during all phases of the proposed development prior to the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance may further be reduced to low levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	M	L	M	M	Medium
Decommissioning and closure (rehabilitation) phase	M	M	L	M	M	Medium
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	M	L	L	L	L	Low
Decommissioning and closure (rehabilitation) phase	M	L	L	L	L	Low
Mitigation Measures	* No trapping, collecting or hunting of faunal species must be allowed during any phases of the proposed mining development. * Road margins close to telephone lines and power lines must be burned and/or mowed regularly to prevent microhabitat for small mammals that could be hunted by raptors. By keeping the grass height low, it lowers the possibility of raptors colliding with vehicles. * Any disturbance of sensitive faunal habitat (Freshwater features) must be actively avoided. In this regard, maintaining migratory corridors and connectivity in the Freshwater and Secondary Grassland habitat units is deemed essential. * Awareness campaigns must be implemented to inform all construction and mine workers, especially vehicle operators/drivers, of the importance of faunal species within the study area, including the presence of faunal SCC species.					

5.2.2 Impact on Important Faunal Species and Species of Conservation Concern within the Degraded Grassland Habitat Unit

No faunal SCC was identified within the Degraded Grassland Habitat, and there is a low probability of such species occurring permanently within this area due to the anthropogenic activities, including the proliferation of alien and invasive plant species and mowing of areas, rendering faunal SCC movement through the area unlikely. The impact associated with the loss of faunal SCC to be of low significance during all phases of the proposed development prior to the implementation of mitigation measures. With the implementation of mitigation measures, the impact significance may further be reduced to low levels.

Unmanaged						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	L	L	L	L	Low
Decommissioning and closure (rehabilitation) phase	M	L	L	L	L	Low
Managed						
	Intensity	Duration of impact	Spatial Scale	Consequence	Probability	Significance
Operational phase	L	L	L	L	L	Low
Decommissioning and closure (rehabilitation) phase	L	L	L	L	L	Low

Mitigation Measures	* No trapping, collecting or hunting of faunal species must be allowed during any phases of the proposed mining development. * Road margins close to telephone lines and power lines must be burned and/or mowed regularly to prevent microhabitat for small mammals that could be hunted by raptors. By keeping the grass height low, it lowers the possibility of raptors colliding with vehicles.

5.3 Assessment Summary

Tables 13 and 14 below summarise the findings, indicating the significance of the impact before mitigation takes place and the likely impact if management and mitigation take place. In the consideration of mitigation, it is assumed that a high level of mitigation takes place, but which does not lead to prohibitive costs.

Prior to mitigation, the impacts within the Secondary Grassland Habitat Unit on faunal habitat integrity are medium significance. If effective mitigation takes place, impacts on the faunal habitat integrity and species diversity may be reduced to low significance impacts. Moreover, prior to mitigation the impacts within the Secondary Grassland Habitat Unit on faunal SCC are medium significance, whereas if effective mitigation takes place, impacts on faunal SCC can be reduced to low significance impacts.

For the Degraded Grassland habitat unit, the impacts on the faunal habitat integrity and species diversity are medium significance impacts, which should remain at a low level if effective mitigation takes place. Prior to mitigation, as well as with the implementation of mitigation, the impacts within the Degraded Grassland habitat unit on faunal SCC are low significance impacts, if effective mitigation takes place, impacts on faunal SCC can remain at low significance impacts.

Table 13: A summary of the results obtained from the impact assessment for the operational phase for the focus area.

Impact	Unmanaged	Managed
Secondary Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for faunal Species	Medium	Low
Impact on faunal Species of Conservation Concern	Medium	Low
Degraded Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for faunal Species	Medium	Low
Impact on faunal l Species of Conservation Concern	Low	Low

Table 14: A summary of the results obtained from the impact assessment for the decommissioning and closure phase for the focus area.

Impact	Unmanaged	Managed
Secondary Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for faunal Species	Medium	Low
Impact on faunal Species of Conservation Concern	Medium	Low
Degraded Grassland Habitat Unit		
Impact on Habitat Integrity and Species Diversity for faunal Species	Medium	Low
Impact on faunal Species of Conservation Concern	Low	Low

5.4 Faunal Resource Impact Mitigation

Based on the findings of the faunal ecological assessment, several recommendations are made to minimise the impact on the faunal ecology of the area, should the proposed mining project proceed. Please note that many of the mitigation measures applicable to floral ecology (refer to Section B) are also applicable to faunal ecology and to avoid repetition, were omitted. However, all floral mitigation measures must be implemented in conjunction with faunal mitigation measures.

5.5 Cumulative Impacts

The proposed MRA is located within an area of increasing pressure from current and historic mining and residential / industrial development. Significant habitat loss has already occurred within the surrounding area as a result of historical mining activities and illegal disposal of waste material, with thickets of *Eucalyptus camaldulensis* (indicating historical disturbance). Due to the high levels of disturbance, only commonly occurring faunal species were noted within proposed MRA. Mining activities and the associated infrastructure will result in a loss of faunal habitat and species diversity and will thus contribute to the overall impact in the area. Therefore, it is vital that rehabilitation measures be implemented within a phased manner as opencast activities are completed to ensure that the habitat and species diversity of the area is restored or reinstated.

6 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to conduct a terrestrial ecological assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The objective of this focus was to provide sufficient information on the faunal ecology of the area, together with other studies on the physical and socio-cultural environment for the Environmental Assessment Practitioner (EAP) and the relevant authorities to apply the principles of Integrated Environmental Management (IEM) and the concept of sustainable development. The needs for conservation as well as the risks to other spheres of the physical and socio-cultural environment need to be compared and considered along with the need to ensure economic development of the country.

It is recommended that, from a faunal ecological perspective, the proposed development activity be considered acceptable, provided that the recommended mitigation measures for the identified impacts (as outlined in Section 5 of this report) are adhered to.

Based on the findings of the ecological assessment, from a faunal ecological perspective, the proposed mining activity poses minimal risk to the faunal resource management and conservation initiatives for the area, due to the present significantly decreased ecological integrity and transformation of the area. However, in order that the significance of perceived impacts remain low, all essential mitigation measures and recommendations presented in this report must be adhered. This could possibly ensure that the ecology within the proposed Mining Right Application Area, is protected or adequately rehabilitated where necessary, in order to ensure that the intended post-closure land use objectives are met.

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APPENDIX A: Faunal Method of Assessment

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. The presence of human habitation nearby the focus area and the associated anthropogenic activities may have an impact on faunal behaviour and in turn the rate of observations. In order to increase overall observation time within the focus area, as well as increasing the likelihood of observing shy and hesitant species, camera traps were strategically placed within the focus area. Sherman traps were also used to increase the likelihood of capturing and observing small mammal species, notably small nocturnal mammals.

Figure A1: Sherman trap and bait used to capture and identify small mammal species.

Mammals

Mammal species were recorded during the field assessment with the use of visual identification, spoor, call and dung. Specific attention was paid to mammal SCC as listed by the International Union for the Conservation of Nature (IUCN), 2015.

Avifauna

The Southern African Bird Atlas Project 2 database (http://sabap2.adu.org.za/) was compared with the recent field survey of avifaunal species identified on the focus area. Field surveys were undertaken utilising a pair of Bushnell 10x50 binoculars and bird call identification techniques were utilised during the assessment in order to accurately identify avifaunal species. Specific attention was given to avifaunal SCC listed on a regional and national level, as well as those identified by the IUCN.

Reptiles

Reptiles were identified during the field survey. Suitable applicable habitat areas (rocky outcrops and fallen dead trees) were inspected and all reptiles encountered were identified. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which reptile species are likely to occur on the focus area. Specific attention was given to reptile SCC listed on a regional and national level, as well as those identified by the IUCN.

Amphibians

Identifying amphibian species is done by the use of direct visual identification along with call identification techniques. Amphibian species flourish in and around wetland, riparian and moist grassland areas. It is unlikely that all amphibian species will have been recorded during the site assessment, due to their cryptic nature and habits, varied stages of life cycles and seasonal and temporal fluctuations within the environment. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which amphibian species are likely to occur within the focus area as well as the surrounding area. Specific attention was given to amphibian SCC listed on a regional and national level, as well as those identified by the IUCN.

Invertebrates

Whilst conducting transects through the focus area, all insect species visually observed were identified, and where possible photographs taken. Furthermore, at suitable and open sites within the focus area sweep netting was conducted, and all the insects captured identified. Due to the terrain, and shallow/ rocky soil structure pitfall traps were not utilised during the site assessment.

It must be noted however that due to the cryptic nature and habits of insects, varied stages of life cycles and seasonal and temporal fluctuations within the environment, it is unlikely that all insect species will have been recorded during the site assessment period. Nevertheless, the data gathered during the assessment along with the habitat analysis provided an accurate indication of which species are likely to occur in the focus area at the time of survey. Specific attention was given to insect SCC listed on a regional and national level, as well as those identified by the IUCN.

Arachnids

Suitable applicable habitat areas (rocky outcrops, sandy areas and fallen dead trees) where spiders and scorpions are likely to reside were searched. Rocks were overturned and inspected for signs of these species. Specific attention was paid to searching for Mygalomorphae arachnids (Trapdoor and Baboon spiders) as well as potential SCC scorpions within the focus area.

Faunal Species of Conservational Concern Assessment

The Probability of Occurrence (POC) for each faunal SCC was determined using the following four parameters:

- Species distribution;
- Habitat availability;
- Food availability; and
- Habitat disturbance.

The accuracy of the calculation is based on the available knowledge about the species in question. Therefore, it is important that the literature available is also considered during the calculation. Each factor contributes an equal value to the calculation.

Scoring Guideline				
Habitat availability				
No Habitat	Very low	Low	Moderate	High
1	2	3	4	5
Food availability				
No food available	Very low	Low	Moderate	High
1	2	3	4	5
Habitat disturbance				
Very High	High	Moderate	Low	Very Low
1	2	3	4	5
Distribution/Range				
Not Recorded		Historically Recorded		Recently Recorded
1		3		5

[Habitat availability + Food availability + Habitat disturbance + Distribution/Range] / 20 x 100 = POC%

Faunal Habitat Sensitivity

The sensitivity of the focus area for each faunal class (i.e. mammals, birds, reptiles, amphibians and invertebrates) was determined by calculating the mean of five different parameters which influence each

faunal class and provide an indication of the overall faunal ecological integrity, importance and sensitivity of the focus area for each class. Each of the following parameters is subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Faunal SCC:** The confirmed presence or potential for faunal SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Habitat Availability:** The presence of suitable habitat for each class;
- **Food Availability:** The availability of food within the focus area for each faunal class;
- **Faunal Diversity:** The recorded faunal diversity compared to a suitable reference condition such as surrounding natural areas or available faunal databases; and
- **Habitat Integrity:** The degree to which the habitat is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contributes equally to the mean score, which determines the suitability and sensitivity of the focus area for each faunal class. A conservation and land-use objective is also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the focus area in relation to each faunal class. The different classes and land-use objectives are presented in the table below:

Table A1: Faunal habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Preserve and enhance the biodiversity of the habitat unit surrounds while optimising development potential.
4> and <5	Moderately high	Preserve and enhance the biodiversity of the habitat unit, development and disturbance.
5	High	Preserve and enhance the biodiversity of the habitat unit; no-go alternative must be considered.

APPENDIX B: Impact Assessment Methodology

Impacts are assessed based on consideration of the impact severity, spatial scale and duration of impacts, which together determine the impact consequence. The impact consequence together with the probability of the impact occurring determine the overall impact significance.

The criteria for determining the severity, spatial scale and duration of potential impacts are presented in Table B1. The criteria are based on the criteria detailed in *Department of Environmental Affairs and Tourism (DEAT, 2002) Specialist Studies, Integrated Environmental Management Information Series 4, Department of Environmental Affairs and Tourism (DEAT), Pretoria*; *DEAT (2002) Impact Significance, Integrated Environmental Management Information Series 5, Department of Environmental Affairs and Tourism (DEAT)* and the criteria and methodology developed by Theo Hacking[2]. Table B1 also provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact).

Table B1: Criteria for the assessment of impacts.

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE		Significance = consequence x probability
Definition of CONSEQUENCE		Consequence is a function of severity, spatial extent and duration
Criteria for ranking of the SEVERITY of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

Impact consequence and significance are determined from Table B2 and Table B3. The interpretation of the impact significance is presented in Table B4.

[2] Hacking, Theo (1999) An innovative approach to structuring environmental impact assessment reports. Anglo American Corporation-Envirolink. Unpublished.

Table B2: Method of determining impact consequence.

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	H	Medium	Medium	Medium
	Medium term	M	Low	Low	Medium
	Short term	L	Low	Low	Medium
SEVERITY = M					
DURATION	Long term	H	Medium	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Low	Medium	Medium
SEVERITY = H					
DURATION	Long term	H	High	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Medium	Medium	High
			L	M	H
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

Table B3: Method of determining impact and significance.

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	H	Medium	Medium	High
	Possible/ frequent	M	Medium	Medium	High
	Unlikely/ seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

Table D4: Interpretation impact significance.

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
High	Influences the decision regardless of any possible mitigation.
Medium	Should have an influence on the decision unless it is mitigated.
Low	Will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

Control Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed project:

- Mitigation and performance improvement measures and actions that address the risks and impacts[3] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - The minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the terrestrial ecology of the resources traversed by or in close proximity of the proposed infrastructure.

[3] Mitigation measures should address both positive and negative impacts

APPENDIX C: Faunal SCC

GDARD IDENTIFIED SPECIES

Table C1: Priority mammal species provided by GDARD and that have either been recorded within the QDS 2627BB or in which suitable habitat has been identified.

Common Name	Species	IUCN v3.1
Spotted-necked otter	*Hydrictis maculicollis*	NT
African clawless otter	*Aonyx capensis*	NT
African Grass Owl	*Tyto capensis*	VU
African Marsh Harrier	*Circus ranivorus*	VU
Giant Bullfrogs[4]	*Pyxicephalus adspersus*	LC

LC = Least Concern, NT = Near Threatened, VU = Vulnerable

AVIFAUNA

Table C2: Avifaunal Species for the Gauteng Province (GDARD 2014).

Scientific Name	Common name	IUCN Status	Regional Status	GDARD Status
Gyps coprotheres	Cape Vulture	EN	EN	VU
Anthropoides paradiseus	Blue Crane	VU	NT	VU
Falco naumanni	Lesser Kestrel	LC	Ad mon	-
Tyto capensis	African Grass-Owl	LC	VU	VU
Circus ranivorus	African Marsh-Harrier	LC	EN	VU
Gorsachius leuconotus	White-backed Night Heron	LC	VU	VU
Eupodotis senegalensis	White-bellied Korhaan	LC	VU	VU
Podica senegalensis	African Finfoot	LC	VU	VU
Mirafra cheniana	Melodious Lark	NT	End and N-end	NT
Sagittarius serpentarius	Secretary bird	VU	VU	NT
Ciconia nigra	Black Stork	LC	VU	-
Eupodotis caerulescens	Blue Korhaan	NT	End and N-end	NT
Polemaetus bellicosus	Martial Eagle	VU	EN	-
Phoenicopterus minor	Lesser Flamingo	NT	NT	-
Phoenicopterus roseus	Greater Flamingo	LC	NT	-
Alcedo semitorquata	Half-collared Kingfisher	LC	NT	NT

NT = Near Threatened, VU = Vulnerable

Table C3: Threatened bird species included in the NEMBA Threatened and Protected Species (TOPS, 2015) for Gauteng.

Common Name	Scientific Name	Threat Status
Tawny Eagle	*Aquila rapax*	EN
White-backed Vulture	*Gyps africanus*	EN

EN = Endangered

[4] The 2627BB QDGC is known to support Giant Bullfrogs (Pyxicephalus adspersus) which, though no longer red data listed, remain of conservation concern and expert input should be obtained if the habitat on site is suitable.

INVERTEBRATES

Table C4: RDL Invertebrates Species for the Gauteng Province (GDARD 2014)

Scientific Name	Common name	IUCN Status	GDARD Status
Lepidochrysops praeterita	Highveld Blue Butterfly	NYBA	VU
Chrysoritis aureus	Heidelberg Copper	NYBA	VU
Ichnestoma stobbiai	Stobbia's Fruit Chafer Beetle	NYBA	VU
Aloeides dentatis	Roodepoort Copper Butterfly	NYBA	VU

VU = Vulnerable, NYBA = Not yet been assesses

Table C5: Threatened invertebrate species included in the NEMBA Threatened and Protected Species (TOPS, 2015) for Gauteng.

Common Name	Scientific Name	Threat Status
Inland Small Stag Beetle	*Oonotus interioris*	VU

VU = Vulnerable

MAMMALS

Table C6: Threatened mammal species included in the Gauteng Conservation Plan V3.3.

Scientific Name	Common name	IUCN Status	GDARD Status
Neamblysomus julianae	Juliana's Golden Mole	EN	VU
Mystromys albicaudatus	White-tailed Mouse	EN	EN
Atelerix frontalis	Southern African Hedgehog	LC	NT
Lutra maculicollis	Spotted-necked Otter	NT	NT
Miniopterus schreibersii	Scheiber's Long-Fingered Bat	NT	NT
Myotis tricolor	Temminck's Hairy Bat	LC	NT
Rhinolophus blasii	Blasius's/Peak-Saddle Horseshoe Bat	LC	VU
Rhinolophus clivosus	Horseshoe Bat	LC	NT
Rhinolophus darlingi	Darling's Horseshoe Bat	LC	NT
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat	LC	NT

EN = Endangered, VU = Vulnerable, NT = Near Threatened

Table C7: Threatened mammal species included in the NEMBA Threatened and Protected Species (TOPS, 2015) of Gauteng.

Common Name	Scientific Name	Threat Status
Pangolin	*Manis temminckii*	VU

VU = Vulnerable

REPTILES

Table C8: Threatened reptile species included in the NEMBA Threatened and Protected Species (TOPS, 2015) of Gauteng.

Scientific Name	Common name	IUCN Status	GDARD Status
Homoroselaps dorsalis	Striped Harlequin Snake	NT	NT

NT = Neat Threatened

South African Bird Atlas Project 2 list for quadrant 2627BB

Table C9: Avifaunal Species for the pentads 2605_2750, 2610_2745, and 2610_2750 within the QDS 2627BB

Pentads	Link to pentad summary on the South African Bird Atlas Project 2 web page
2605_2750	http://sabap2.adu.org.za/pentad_info.php?pentad=2605_2750#menu_top
2610_2745	http://sabap2.adu.org.za/pentad_info.php?pentad=2610_2745#menu_top
2610_2750	http://sabap2.adu.org.za/pentad_info.php?pentad=2610_2750#menu_top

APPENDIX D: Observed and Expected Faunal Species

Table D1: Mammal species recorded during the field assessment.

Scientific Name	Common Name	IUCN Status	Protected Status
Lepus saxatilis	Scrub hare	LC	-
Canis familiaris.	Domestic dog	-	-

Highlighted species are protected species

Table D2: Avifaunal species recorded during the field assessment.

Scientific name	English name	National Conservation Status (Taylor *et al.* 2015)	IUCN Status
Upupa africana	African Hoopoe	LC	LC
Ortygospiza fuscocrissa	African Quail-finch	LC	LC
Threskiornis aethiopicus	African Sacred Ibis	LC	LC
Saxicola torquatus	African Stonechat	LC	LC
Ardea melanocephala	Black-headed Heron	LC	LC
Elanus caeruleus	Black-shouldered Kite	LC	LC
Vanellus armatus	Blacksmith Lapwing	LC	LC
Macronyx capensis	Cape Longclaw	LC	LC
Passer melanurus	Cape Sparrow	LC	LC
Streptopelia capicola	Cape Turtle Dove	LC	LC
Motacilla capensis	Cape Wagtail	LC	LC
Lanius collaris	Common Fiscal	LC	LC
Acridotheres tristis	Common Myna	LC	LC
Vanellus coronatus	Crowned Lapwing	LC	LC
Pycnonotus tricolor	Dark-capped Bulbul	LC	LC
Ardea cinerea	Grey Heron	LC	LC
Bostrychia hagedash	Hadeda Ibis	LC	LC
Numida meleagris	Helmeted Guineafowl	LC	LC
Passer domesticus	House Sparrow	LC	LC
Streptopelia senegalensis	Laughing Dove	LC	LC
Apus affinis	Little Swift	LC	LC
Euplectes progne	Long-tailed Widowbird	LC	LC
Asio capensis	Marsh Owl	LC	LC
Cisticola fulvicapilla	Neddicky	LC	LC
Corvus albus	Pied Crow	LC	LC
Calandrella cinerea	Red-capped Lark	LC	LC
Streptopelia semitorquata	Red-eyed Dove	LC	LC
Urocolius indicus	Red-faced Mousebird	LC	LC
Columba livia	Rock Dove	LC	LC
Ploceus velatus	Southern Masked Weaver	LC	LC
Euplectes orix	Southern Red Bishop	LC	LC
Colius striatus	Speckled Mousebird	LC	LC
Columba guinea	Speckled Pigeon	LC	LC

Scientific name	English name	National Conservation Status (Taylor *et al.* 2015)	IUCN Status
Cisticola juncidis	Zitting Cisticola	LC	LC

LC = Least Concern, N-End Near-endemic

Table D3: Reptile species recorded during the field assessment.

Scientific name	Common Name	IUCN 2016 Status
Trachylepis punctatissima	Montane Striped Skink	LC

LC = Least Concern, NYBA = Not Yet Been Assessed

Table D4: General invertebrate recorded during the field assessment.

Scientific Name	Common Name	IUCN 2016 Status
Eurema brigitta	Broad-bordered Grass Yellow	NYBA
Belenois aurota	Brown-veined White	NYBA
Junonia hierta	Yellow Pansy	LC
Musca domestica	House Fly	NYBA
Catantops humeralis	N/A	NYBA
Odaleus sp.	N/A	NYBA
Rhachitopis sp.	N/A	NYBA
Anterhynchium natalense	N/A	NYBA
Anoplolepis custodiens	Pugnacious Ant	NYBA
Gryllus bimaculatus	Common Garden Cricket	NYBA
Cheilomenes lunata	Lunate Ladybird	NYBA
Spilostethus pandurus	Milkweed Bug	NYBA

LC = Least Concern, NYBA = Not yet been assessed by the IUCN

Table D5: Arachnid species recorded during the site assessment.

Common Name	Scientific Name	IUCN 2016 Status
Thomisus onustus	Crab Spider	NYBA
Argiope trifasciata	Banded Garden Orb-web spider	
Olurunia ocellata	Grass Funnel-web Spider	NYBA

LC = Least Concern, NYBA = Not Yet Been Assessed

FRESHWATER RESOURCE AND AQUATIC ECOLOGICAL ASSESSMENT FOR THE PROPOSED WEST WITS MINING PROJECT

Prepared for

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May 2019

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EXECUTIVE SUMMARY

Based on the findings of the freshwater and aquatic assessment, the watercourses assessed are ecologically impacted, and moderately to largely modified mainly due to historical and recent mining activities. As per the results of the impact assessment, it is the opinion of the ecologist that the proposed West Wits Mining Project does not pose a direct and significant risk to the watercourses as the watercourses will not be contaminated through the proposed mining processes, provided that adherence to cogent, well-conceived and ecologically sensitive site development plans, and the mitigation measures provided in this report as well as general good mining practice, are strictly adhered to.

It is the opinion of the specialist therefore that the proposed mining activities, from a watercourse ecological perspective, be considered favourably, with the proviso that strict adherence to mitigation measures is enforced, in order to ensure that the already degraded ecological integrity of the watercourses not be further compromised.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a Freshwater and Aquatic Ecological Assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining of the proposed West Wits Project, located north of Soweto, Gauteng Province. The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA.

In broad terms the proposed project entails:

- The development of five open pit mining areas, referred to as:
  - Mona Lisa Bird Reef Pit;
  - Roodepoort Main Reef Pit;
  - Rugby Club Main Reef Pit;
  - 11 Shaft Main Reef Pit; and
  - Kimberley Reef East Pit.
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings):
  - Bird Reef Central Infrastructure Complex; and
  - Kimberley Reef East Infrastructure Complex.

The project will also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps (WRD) as well as supporting infrastructure.

The purpose of this report is to define the ecology of the proposed development in terms of watercourse characteristics, including mapping of the watercourses, defining areas of increased Ecological Importance and Sensitivity (EIS), and defining the Present Ecological State (PES) of the watercourses associated with the proposed MRA. This report additionally presents the results obtained during the aquatic ecological assessment, which include the *in-situ* water quality at two points along the Klip River, as well as at a single point along an unnamed tributary of the Klip River, a survey of habitat conditions for aquatic macro-invertebrates and aquatic macro-invertebrate community integrity. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

This study further aims to provide detailed information to guide the proposed project activities in the vicinity of the watercourses, to ensure the ongoing functioning of the ecosystems, such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development. This report, after

consideration of the above, must guide the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed mining activities from a watercourse management and aquatic ecology perspective.

Freshwater Assessment

- A desktop study was conducted, in which possible watercourses were identified for on-site investigation, and relevant national and provincial databases were consulted. The results of the desktop study are contained in Section 3 of this report;
- Field assessments took place in March and June 2018, in order to ground-truth the identified watercourses associated with the proposed MRA;
- During the field assessment, several watercourses, comprising three Hydrogeomorphic (HGM) types, were identified within the proposed MRA. These include several channelled valley bottom wetlands, pans/depressions and the Klip River system. These watercourses have all been impacted upon to some degree, with specific mention of the historical and ongoing surrounding agricultural, mining activities and rapid urbanisation; and
- Due to the extent of the proposed MRA, only those watercourses in which surface infrastructure/open pit areas are located within 500 m of the watercourses were assessed. Due to the topography and the existing developments within the proposed MRA, the proposed mining activities not within 500 m of a watercourse are considered to have a negligible impact on those watercourses.

A summary of the assessment of the watercourses are presented in the table below.

Table A: Summary of the results of the field assessment.

Watercourse	Locality within the proposed MRA	PES	Ecoservices	EIS	REC
Klip River	Located on the western boundary of the proposed MRA. The Mona Lisa Bird Reef Pit is approximately 760 m east of the river.	C/D (Moderately to Largely Modified)	Intermediate	B (High)	D (Largely Modified)
*CVB 2	Located within the western portion of the proposed MRA. The Mona Lisa Bird Reef Pit is located approximately 57 m north of this CVB.	D (Largely Modified)	Intermediate	B (High)	D (Largely Modified)
*CVB 3	Located within the eastern portion of the proposed MRA and investigation area. The 11 Shaft Main Reef Pit is located approximately 54 m north of the wetland.	D (Largely Modified)	Moderately Low/ Intermediate	B (High)	D (Largely Modified)

*CVB = Channelled Valley Bottom

Aquatic Assessment

Table B: Summary of the results of the biota specific water quality and potential impacts on the aquatic community of the Klip River and the unnamed tributary.

Water management area: Upper Vaal	
Quaternary Catchment: C22A	
Ecoregion: Highveld	
Weather condition: Warm and clear during the high flow assessment (March 2018) and cool and clear during the low flow assessment (June 2018).	
Flows: Moderately low during both assessments.	
Water Clarity: Clear during high flow assessment and discoloured during the low flow assessment.	
Map: Two monitoring points on the Klip River and two monitoring points on an unnamed tributary, to indicate the PES prior to the proposed mining activity.	

Table B (continued): Summary of the results of the biota specific water quality and potential impacts on the aquatic community of the Klip River and the unnamed tributary.

Site KLIP US		Site KLIP DS	
High Flow (March 2018)	Low Flow (June 2018)	High Flow (March 2018)	Low Flow (June 2018)
			
Water quality: pH 5.65 EC 32.4 mS/m Temperature 21.0 ºC DO 6.38 mg/l DO saturation 87.2 % sat	Water quality: pH 8.02 EC 48.5 mS/m Temperature 8.0 ºC DO 8.38 mg/l DO saturation 85.6 % sat	Water quality: pH 6.01 EC 34.6 mS/m Temperature 20.5 ºC DO 1.87 mg/l DO saturation 25.2 % sat	Water quality: pH 8.02 EC 73.2 mS/m Temperature 9.0 ºC DO 6.74 mg/l DO saturation 68.4 % sat
Aquatic Macro-invertebrate community assessment: SASS5 Score: 71 ASPT Score: 4.4 MIRAI: 63.4% (Category C)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 57 ASPT Score: 3.8 MIRAI: 61.2% (Category C)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 25 ASPT Score: 3.1 MIRAI: 58.0% (Category D)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 18 ASPT Score: 3.0 MIRAI: 53.5% (Category D)
Invertebrate Habitat Assessment: Class: Poor IHAS Score: 52	Invertebrate Habitat Assessment: Class: Adequate IHAS Score: 60	Invertebrate Habitat Assessment: Class: Adequate IHAS Score: 63	Invertebrate Habitat Assessment: Class: Adequate IHAS Score: 64
Habitat Integrity: Instream IHI: 71.1 (Category C) Riparian IHI: 65.1 (Category C)	Habitat Integrity: Instream IHI: 57.3 (Category D) Riparian IHI: 66.2 (Category C)	Habitat Integrity: Instream IHI: 57.5 (Category D) Riparian IHI: 58.5 (Category D)	Habitat Integrity: Instream IHI: 60.1 (Category C) Riparian IHI: 59.1 (Category D)
Integrated Ecological Category: Category C	Integrated Ecological Category: Category C	Integrated Ecological Category: Category D	Integrated Ecological Category: Category D

Table B (continued): Summary of the results of the biota specific water quality and potential impacts on the aquatic community of the Klip River and the unnamed tributary.

Site UN-TRIB US		Site UN-TRIB DS	
High Flow (March 2018)	Low Flow (June 2018)	High Flow (March 2018)	Low Flow (June 2018)
			
Water quality: pH 5.59 EC 72.8 mS/m Temperature 19.3 ºC DO 3.28 mg/l DO saturation 43.7 % sat	Water quality: pH 7.48 EC 77.6 mS/m Temperature 10.4 ºC DO 6.63 mg/l DO saturation 70.3 % sat	Water quality: pH 5.72 EC 29.8 mS/m Temperature 23.5 ºC DO 3.84 mg/l DO saturation 55.3 % sat	Water quality: pH 7.31 EC 50.0 mS/m Temperature 14.5 ºC DO 6.53 mg/l DO saturation 78.4 % sat
Aquatic Macro-invertebrate community assessment: SASS5 Score: 29 ASPT Score: 4.8 MIRAI: 60.3% (Category C)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 4 ASPT Score: 1.0 MIRAI: 38.1% (Category E)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 58 ASPT Score: 4.5 MIRAI: 59.2% (Category D)	Aquatic Macro-invertebrate community assessment: SASS5 Score: 40 ASPT Score: 4.0 MIRAI: 58.0% (Category D)
Invertebrate Habitat Assessment: Class: Good IHAS Score: 67	Invertebrate Habitat Assessment: Class: Poor IHAS Score: 49	Invertebrate Habitat Assessment: Class: Good IHAS Score: 70	Invertebrate Habitat Assessment: Class: Adequate IHAS Score: 59
Habitat Integrity: Instream IHI: 55.4 (Category D) Riparian IHI: 52.9 (Category D)	Habitat Integrity: Instream IHI: 52.3 (Category D) Riparian IHI: 51.8 (Category D)	Habitat Integrity: Instream IHI: 51.8 (Category D) Riparian IHI: 51.8 (Category D)	Habitat Integrity: Instream IHI: 50.7 (Category D) Riparian IHI: 50.7 (Category D)
Integrated Ecological Category: Category D	Integrated Ecological Category: Category D	Integrated Ecological Category: Category D	Integrated Ecological Category: Category D

The water quality of the watercourses may be considered largely altered during both the high flow (March 2018) and low flow (June 2018) assessments. Significant catchment-wide anthropogenic, mining and agricultural activities have caused the deviations observed in the dissolved salt concentration, lowered Dissolved Oxygen (DO) concentration and pH. The Electrical Conductivity (EC) at all three sites increased temporally from the high flow (HF) to the low flow (LF) assessment and slight potential for adverse effects on the aquatic ecology is anticipated. Monitoring of the pH values in future assessments is considered essential as the pH value is an indication of potential AMD occurring and it is likely that during the HF assessment in March 2018, AMD could have lowered the pH within the catchment. The DO concentration of the KLIP DS and UN-TRIB US sites during both assessments was below the 80% saturation (as stipulated by the Target Water Quality Recommendation by the Department of Water Affairs and Forestry (DWAF), 1996 and is therefore considered inadequate in supporting diverse and sensitive aquatic biota. Temperature variation between sites can be explained by diurnal variation and water volume at the time of each assessment.

Spatially, the three sites were compared to determine the present ecological state prior to the proposed West Wits mining project development. The two upstream sites, KLIP US and UN-TRIB US, are considered largely modified in terms of the water quality and from spatial analysis it is clear that the upstream Klip River site is in slightly better condition than its unnamed tributary site. The EC is significantly higher at the UN-TRIB US site, while the DO concentration and pH is lower, indicating the degraded state of the system before any potential activity from the proposed West Wits mining project development. When the upstream and downstream sites of the Klip River were compared, it showed catchment-wide anthropogenic activities as well as point and diffuse sources of pollution between the two sites and therefore existing impacts can be anticipated. Due to the distance between the two points, it is suggested that an additional monitoring point be added closer to the proposed West Wits mining project development on the Klip River to minimise the potential point and diffuse sources of pollution affecting the results of future studies.

From the results of the application of the Index of Habitat Integrity (IHI) to the three sites during the two assessments, it is evident that there is moderate to large impact on the assessment areas of the unnamed tributary of the Klip River and the Klip River. Instream impacts were limited to impacts relating to lack of strong flow, limited aquatic vegetation habitat and channel modifications such as roads and river crossings. Riparian zone impacts were due to a lack of vegetation diversity such as the presence of invasive vegetation, livestock grazing, informal agriculture and indiscriminate disposal of rubbish in certain sections of the sites. The biomonitoring data from both the high and low flow assessments shows that the catchment is already impacted on by point and diffuse sources of pollution. Should the proposed mining activities proceed, addition of similar infrastructure will likely lead to similar impacts (or risks thereof), potentially resulting in a cumulative effect. Should the proposed mining activities proceed, very well planned and executed mitigation is required to avoid and minimise potential impacts on the receiving environment, in line with the requirements of the mitigation hierarchy (prevention, reduction, remediation and compensation) as advocated by the Department of Environmental Affairs (DEA) *et al* 2013.

Impact Assessment

Following the assessment of the watercourses associated with proposed mining infrastructure within the proposed MRA, an impact assessment was performed to ascertain the significance of potential impacts on the receiving environment should the proposed activities within the proposed MRA proceed. The impact assessment was undertaken based on the preliminary layout provided by the proponent, which indicates that the following proposed mining activities are associated with the assessed watercourses:

Table C: Summary of the watercourses and their 500 m surrounding area being intersected by the proposed mining activities.

Watercourse		Proposed mining activity within 500m of a watercourse
Klip River system		Mona Lisa Bird Reef Pit (Haul road associated with this open pit area is approximately 505 m east of the river, whilst all other activities are approximately 760 m east of the river).
CVB Wetlands Group 1	CVB 1	Roodepoort Main Reef Pit (The western portion of the open pit area and associated top soil dump is approximately 415 m upgradient/south of this CVB).
	CVB 2	Mona Lisa Bird Reef Pit (The waste rock dump associated with this open cast area is located approximately 57 m and the open pit area approximately 214 m upgradient/north of this CVB).
CVB Wetlands Group 2	CVB 3	11 Shaft Main Reef Pit (The waste rock dump associated with this open cast area is located approximately 54 m north of the wetland, and the open cast pit is approximately 219 m north of the wetland). Kimberley Reef East Pit & Infrastructure Complex (IC) (A portion of the haul road, open cast pit area and the waste rock dump is located approximately 412 m west of the wetland. Kimberley Reef (KR) new ventilation shaft (Located approximately 280 m west of the wetland).

A summary of the impact assessment is provided in Table D.

Table D: Summary of the impact assessment undertaken as part of the assessment of the proposed West Wits Mining Project

Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Site preparation as part of the development of the proposed surface infrastructure, and haul roads, including placement of contractor laydown areas and storage facilities, associated with the Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area (the closest surface infrastructure components to any of the watercourses, specifically CVB 2 and 3).							
* Removal of vegetation (terrestrial and wetland – albeit significantly disturbed) and associated disturbances (rubble and litter) to the watercourses and the watercourse soils; * Earthworks, leading to the exposure of soils, and thus to increased runoff, erosion and stream incision of the watercourses, and the potential for sedimentation of the downgradient watercourses; * Soil stockpiling; * Increased hardened surfaces and compacted soils thus reducing integrity of interflow; * Potential for increased sedimentation of the watercourse habitat, leading to changes in instream habitat and potentially altering surface water quality (if present); * Decreased ecoservice provision by the watercourses; and * Proliferation of alien vegetation due to disturbances.	Habitat & ecological structure	Unmanaged	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water Quaity		L	L	L	L	L	L
	Habitat & ecological structure	Managed	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water Quality		L	L	L	L	L	L
Impact Discussion	The impact significance of the site preparation activities will have a Low impact significance on the on all five of the ecological aspects. This can be attributed to the distance these activities are located from the watercourses. Allthough the site preparation activities does entail the removal of vegetation, this will primarily be terrestrial vegetation, and not the habitat assocaited with the watercourses. Additionally, due to the existing degraded state of the surrounding terrestrial habitat, the removal thereof is not considered to be significant. Impacts to the watercourse biotic integrity and water quality are expected to be very low, due to these activities located outside of the watercourses.							

Impact		Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Development of the Kimberley Reef (KR) new ventilation shaft (Located approximately 280 m west of the CVB 3)								
* Construction of surface infrastructure, leading to disturbance to surrounding vegetation and soil; * Excavation of shaft and stockpiling of removed materials; * A reduction of groundwater level and/or volumes of the wetland as a result of dewatering of the ventilation shaft, potentially resulting in the formation of a cone of depression.		Habitat & ecological structure	Unmanaged	L	L	L	L	L	L
		Ecoservices		L	L	L	L	L	L
		Biotic integrity		L	L	L	L	L	L
		Hydrology & sediment balance		L	L	L	L	L	L
		Water Quaity		L	L	L	L	L	L
		Habitat & ecological structure	Managed	L	L	L	L	L	L
		Ecoservices		L	L	L	L	L	L
		Biotic integrity		L	L	L	L	L	L
		Hydrology & sediment balance		L	L	L	L	L	L
		Water Quaity		L	L	L	L	L	L
Impact Discussion	The impact significance of the KR new ventilation shaft will have a Low impact significance on the on all five of the ecological aspects. This can be attributed to the distance this ventilation shaft is located from the watercourses. Allthough the construction of this shaft would entail the remaoval of vegetation and the stockpiling of soil, the footprint thereof is small, and thus the potential impact significance thereof is also regarded as low to very low.								

Impact		Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Establishment of the open cast pit areas (Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area) and operation thereof, as these are the open cast areas located the closest to any watercourses								
* Removal of topsoil and placing it along the open cast pit area, to create a topsoil berm, north of the open cast pits. Removal of overburden and stockpiling thereof on the waste rock dumps south of the open cast pits, but north of the wetlands. Runoff from these areas could enter the downgradient wetlands, potentially causing a decrease in the water quality of the surface water and adding to the sediment load within the wetlands; * Possible contamination of surface and ground water, leading to impaired water quality and salination of soils; and * Mining of ore and hauling thereof to the ore crusher, where after it would be transported off-site. Transportation of the ore would cause soil compaction and potential indiscriminate movement of the vehicles within close proximity to the watercourses.		Habitat & ecological structure	Unmanaged	L	M	L	L	M	M
		Ecoservices		L	M	L	L	M	M
		Biotic integrity		M	M	L	M	M	M
		Hydrology & sediment balance		M	M	L	M	M	M
		Water quality		M	M	L	M	M	M
		Habitat & ecological structure	Managed	L	M	L	L	L	L
		Ecoservices		L	M	L	L	L	L
		Biotic integrity		L	M	L	L	L	L
		Hydrology & sediment balance		L	M	L	L	L	L
		Water quality		L	M	L	L	L	L
Impact Discussion	The stockpiling of topsoil and waste rock can increase the sediment load that enters the downgradient watercourses. This in turn may potentially impact on the water quality and the bentic integrity of the watercourses. Runoff from the waste roack dumps and haul roack could further decreased the water quality of the watercourses. The ongoing operation of these activities may potentially impact the habitat provisioning and other ecoservice delivery of the watercourses if mitigation measures are not implemented.								

Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Presence of clean and dirty water separation infrastructure within close proximity to the Zone of Regulation (GN704) of CVB 2 and CVB 3							
* Loss of catchment yield due to storm water containment is expected to occur which will affect the recharge of the wetlands; * Increased flood peaks of water reporting to the downgradient wetlands as a result of formalisation and concentration of surface runoff; and * Potential for erosion of terrestrial soils as a result of the formation of preferential flow paths, leading to sedimentation of the downgradient wetlands.	Habitat & ecological structure	Unmanaged	L	M	L	L	L	L
	Ecoservices		L	M	L	L	L	L
	Biotic integrity		M	M	L	M	M	M
	Hydrology & sediment balance		M	M	L	M	M	M
	Water quality		M	M	L	M	M	M
	Habitat & ecological structure	Managed	L	M	L	L	L	L
	Ecoservices		L	M	L	L	L	L
	Biotic integrity		L	M	L	L	L	L
	Hydrology & sediment balance		L	M	L	L	L	L
	Water quality		L	M	L	L	L	L
Impact Discussion	Loss of catchment yield due to storm water containment is expected to occur which will affect the hydrological regime of the watercourses, however, if water collected within the clean water system is released into the watercourses (and of suitable water quality), the significance of the impact would be low and the loss of catchment yield would be negligible. If the storm water containment structures fail, the dirty water that enters the watercourses can decrease the surface water quality of the watercourses and its biotic integrity. This can also lead to erosion and subsequent sedimentation of the watercourses if mitigation measures are not implemented.							
CLOSURE AND DECOMMISSIONING PHASE								
Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Backfilling of the open cast pit areas with material from the WRD and topsoil stockpiles. These activities are the closest in proximity to CVB 2 and 3.							
* Removal and utilisation of materials from the WRD could cause sedimentation of the downgradient wetlands; * Vehicles used as part of the backfilling activities could potentially drive indiscriminately through the wetlands; * Topsoil used could contain seeds from invasive and alien plant species; and * The profile of the infilled opencast areas potentially allows for preferential flow paths to develop and erosion gullies to establish, transporting sediment-laden water into the downgradient wetlands.	Habitat & ecological structure	Unmanaged	M	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		M	L	L	L	L	L
	Water quality		L	L	L	L	L	L
	Habitat & ecological structure	Managed	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water quality		L	L	L	L	L	L
Impact Discussion	The decommissioning of the surface infrastructure is expected to disturb the established vegetation, which in turn may potentially impact on the habitat and ecological structure of the watercourses. The potential for sediment to enter the watercourses is also increased, due to dust creation and vehicle movement. Nevertheless, the impacts are expected to be of low impact significance due to their distance from the watercourses.							

Based on the outcome of the impact assessment, almost all of the activities associated with the construction and operational mining activities were determined to have a low impact significance on the watercourses, prior to the implementation of mitigation measures. The impact of the establishment of

the open cast pit areas (Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area) and operation thereof (these are the proposed mining activities within the closest proximity to any watercourses) was determined to have a moderate impact significance on the CVB 2 and CVB 3 wetlands prior to the implementation of mitigation measures. The overall low impact significance is mainly due to the distance between the activities and the watercourses. With the implementation of the mitigation measures, all activities associated with the construction phase, and most of the activities associated with the operational phase would pose a low impact significance to the watercourses. In this regard, specific mitigation measures to be implemented to ensure a very low impact significance include limiting driving through the watercourses (use only existing watercourse road crossings) and all temporary stockpiles should be located outside of the GN704 Zone of Regulation.

The loss of catchment yield is considered to have a low impact significance on the watercourses. If water collected within the clean water system is released into the watercourses (if it is of suitable water quality), the significance of the impact would be very low and the loss of catchment yield would be negligible. It is important that the stormwater infrastructure is regularly inspected to prevent any dirty water from entering the watercourses and to prevent erosion and sedimentation of the watercourses.

During the closure phase of the proposed mining project, backfilling of the open cast pit areas with the implementation of mitigation measures would have a very low impact significance on the watercourses. It is recommended that material from the waste rock dumps be used to fill the open cast pits and that the backfilled areas be reprofiled so as to resemble that of the natural landscape pre-mining activities, in order to reinstate natural drainage patterns and to become free draining. This area should also be revegetated with indigenous vegetation species, and monitoring for alien and invasive species establishment should be conducted every few months in line with an Alien and Invasive Species Control Plan and be overseen by the appointed Environmental Control Officer (ECO).

It is recommended that all the provided mitigation measures as presented in this report be implemented in order to reduce the overall impact significance of the proposed mining activities on the receiving environment.

DOCUMENT GUIDE

The Document Guide below is for reference to the procedural requirements for environmental authorisation applications in accordance to GN267 of 24 March 2017, as it pertains to NEMA.

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix G
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix G
b)	A declaration that the specialist is independent	Appendix G
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
cA)	An indication of the quality and age of base data used for the specialist report	Section 2.1 and 3.1
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4.1, 5.1 and 6.1
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 2.1 and 2.3
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Appendix C
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 4 and 5
g)	An identification of any areas to be avoided, including buffers	Section 4.3 and 5.2
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4.3 and 5.2
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.3
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4, 5, and 6
k)	Any mitigation measures for inclusion in the EMPr	Section 6.1.2
l)	Any conditions for inclusion in the environmental authorisation	Section 6
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 6
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 7
(iA)	Regarding the acceptability of the proposed activity or activities	Section 7
(ii)	If the opinion is that the proposed activity, activities 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	Section 7
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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GLOSSARY OF 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.
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Base flow:	Long-term flow in a river that continues after storm flow has passed.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Ephemeral stream:	Ephemeral systems flow for less time than they are dry. Flow or flood for short periods of most years in a five-year period, in response to unpredictable high rainfall events. Support a series of pools in parts of the channel.
Episodic stream:	Highly flashy systems that flow or flood only in response to extreme rainfall events, usually high in their catchments. May not flow in a five-year period, or may flow only once in several years.
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of

	wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50 cm of the surface
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50 cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
AMD	Acid Mine Drainage
BAR	Basic Assessment Report
BAS	Best Attainable State
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
CVB	Channelled Valley Bottom
DO	Dissolved Oxygen (mg/l)
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (mS/m) [use to be defined in relevant sections]
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Program
ESA	Ecological Support Area
EWR	Ecological Water Requirement
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
HF	High Flow
IC	Infrastructure Complex
IHI	Index of Habitat Integrity
KR	Kimberley Reef
LF	Low Flow
m	Meter
MAP	Mean Annual Precipitation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
NWCS	National Wetland Classification System
PES	Present Ecological State
PNE	Protected Natural Environment
REC	Recommended Ecological Category
RMO	Recommended Management Objective
ROM	Run of mine
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a Freshwater and Aquatic Ecological Assessment as part of the Environmental Impact Assessment process for an application for a Mining Right for opencast and underground mining for the proposed West Wits Project, located north of Soweto, Gauteng Province.

The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA (Figure 1 and 2). The proposed MRA partly falls within Roodepoort (northern portion) and partly within Soweto (southern portion). A description of the project is provided in Section 1.2 below, which includes the locality of the proposed MRA relative to the surrounding areas (Figure 1 and 2).

To identify all potential watercourses that may potentially be impacted by the mining activities, a 500 m “zone of investigation” around the proposed MRA, in accordance with Government Notice 509 as it relates to activities as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998) was used as a guide in which to assess possible sensitivities of the receiving environment. This area will henceforth be referred to as the “investigation area”.

The purpose of this report is to define the ecology of the study area in terms of watercourse location, extent and characteristics, including mapping and classification of the watercourses, defining areas of increased Ecological Importance and Sensitivity (EIS), and to define the Present Ecological State (PES) of the watercourses associated with the study area. Also, this report aims to define the socio-cultural and ecological service provision of the watercourses and the Recommended Management Objective (RMO) and Recommended Ecological Category (REC) for the watercourses. An impact assessment was undertaken to determine the significance of the perceived impacts associated with the mining activities. In addition, mitigatory measures were developed which aim to minimise the impacts, followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented. Please refer to Section 1.3 for the detailed scope of work encompassed by this study.

This report additionally presents the results obtained during the aquatic ecological assessment, which include the *in-situ* water quality at two points along the Klip River, as well as a point along an unnamed tributary of the Klip River (falling within the CVB 2 wetland), a survey of habitat conditions for aquatic macro-invertebrates and aquatic macro-invertebrate community integrity. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

This study further aims to provide detailed information to guide the proposed project activities in the vicinity of the watercourses, to ensure the ongoing functioning of the ecosystems, such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development. This report, after consideration of the above, must guide the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed mining activities from a watercourse management and aquatic ecology perspective.

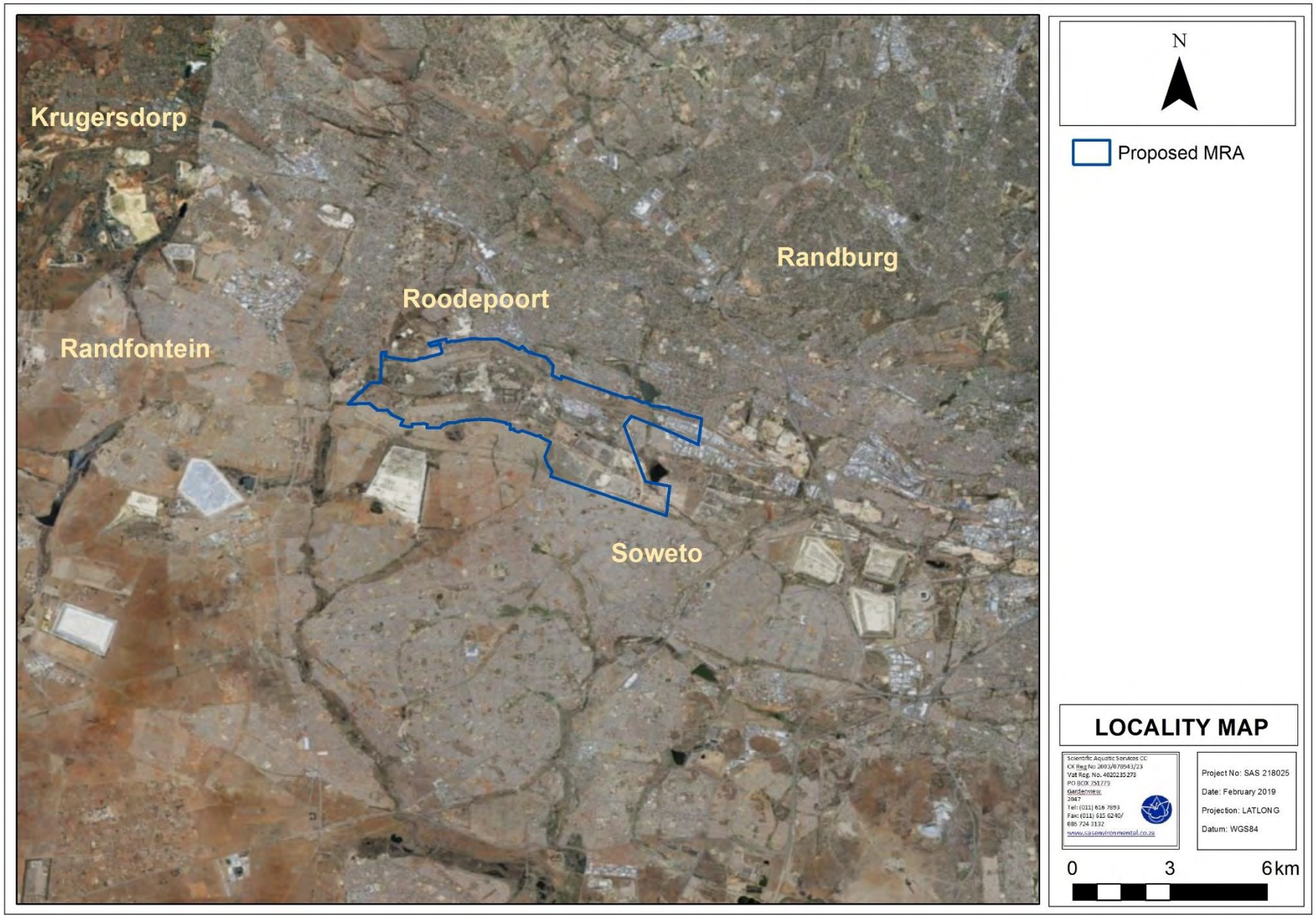

Figure 1: Digital Satellite image depicting the location of the proposed MRA in relation to surrounding areas.

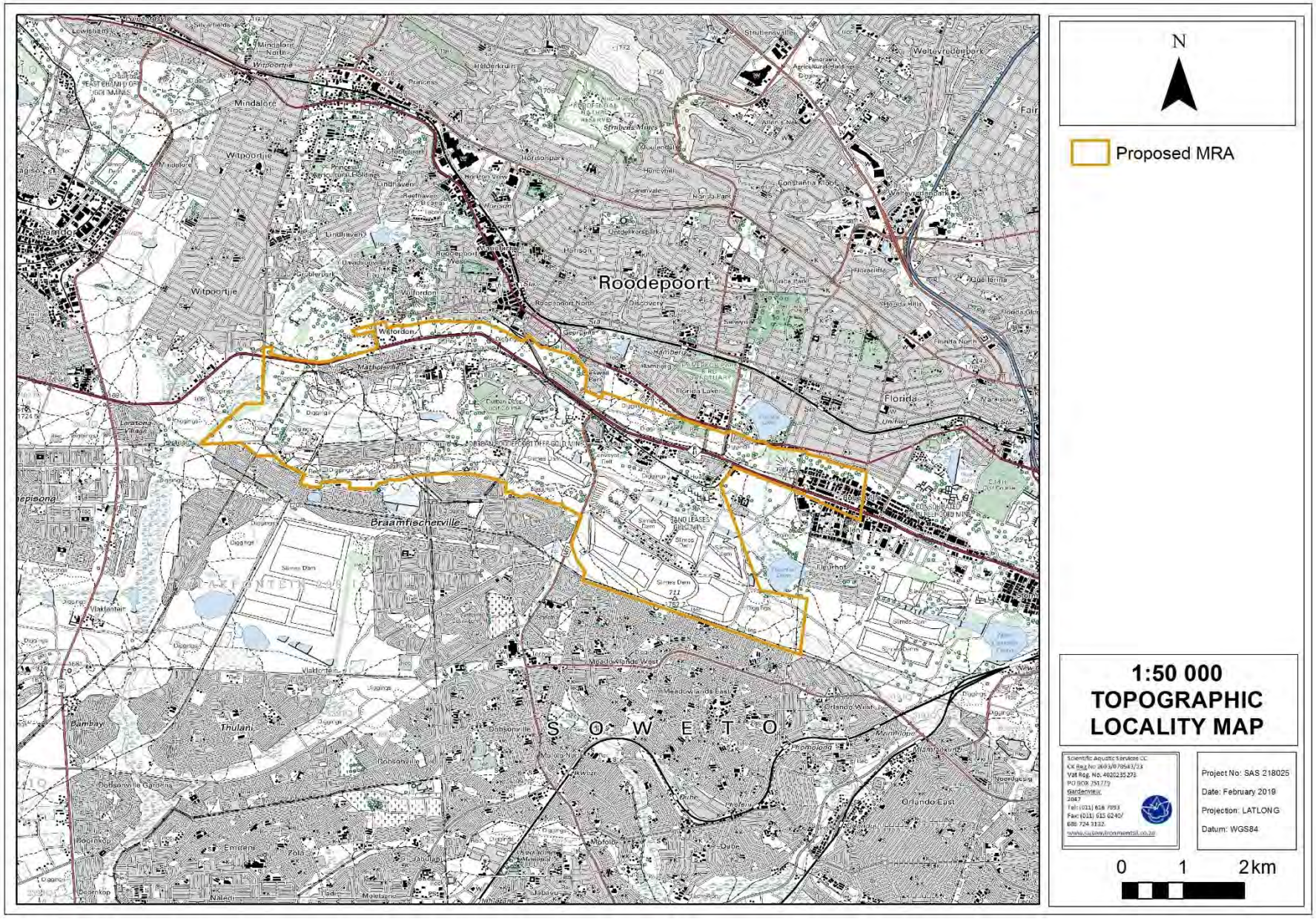

Figure 2: Proposed MRA depicted on a 1:50 000 topographical map in relation to its surrounding area.

1.2 Project Description

In broad terms the proposed project entails:

- The development of five open pit mining areas, referred to as:
  - Mona Lisa Bird Reef Pit;
  - Roodepoort Main Reef Pit;
  - Rugby Club Main Reef Pit;
  - 11 Shaft Main Reef Pit; and
  - Kimberley Reef East Pit.
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings):
  - Bird Reef Central Infrastructure Complex; and
  - Kimberley Reef East Infrastructure Complex.

The project would also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps (WRD) as well as supporting infrastructure including material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, washbays, stores, change houses, lamprooms, vent fans and security facilities.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is five (5) years and 20 years for the underground operations. The pits would be mined in a phased approach with each pit taking between six and 16 months to be mined and rehabilitated.

The proposed location for the open pit mining areas and surface infrastructure complexes forming part of this project are depicted in Figure 1 and 2, with their approximate extent, presented in Table 1.

Table 1: Extent of the proposed infrastructure and open cast areas investigated pertaining to the proposed MRA.

Mining Right Area	Area (ha)
Proposed MRA	2076
Proposed Infrastructure Complexes Investigated	
Bird Reef Central	± 2.19
Kimberley Reef East	± 4.74
Underground Workings	
Bird Reef Central underground mining area	± 53.7
Kimberley Reef East underground mining area	± 62.7
West Wits Opencast Areas Investigated (including open cast, topsoil dump and WRD footprint areas)	
11 Shaft Main Reef Pit	14
Kimberley Reef East Pit	9.92
Mona Lisa Bird Reef Pit	19.2
Roodepoort Main Reef Pit	26.4
Rugby Club Reef East Pit	2.5

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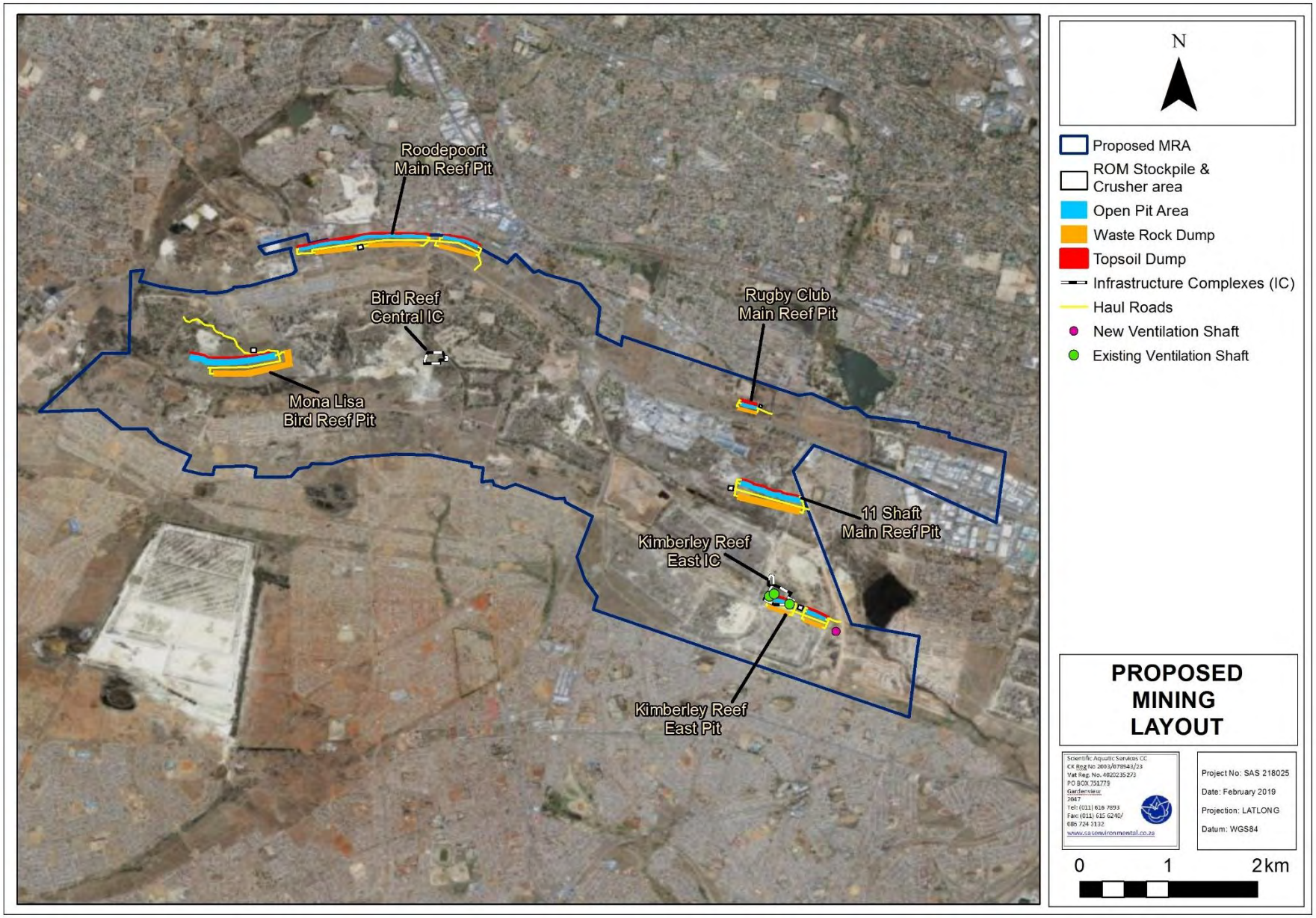


Figure 3: Proposed Opencast operations and infrastructure associated with the proposed MRA.

1.3 Scope of Work

Specific outcomes in terms of this report are outlined below:

Freshwater Resource Assessment

- A background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA] 2011 database; and the Department of Water and Sanitation Research Quality Information Services [DWS RQIS PES/EIS] 2014 database) was undertaken to aid in defining the PES and EIS of the watercourses;
- Watercourses were delineated according to "DWAF[1], 2008: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". Aspects such as soil morphological characteristics, vegetation types and wetness were used to delineate the watercourses;
- All watercourses within 500 m of the proposed MRA were delineated on a desktop basis in accordance with GN 509 of 2016 as it pertains to the NWA;
- The wetland classification assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- The EIS of the watercourses were determined according to the method described by Rountree & Kotze*,* (2013);
- The services provided by the watercourses associated with the proposed MRA were assessed according to the method of Kotze *et al.* (2009) in which services to the ecology of the site as well as services to the people of the area were defined;
- The PES of the watercourses was determined according to the resource-directed measures guideline of Macfarlane *et al.,* (2008);
- Watercourses were mapped according to the ecological sensitivity of the hydrogeomorphic (HGM) unit in relation to the proposed MRA. In addition to the watercourses boundaries, the appropriate provincial recommended buffers and legislated zones of regulation were depicted where applicable;
- Allocation of a suitable Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS) based on the outcome of the PES, EIS and ecological service provision assessments;

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

- To determine the impact that the project might have on the watercourses as a result of the proposed activities and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment.

Aquatic Ecological Assessment

- To define the Present Ecological State (PES) of the aquatic resources within the study area;
- To define the Ecological Importance and Sensitivity (EIS) of the aquatic resources within the study area;
- To collect baseline data and present recommendations with the intention to:
  - Maintain the PES of the system in support of the EIS of the aquatic ecosystem;
  - Ensure that connectivity of the aquatic resources is maintained between the areas upstream and downstream of the proposed development areas;
  - Ensure that no further incision and erosion of the river system takes place as a result of the proposed development;
  - Ensure that no significant persistent impact on water quality will take place;
- To determine the environmental impact that the proposed project might have on the aquatic ecology of the area as a result of the proposed gold mining activities, and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented by the proponent to assist in minimising the impact on the receiving environment.

1.4 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The determination of the watercourse boundaries and the assessment thereof, is confined to the portion of the identified watercourses within 100 m of any of the open cast mining and surface infrastructure areas associated with the proposed MRA. The portions of the watercourses located further than 100 m, but within 500 m of these open pit/infrastructure areas, were delineated in fulfilment of GN 509 of the NWA using various desktop methods including use of topographic maps, historical and current digital satellite imagery and aerial photographs. The general surroundings were, however, considered in the desktop assessment of the proposed MRA;
- Portions of the proposed MRA were inaccessible as it posed a threat to the personal safety of the consultant. Thus, whilst every effort was made to ensure that all

watercourses potentially within the 500m of the open cast areas were identified and delineated, less distinct features within these inaccessible areas may not have been identified;

- Due to the significantly degraded nature and anthropogenic impacts on the watercourses within the study area, the natural extent thereof was difficult to determine (especially when using watercourse indicators such as soil and vegetation), due to these impacting factors. Nevertheless, the delineations as presented in this report are regarded as the best estimate of the temporary zone boundaries of the watercourses based on the site conditions present at the time of assessment;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. Despite this, the delineation of the watercourses as provided in this report is considered accurate for the purposes of the this investigation. If more accurate assessments are required the watercourses will need to be surveyed and pegged according to surveying principles and with survey equipment;
- Wetland, riparian and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater resource boundary may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results;
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, it is expected that the proposed mining activities have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of watercourse ecology;
- Considering historical mining, industrial and agricultural activities in the larger catchment, the composition of aquatic biota in the study area, prior to major disturbance, is largely unknown. The systems within the study area have been extensively utilised for informal cultivation purposes. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available, such as the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database as discussed in Section 3;
- Due to the lack of historical temporal data where the effects of natural seasonal and long-term variation in the ecological conditions and aquatic biota found in the systems are, therefore, unknown at the time of writing this report. However, consideration was given to local data on the DWS RQIS PES/EIS database. Said information assists in

understanding variability in the system and thus ensure that observations and discussions on impacts are adequately understood to inform this study; and

- Due to access restraints relating to terrain and personal safety concerns, limitations were experienced in site selection. Due to the limitations, some aspects of the aquatic ecology of the area, which may be important, may have been overlooked. However, based on the data available and based on the observations of site assessments, it is deemed adequate to provide the required level of understanding of the systems for the study.

1.5 Legislative Requirements and Provincial Guidelines

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- The National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act 36 of 1998) (NWA);
- Government Notice (GN) 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998);
- The Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA);
- Government Notice 704 Regulations as published in the Government Gazette 20119 of 1999 as it relates to the NWA, 1998 (Act 36 of 1998) regarding the use of water for mining and related activities aimed at the protection of water resources; and
- The National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA); and
- The Gauteng Department of Agriculture and Rural Development's (GDARD) Requirements for Biodiversity Assessments, Version 3 (GDARD, 2014).

2 ASSESSMENT APPROACH

2.1 Watercourse Field Verification

For the purposes of this investigation, the definition of wetland and riparian systems was taken as per that in the National Water Act, 1998 (Act 36 of 1998). The definitions are as follows:

Wetland habitat is "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow

water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure **distinct** from those of adjacent areas.

As mentioned in Section 1.3 use was made of historical aerial photographs, historical and current digital satellite imagery, topographic maps and available provincial and national wetland databases to aid in the delineation of those portions of the watercourses located between 100 m - 500 m from the open pit areas/surface infrastructure within the proposed MRA following the field assessment. The following was taken into consideration when utilizing the above during delineation:

- Hydrophytic and riparian vegetation: a distinct increase in density, changes in species composition, as well as tree size near drainage lines;
- Hue: with wetlands, riparian areas and drainage lines displaying varying chroma created by varying vegetation cover and soil conditions in relation to the adjacent terrestrial areas; and
- Texture: with wetland and riparian areas displaying various textures which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the watercourse.

The watercourse delineation was verified in the field, and this delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" (DWAF, 2008). The foundation of the method is based on the fact that watercourses have several distinguishing factors including the following:

- Landscape position;
- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

Field assessments were undertaken on the 6th of March and 14th of June 2018, during which the presence of any riparian or wetland characteristics as defined by DWAF (2008) and by the NWA, were noted (please refer to Section 4 of this report). In addition to the delineation process, detailed assessments of the delineated watercourses were undertaken, at which time

factors affecting the integrity of the watercourses were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the watercourses. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.2 Sensitivity Mapping

All watercourses associated with the proposed MRA were delineated with the use of a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 4.4 should guide the design and layout of the development.

2.3 Aquatic Ecological Assessment

This document presents the results obtained during the aquatic ecological assessments performed during high flow (HF) in March 2018 and low flow (LF) in June 2018. It includes a desktop assessment of the aquatic ecosystems and field assessments. The latter were performed at two points on the Klip River and two points on an unnamed tributary within the proposed MRA. The field assessment included the following:

- an assessment of the *in-situ* water quality;
- a survey of habitat condition suitability for habitation by aquatic macro-invertebrates; and
- aquatic macro-invertebrate community integrity.

The protocols of applying the indices were strictly adhered to, and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

An impact assessment based on the findings of both the desktop and field assessments is provided (see Section 6).

Table 2 below contains geographic information with regard to the selected biomonitoring points, namely, an upstream and downstream site on the Klip River and its unnamed tributary within the proposed MRA.

Table 2: Coordinates of the biomonitoring sites.

Site	Description	GPS Coordinates	
		South	East
Klip U/S	Located on the Klip River, upstream of the proposed MRA.	S 26°10'8.79"	E 27°50'0.78"
Klip D/S	Located on the Klip River, downstream of the proposed MRA.	S 26°13'48.44"	E 27°48'49.77"
Unnamed Tributary U/S	Located on the Unnamed Tributary of the Klip River, upstream of the proposed MRA.	S 26°10'41.62"	E 27°50'11.53"
Unnamed Tributary D/S	Located on the Unnamed Tributary of the Klip River, downstream of the proposed MRA.	S 26°12'26.86"	E 27°54'38.05"

Figure 4 indicates the location of the study areas on digital satellite image.

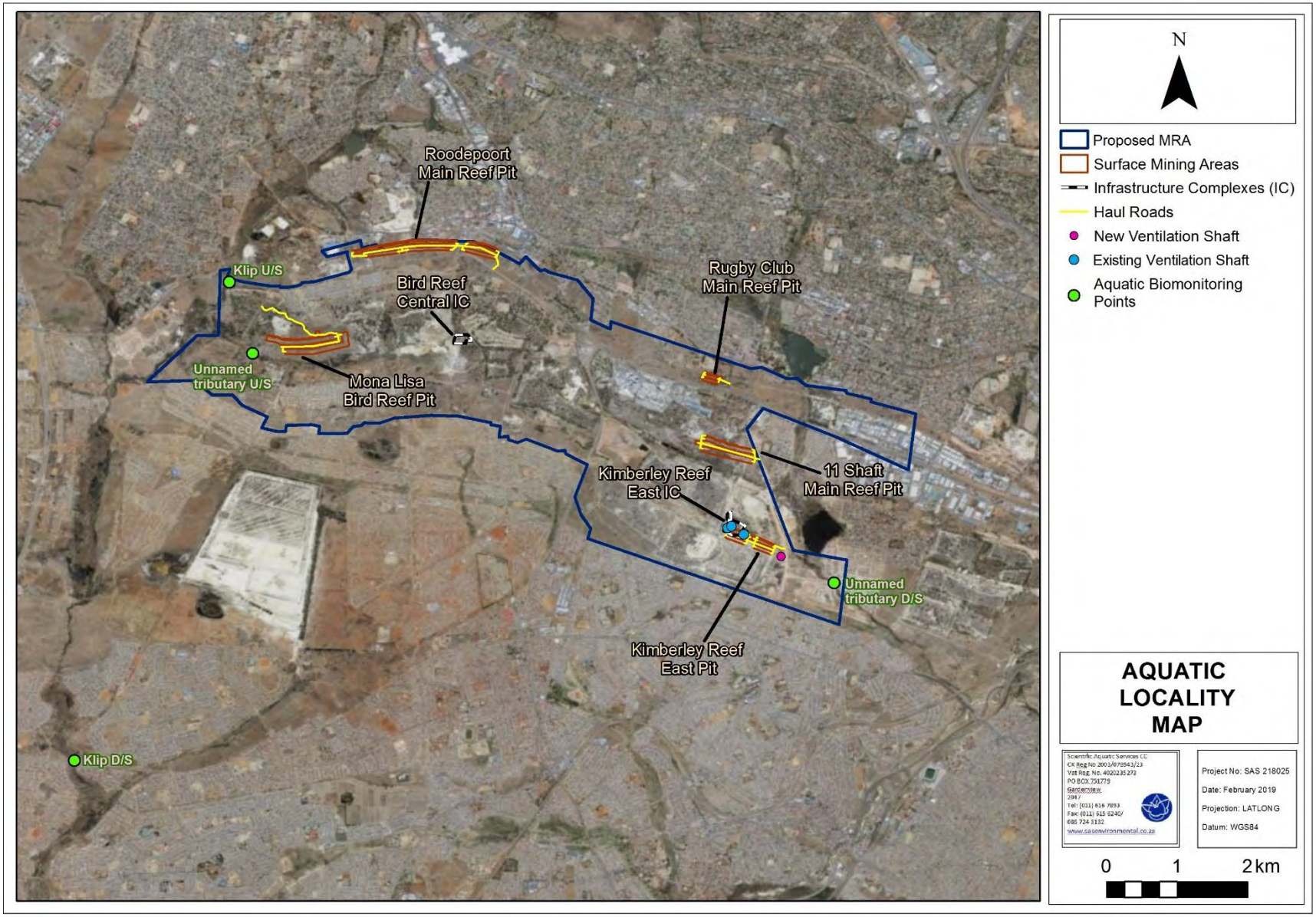


Figure 4: Depiction of the aquatic biomonitoring points within the proposed MRA.

2.4 Impact Assessment and Recommendations

Following the completion of the assessment, an impact assessment was conducted (please refer to Appendix D for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed development.

The recommendations provided also include general 'best practice' management measures, which apply to the proposed developments as a whole, and which are presented in Appendix F. Mitigation measures have been developed to address issues in all phases throughout the life of the operation including planning, construction and operation. The detailed site-specific mitigation measures are outlined in Section 6 of this report.

3 RESULTS OF THE DESKTOP ANALYSIS

The following section contains data accessed as part of the desktop assessment and are presented as a "dashboard" style report below (Table 3). The dashboard report aims to present concise summaries of the data on a few pages as possible to allow for the integration of results by the reader to take place.

It is important to note that although all data sources used to provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the proposed MRA actual site characteristics at the scale required to inform the environmental authorisation and/or water use licencing processes. However, this information is considered useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance.

Table 3: Desktop data relating to the character of freshwater resources within the proposed MRA.

AQUATIC ECOREGION AND SUB-REGIONS IN WHICH THE PROPOSED MRA IS LOCATED			
Ecoregion	Highveld		
Catchment	Vaal		
Quaternary Catchment	C22A		
WMA	Upper Vaal		
subWMA	Downstream Vaal Dam		
DOMINANT CHARACTERISTICS OF THE HIGHVELD ECOREGION LEVEL 2 (11.01) (KLEYNHANS *et al.*, 2007)			
Ecoregion	Highveld (11.01)	Rainfall concentration index	55 to 64
Dominant primary terrain morphology	Plains: Low relief, plains	Rainfall seasonality	Early to mid-summer
Dominant primary vegetation types	Rocky Highveld Grassland, Mixed Bushveld	Mean annual temp. (°C)	14 to 18
Altitude (m a.m.s.l)	1300 to 1900	Winter temperature (July)	0 to 20
MAP (mm)	500 to 700	Summer temperature (Feb)	12 to 30
Coefficient of Variation (% of MAP)	20 to 34	Median annual simulated runoff (mm)	20 to 60

DETAIL OF THE PROPOSED MRA IN TERMS OF THE NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA (NFEPA) (2011) DATABASE	
FEPACODE	The proposed MRA is located within a subWMA not considered important in terms of River or Fish conservation (FEPACODE = 0)
NFEPA Wetlands (Figure 5 & 6)	According to the NFEPA database, a natural wetland flat is located within the proposed MRA which is moderately modified (WETCON = C). Several seep wetlands are located within the proposed MRA, these are considered to be heavily to critically modified (WETCON: Z1 and Z3). Two depression wetlands are located within the south western portion of the investigation area, which is considered to be modified (WETCON: Z1).
Wetland vegetation Type	The proposed MRA is located within the Mesic Highveld Grassland Group 3 wetland vegetation type, which is classified as Critically Endangered (SANBI, 2012; Mbona *et al*, 2014). These are sensitive vegetation types that have been afforded hardly any to no protection, thus, this could lead to limitations on the potential for mining activities to be authorised and/or biodiversity offsets may need to be specified.
NFEPA Rivers (Figure 4)	According to the NFEPA database the Klip River is located on the western boundary of the proposed MRA. This river is in a seriously modified to critically/extremely modified (RIVCON = EF) ecological condition. The DWS PES 1999 data indicate this river to be in a seriously modified to critically/extremely modified condition (PES 1999 Class E - F).

ECOLOGICAL STATUS OF THE MOST PROXIMAL SUB-QUATERNARY REACH (DWS, 2014)	
Sub-quaternary reach	C22A-01315 (Klip)
Assessed by expert?	Yes
PES Category Median	E: Loss of natural habitat, biota and basic ecosystem functions is extensive. Modifications to the aquatic ecology are generally-too-frequently present where, for most categories, only small areas are not yet affected.
Mean Ecological Importance (EI) Class	Moderate. Ecological importance of aquatic fauna is high. Habitat diversity and integrity is perceived of low-moderate sensitivity, with migration links all of moderate sensitivity.
Mean Ecological Sensitivity (ES) Class	Moderate Ecological sensitivity of riparian/wetland fauna is moderate – very high; however, habitat and vegetation are of low sensitivity
Stream Order	1.0
Default Ecological Class (based on median PES and highest EI or ES mean)	C (Moderate)

GAUTENG CONSERVATION PLAN (C-Plan V3.3, 2011) (Figure 7 – 9)	
Critical Biodiversity Areas (CBAs)	The proposed MRA is located in, and surrounded by, numerous Critical Biodiversity Areas (CBAs). None of the Infrastructure Complex areas are located within a CBA. The Mona Lisa Bird Reef Pit and the Rugby Club Main Reef Pit open cast areas fall within CBAs. CBAs include natural or near-natural terrestrial and aquatic features that were selected based on an areas' biodiversity characteristics, spatial configuration and requirement for meeting both biodiversity pattern and ecological process targets.
Ecological Support Areas (ESAs)	The proposed MRA is located in, and surrounded by, numerous Ecological Support Areas (ESAs). None of the Infrastructure Areas are located within an ESA, however, the 11 Shaft Main Reef Pit partly intersects an ESA. ESAs are natural, near-natural, degraded or heavily modified areas required to be maintained in an ecologically functional state to support CBAs and/or Protected Areas.
Wetland and River Buffer	The GDARD C-Plan V3.3 (2011) indicates several non-perennial river buffers associated with the investigation area of the proposed MRA. This includes the Klip River buffer that traverses the western border of the proposed MRA with another river buffer located within the eastern portion of the investigation area. In addition, wetland buffers are indicated to be mainly located within the western portion of the proposed MRA and within the eastern portion of the investigation area. This includes the Klip River buffer that traverses the southwestern border of the proposed MRA and the Hugenote Spruit traversing the western border. Two dams are indicated to be associated with the proposed MRA, i.e. Florida Lake bordering the northern border of the proposed MRA and Fleurhof Dam falling within the eastern portion of the proposed MRA. Additionally, several pans, wetland and waterbody buffers are indicated within the proposed MRA.
Urban Edge and Gauteng Environmental Management Framework (2015)	Although rescinded as a policy document in the Gauteng Spatial Development Framework in 2011, the Urban Edge nevertheless remains a useful indicator of where concentration [of development] should occur. According to the Gauteng C-Plan (2011) and the Gauteng EMF (2015), the proposed MRA is located within the Urban Edge and the EMF Zone 1 (urban development zone) with some of the central areas of the proposed MRA considered EMF Zone 5 (industrial or large commercial focus zone).

IMPORTANCE OF THE PROPOSED MRA ACCORDING TO THE MINING AND BIODIVERSITY GUIDELINES (2013) (Figure 10 & 11)	
Moderate Biodiversity Importance	The southern central part of the proposed MRA fall within areas of Moderate Biodiversity Importance. The proposed MRA is also surrounded by areas of Moderate Biodiversity Importance. The 11 Shaft Main Reef Pit, Kimberley Reef East Pit and the Kimberley Reef East Infrastructure complex are situated within areas of Moderate Biodiversity Importance (Figure 11). Biodiversity priority areas: Ecological support areas, vulnerable ecosystems, focus areas for protected area expansion (land based and offshore protection). Risk for mining: Moderate risk for mining. Implications for mining: These areas are of moderate biodiversity value. EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, identifying features (e.g. threatened species) not included in the existing datasets, and on providing site-specific information to guide the application of the mitigation hierarchy. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.
High Biodiversity Importance	The northern-most portion of the proposed MRA overlaps with a larger area of High Biodiversity Importance. The Bird Reef Central infrastructure complex and Roodepoort Main Reef Pit falls within areas of High Biodiversity Importance (Figure 11). Biodiversity priority areas: Protected area buffers (including buffers around National Parks, World Heritage Sites and Nature Reserves), Transfrontier Conservation Areas (remaining areas outside of formally proclaimed protected areas), other identified priorities from provincial spatial biodiversity plans, high water yield areas, Coastal Protection Zone, Estuarine functional zone. Risk for mining: High risk to mining Implications for mining: These areas are important for conserving biodiversity, for supporting or buffering other biodiversity priority areas, for maintaining important ecosystem services for particular communities or the country as a whole. An environmental impact assessment should include an assessment of optimum, sustainable land use for a particular area and will determine the significance of the impact on biodiversity. Mining options may be limited in these areas, and red flags for mining projects are possible. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.
Highest Biodiversity Importance	The larger part of the western portion of the proposed MRA is classified as areas of Highest Biodiversity Importance. The Rugby Club Main Reef Pit, a small part on the eastern side of the 11 Shaft Main Reef Pit, and the entire Mona Lisa Bird Reef Pit are located within areas of Highest Biodiversity Importance (Figure 11). Biodiversity priority areas: Critically endangered and endangered ecosystems, Critical Biodiversity Areas (or equivalent areas) from provincial spatial biodiversity plans, River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and a 1 km buffer around these FEPAs, Ramsar Sites. Risk for mining: Highest risk for mining. Implications for mining: Environmental screening, EIA's and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision making for mining, water use licences, and environmental authorisations. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being.

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State WMA = Water Management Area.

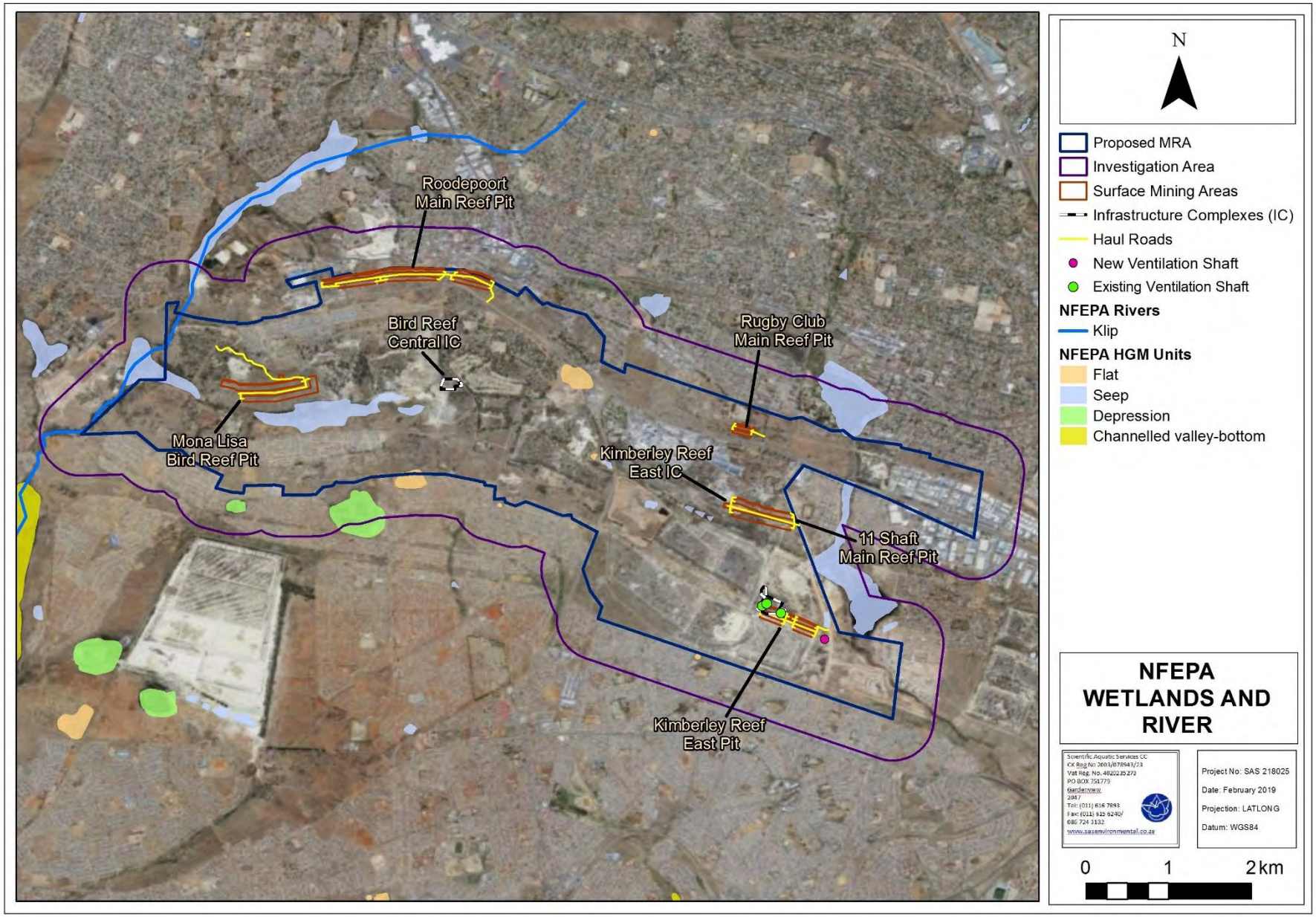


Figure 5: Wetland HGM Units and Rivers located within the proposed MRA, as identified by the NFEPA (2011) database.

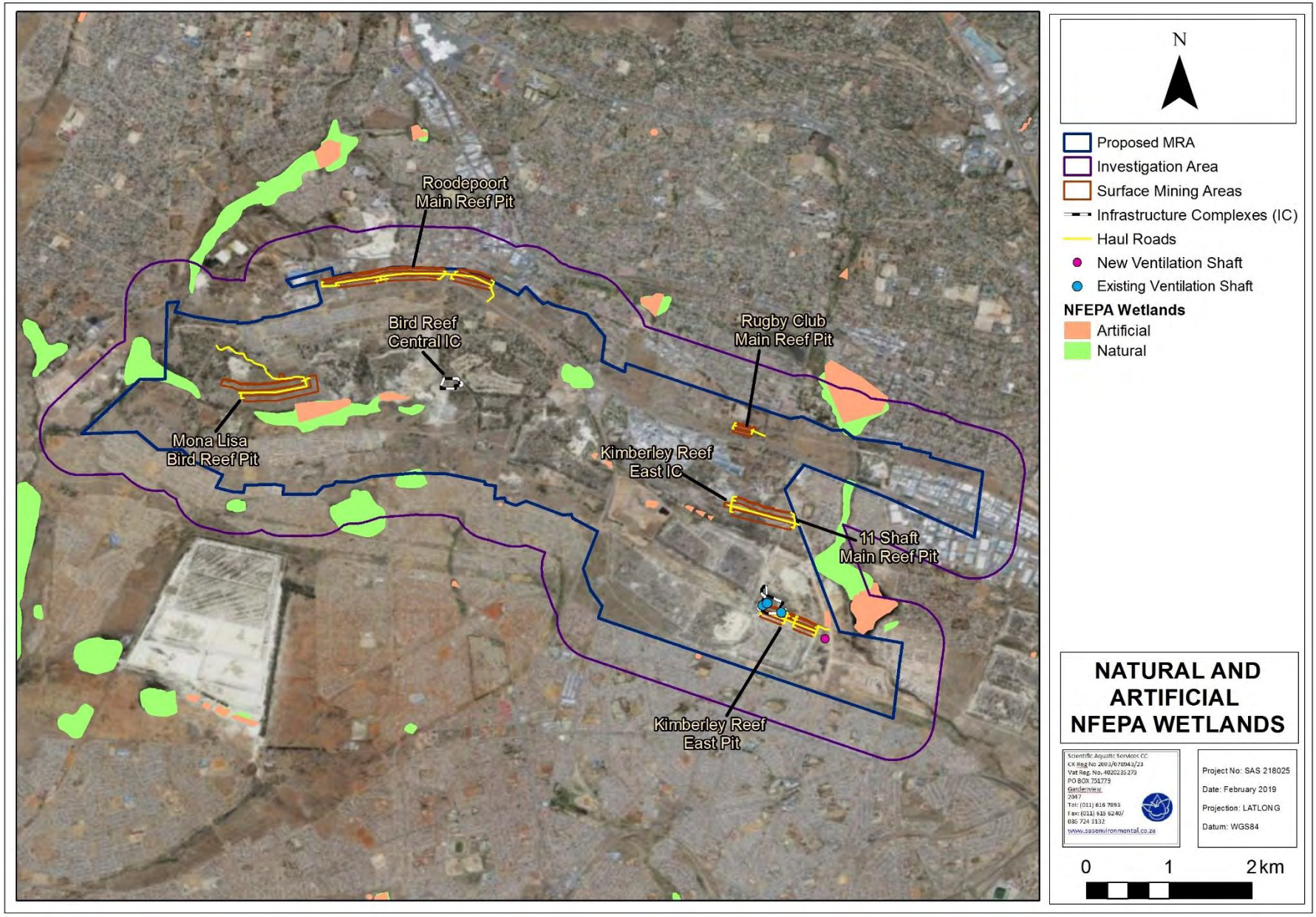


Figure 6: Natural and artificial wetlands associated with the proposed MRA, according to NFEPA (2011) database.

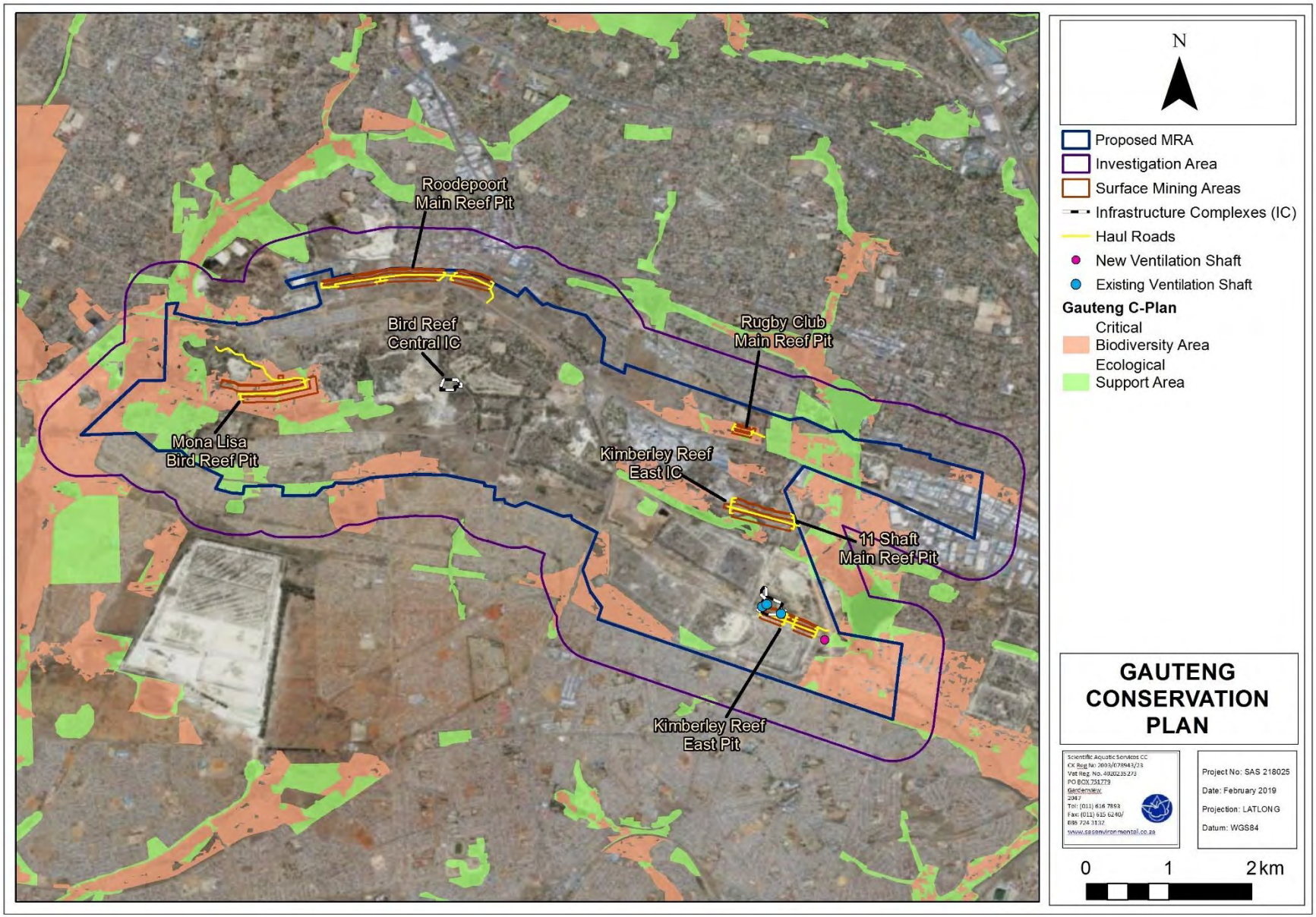


Figure 7: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are associated with the proposed MRA (Gauteng C-Plan v3.3)

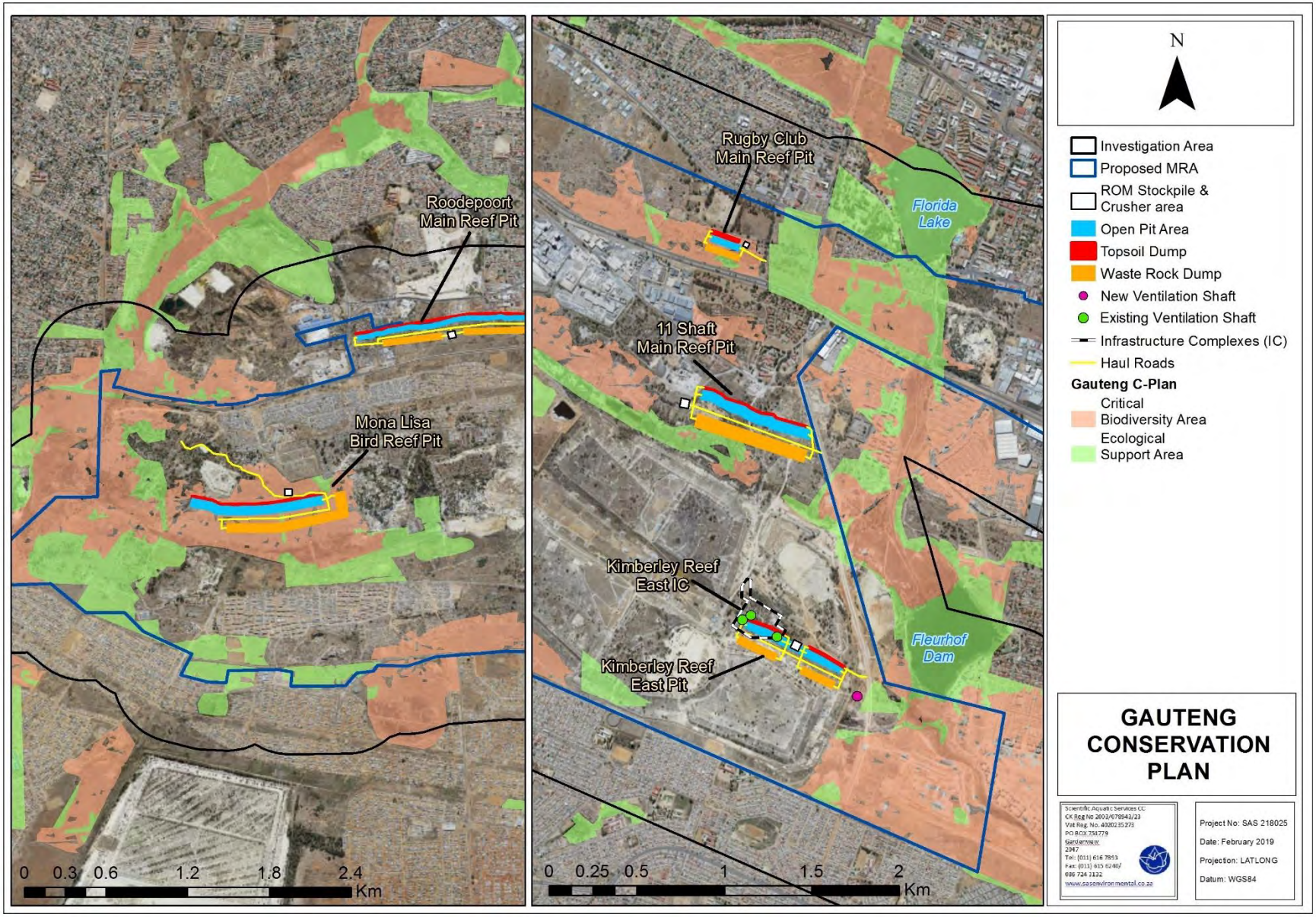


Figure 8: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are associated with the various open cast and infrastructure areas (Gauteng C-Plan v3.3).

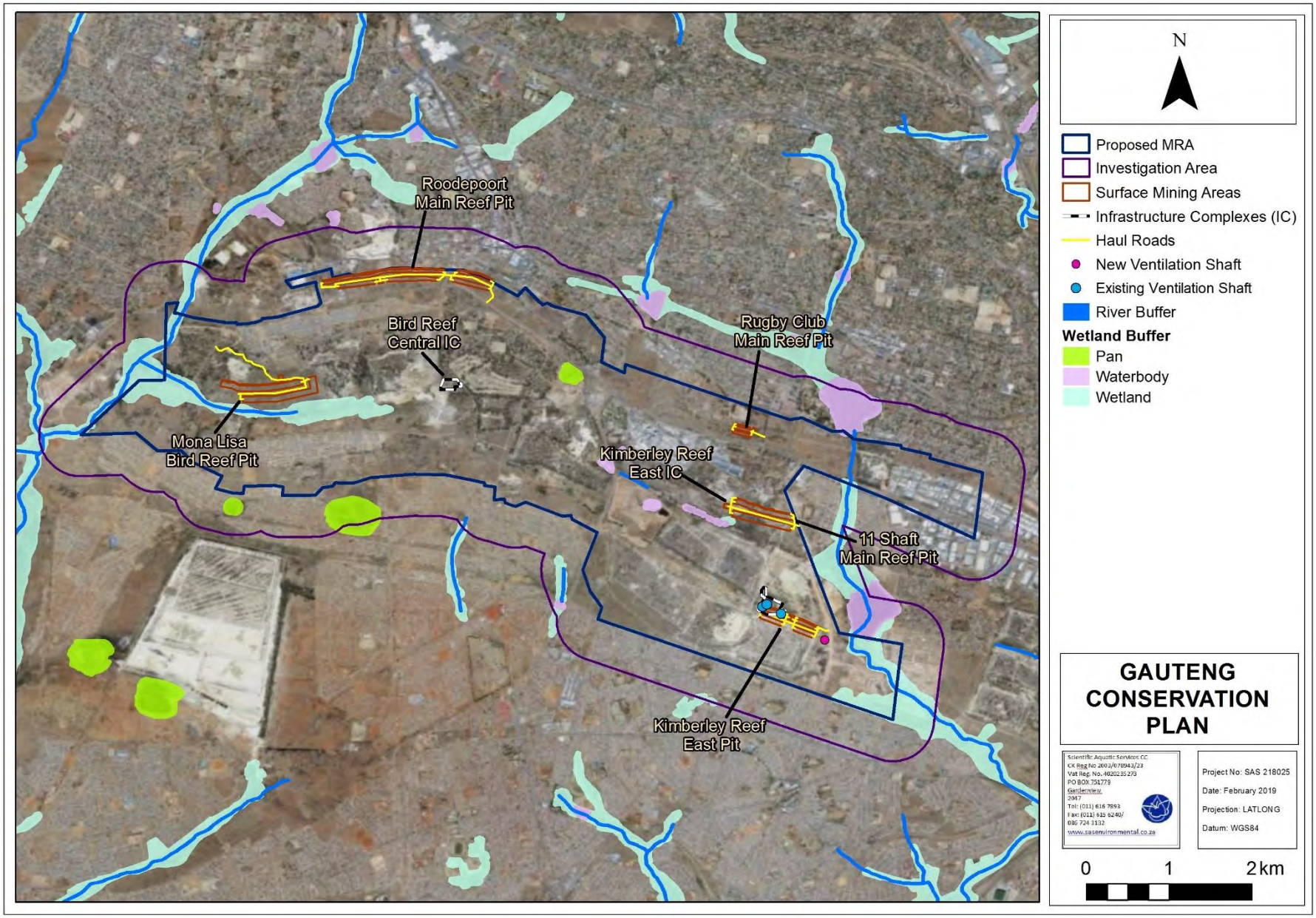


Figure 9: Wetland and River Buffer associated with the study area according to the Gauteng Conservation Plan v3 (2011).

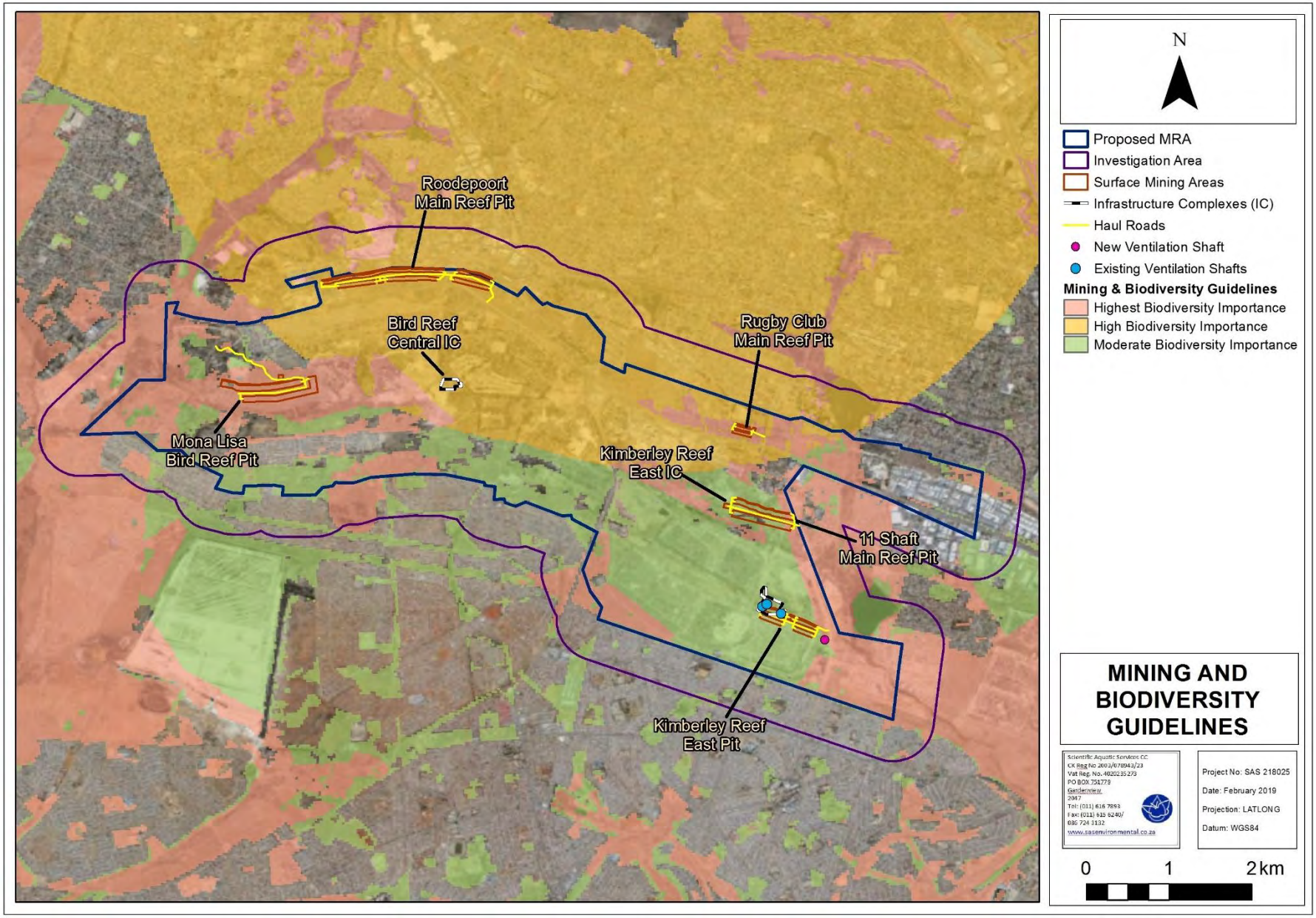


Figure 10: Areas of biodiversity importance associated with the proposed MRA (Mining and Biodiversity Guidelines, 2013).

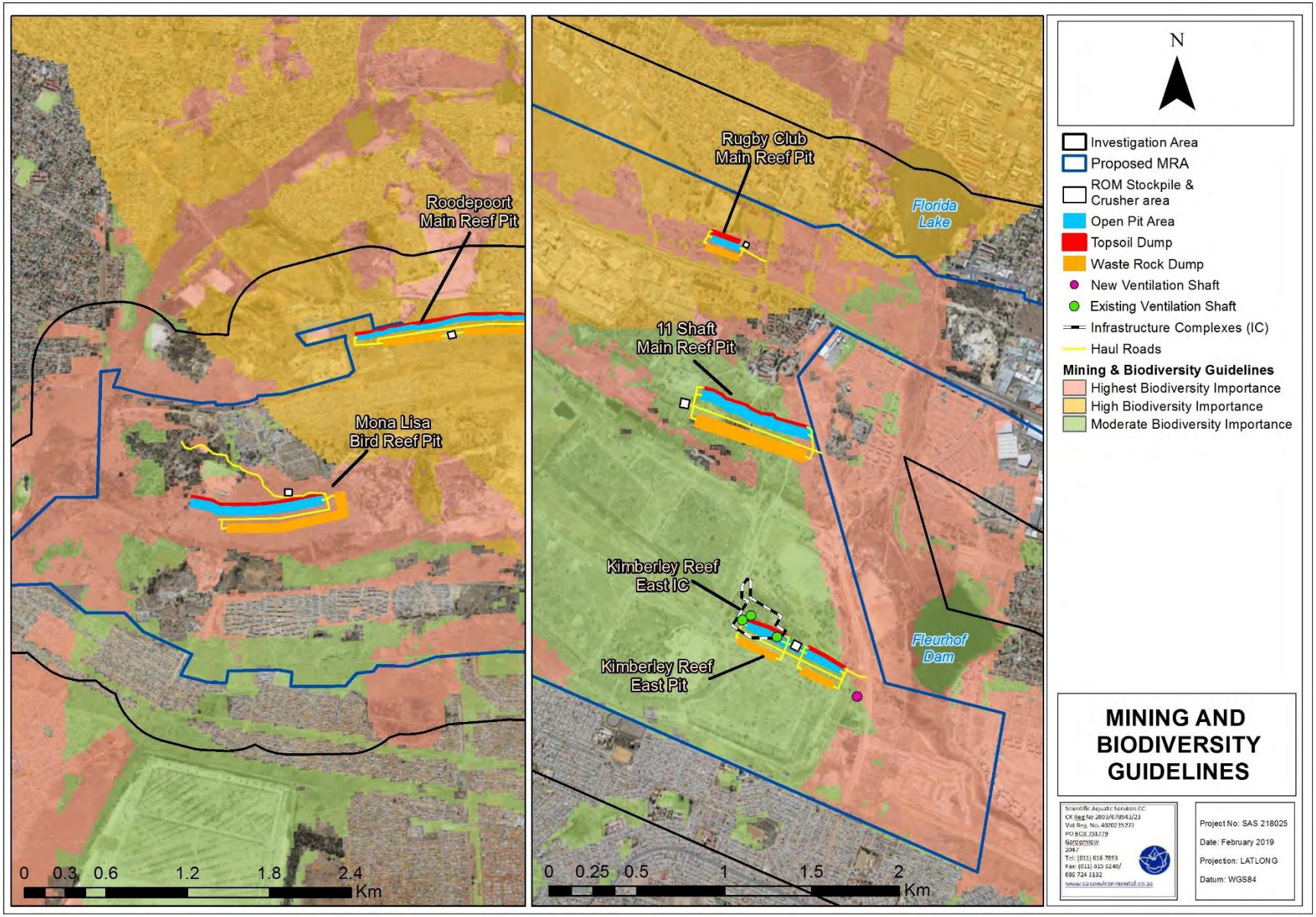


Figure 11: Areas of biodiversity importance that are associated with the various open cast and infrastructure areas (Mining and Biodiversity Guidelines, 2013).

3.1 Ecological status of sub-quaternary catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS database]

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the proposed MRA. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, Ecological Water Requirement (EWR) sites and Hydro Water Management System (WMS) sites.

Key information on background conditions associated with the proposed MRA, as contained in this database and pertaining to the Present Ecological State (PES), ecological importance and ecological sensitivity for the sub-quaternary catchment reach (SQR) (C22A-01315) Klip River source is tabulated in Table 4 and indicated in Figure 12.

The Ecological Importance (EI) data for SQR C22A-01315 (Klip River) indicates that the following macro-invertebrate species are expected to occur at this site:

Baetidae 2 sp	*Gomphidae*	*Nepidae*
Belostomatidae	*Gyrinidae*	*Notonectidae*
Caenidae	*Hirudinea*	*Oligochaeta*
Ceratopogonidae	*Hydracarina*	*Pleidae*
Chironomidae	*Hydrometridae*	*Potamonautidae*
Coenagrionidae	*Hydropsychidae 1 sp*	*Psychodidae*
Corixidae	*Libellulidae*	*Simuliidae*
Culicidae	*Muscidae*	*Syrphidae*
Gerridae	*Naucoridar*	*Veliidae/Mesoveliidae*

The Ecological Importance (EI) data for SQR C22A-01315 (Klip River) indicate that the following fish species are expected to occur at this site:

Barbus anoplus	*Clarias gariepinus*	*Labeobarbus aeneus*
Barbus pallidus	*Labea umbratus*	*Pseudocrenilabrus philander*
Barbus paludinosus	*Labeo capensis*	

Table 4: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR C22A-01315 (Klip River) based on the DWS RQS PES/EIS database.

SYNOPSIS (SQR C22A-01315 (Klip River))					
PES[1] category median	Mean EI[2] class	Mean ES[3] class	Length (km)	Stream order	Default ECat[4]
E	Moderate	Moderate	65.3	1.0	C
PES DETAILS					
Instream habitat continuity MOD		Large	Riparian/wetland zone MOD		Serious
RIP/wetland zone continuity MOD		Large	Potential flow MOD activities		Serious
Potential instream habitat MOD activities		Serious	Potential physico-chemical MOD activities		Serious
EI DETAILS					
Invertebrate taxa/SQ		27.0	Invertebrate average confidence		2.63
Invertebrate representivity per secondary class		Moderate	Invertebrate rarity per secondary class		High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		High	Habitat diversity class		Moderate
Habitat size (length) class		High	Instream migration link class		Moderate
Riparian-wetland zone migration link		Moderate	Riparian-wetland zone habitat integrity class		Moderate
Instream habitat integrity class		Low	Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500 m		Low
Riparian-wetland natural vegetation rating based on expert rating		High			
Fish spp./SQ		9.00	Fish: Average confidence		4.78
Fish representivity per secondary class		High	Fish rarity per secondary class		High
ES DETAILS					
Fish physical-chemical sensitivity description		High	Fish no-flow sensitivity description		High
Invertebrates physical-chemical sensitivity description		Moderate	Invertebrates velocity sensitivity		Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low

[1] PES = Present Ecological State; confirmed in the database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

Figure 12: DWS RQIS PES/EIS sub-quaternary catchment reaches (SQRs) indicated in the vicinity of the proposed MRA.

4 RESULTS: WATERCOURSE ASSESSMENT

4.1 Watercourse System Characterisation

In preparation for the field assessment, aerial photographs, digital satellite imagery and provincial and national wetland databases (as outlined in Section 3 of this report) were used to identify areas of interest at a desktop level. All possible measures were undertaken to ensure all watercourses which may be affected by the proposed activities within the proposed MRA were identified, delineated and assessed.

During the field assessment, several watercourses, comprising three Hydrogeomorphic (HGM) types, were identified within the proposed MRA. These watercourses were characterised as inland systems, located within the Highveld Aquatic Ecoregion. The applicable Wetland Vegetation (WetVeg) group is the Mesic Highveld Grassland Group 2 and 3. The characterisation of these watercourses is summarised in Table 5 below, whilst Figure 13 and 14 illustrates the locality of the watercourses in relation to the proposed open pit areas and surface infrastructure within the proposed MRA.

Table 5: Characterisation of the watercourses associated with the proposed MRA according to the Classification System (Ollis *et. al.,* 2013)

Freshwater Resource	Level 3: Landscape unit	Level 4: HGM Type
Watercourses within the MRA	Valley: The typically gently sloping, lowest surface of a valley.	Channelled valley bottom: A valley bottom wetland with a river channel running through it.
		River: a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
	Plain: an extensive area of low relief. These areas are generally characterised by relatively level, gently undulating or uniformly sloping land with a very gentle gradient that is not located within a valley. Gradient is typically less than 0.01 or 1:100.	Depression: a wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates.

The watercourses located within the proposed MRA have all been impacted upon to some degree, with specific mention of the historical and ongoing surrounding agricultural, urbanisation and mining activities. The small agricultural fields (located within the north-western portion of the proposed MRA) have in some areas encroached on the wetland boundaries, whilst artificial dams have historically also been created within the wetland systems of the proposed MRA but are now utilised as part of the stormwater management systems. Road infrastructure was found to also traverse several of the watercourses. Therefore, some watercourses are connected to the larger Klip River system within the

western portion of the proposed MRA, whilst others have been isolated from the natural freshwater system, due to the establishment of such infrastructure. Generally, the conversion of the natural areas to largely informal residential area and mining land-uses have impacted on the overall topography and hydrological functioning of these watercourses, also allowing for terrestrial vegetation encroachment into these watercourses.

Several areas of artificial ponding and drainage areas (where facultative wetland species have established) surround the existing mining developments as well as in several road reserves within the proposed MRA. Here, stormwater from the surrounding roads and runoff from the mining areas accumulate in these impounded areas/farrows. These features were not assessed, since it is apparent from historical and current digital satellite imagery as well as observations made during the site assessment that most of these features were formed due to altered topography as a result of the construction of the road infrastructure/surrounding developments, and therefore these features would not persist under “normal circumstances” as per the definition of a wetland in the NWA.

Due to the extent of the proposed MRA and all of the proposed mining activities located within the northern extent of the proposed MRA, only those watercourses in which surface infrastructure/open pit areas are located within 500 m of the watercourses were assessed. Due to the topography and the existing developments within the proposed MRA, the proposed mining activities not situated within 500 m of a watercourse are considered to have a negligible impact on those watercourses.

Due to the relatively homogenous freshwater characteristics of some wetlands, the assessment of these wetlands is reported upon in a combined fashion (grouped according to HGM type and similar characteristics) and not individually in Section 4.2. A summary of these groupings and a general description of their characteristics are provided in the table below.

Table 6: Summary of the watercourses and their 500 m surrounding area being intersected by the proposed mining activities.

Watercourse	Locality within the proposed MRA		Proposed mining activity within 500 m of the watercourse	General Characteristics
Klip River system	Located on the western boundary of the proposed MRA.		Mona Lisa Bird Reef Pit (Haul road associated with this open pit area is approximately 505 m east of the river, whilst all other activities are approximately 760 m east of the river).	This river flows in a north to south direction. It is surrounded by residential (formal and informal) developments and is being traversed several times by road infrastructure.
Channelled Valley Bottom (CVB) Wetlands Group 1	CVB 1	Located within the north western portion of the investigation area, outside of the proposed MRA.	Roodepoort Main Reef Pit (The western portion of the open pit area and associated top soil dump is approximately 415 m upgradient/south of this CVB)	These wetlands are mainly surrounded by residential (formal and informal) developments and are currently impacted by historical mining activities (i.e. receives seepage from tailing facilities upstream) and informal agricultural fields.
	CVB 2	Located within the western portion of the proposed MRA.	Mona Lisa Bird Reef Pit (The waste rock dump associated with this open pit area is located approximately 57 m and the open pit area approximately 214 m upgradient/north of this CVB)	
Channelled Valley Bottom (CVB) Wetlands Group 2	CVB 3	Located within the eastern portion of the proposed MRA and investigation area.	11 Shaft Main Reef Pit (The open pit area is located approximately 54 m north of the wetland) Kimberley Reef East Pit & Infrastructure Complex (IC) (A portion of the haul road, open pit area and the waste rock dump is located approximately 412 m west of the wetland. The IC is located approximately 780 m west of the wetland) Kimberley Reef (KR) new ventilation shaft (Located approximately 280 m west of the wetland)	This is a wetland system which drains from the Florida dam (located within the north-eastern portion of the investigation area) into the downstream Fleurhof Dam. The western portion of this wetland system is surrounded by historical mining activities, whilst the northern and southern portions are surrounded by urban built-up areas. Portions of this wetland system have been canalised as part of the stormwater management of the area.

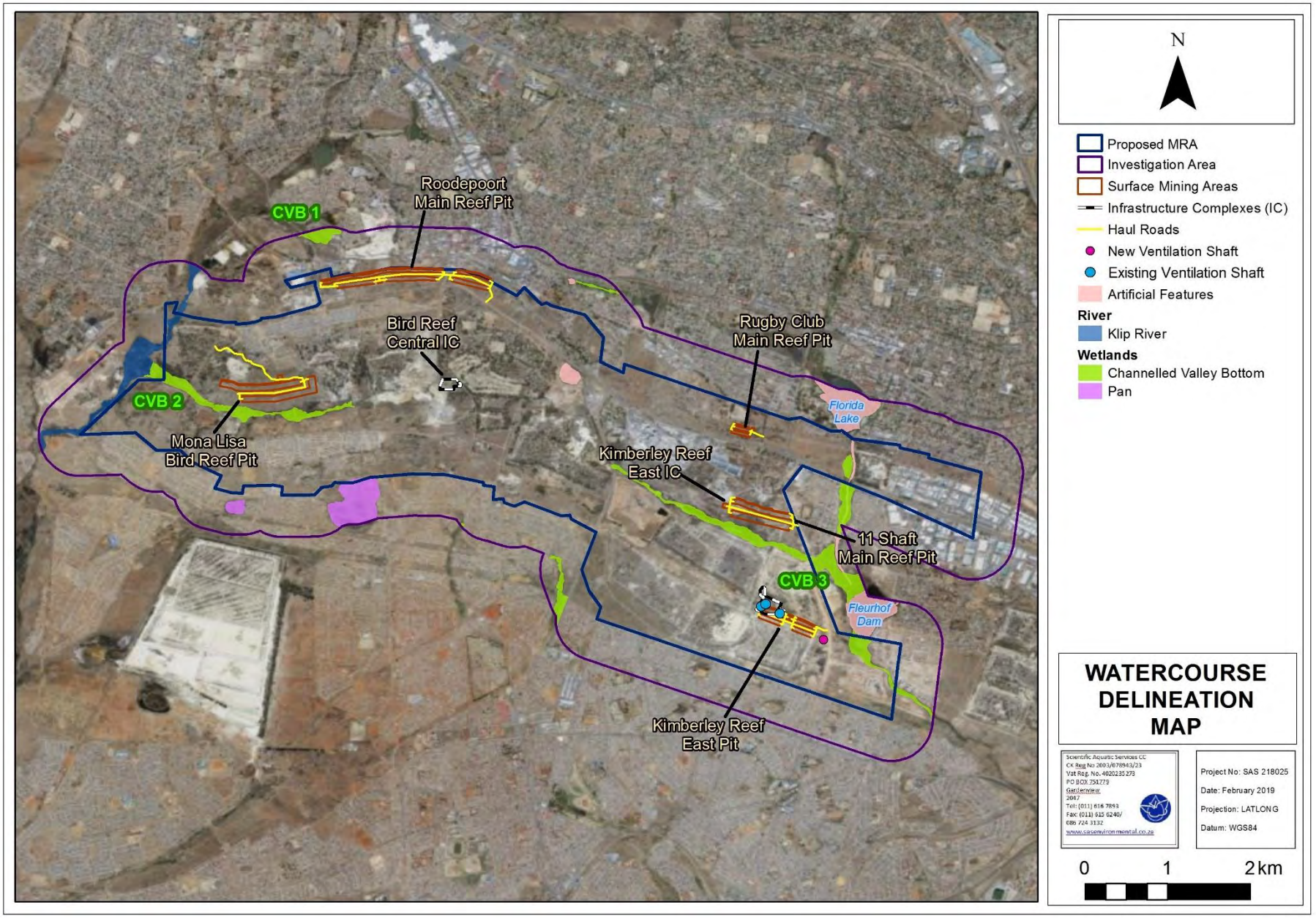


Figure 13: Locality and extent of the watercourses identified within the proposed MRA, in relation to the proposed mining activities.

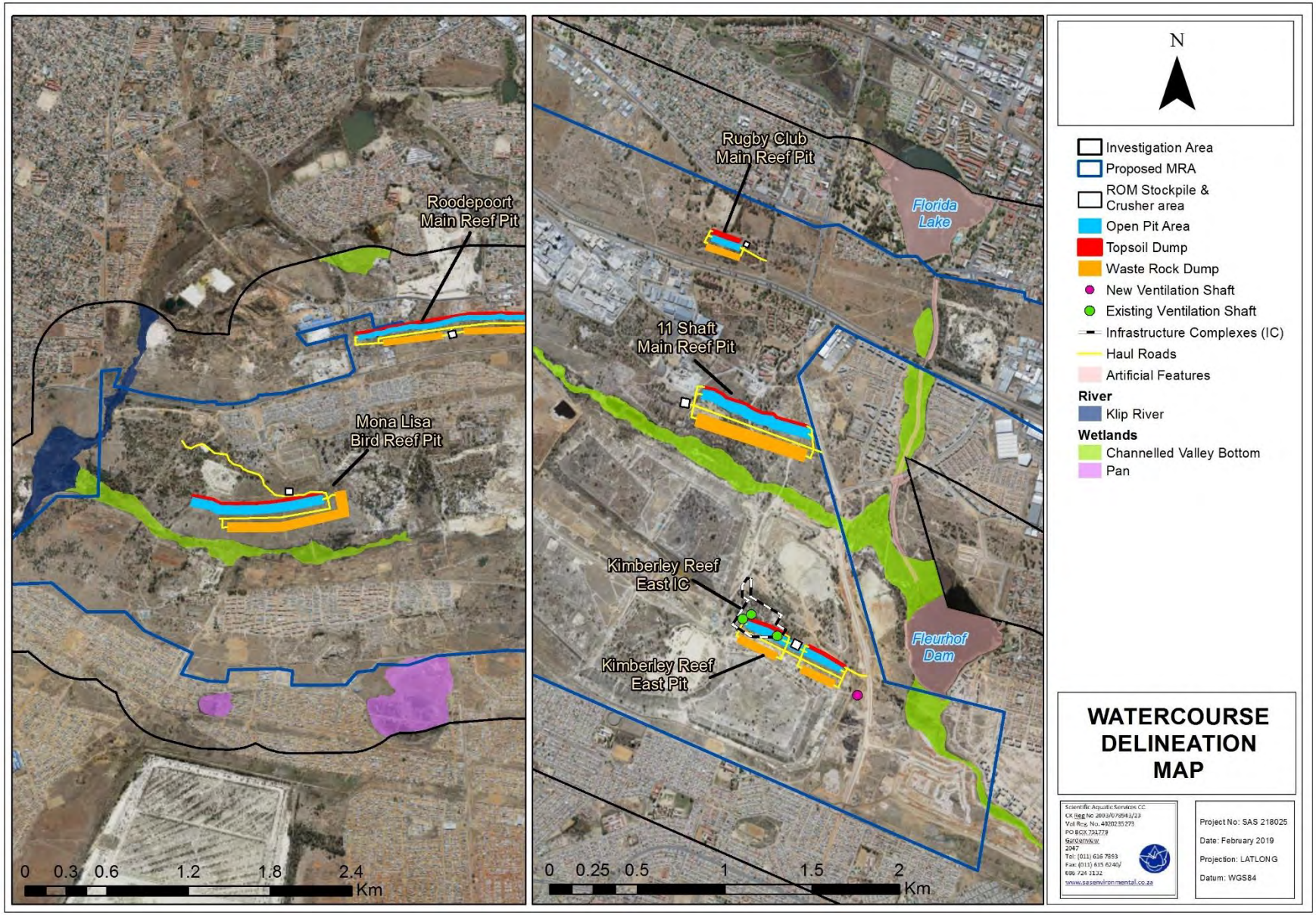


Figure 14: Locality and extent of the watercourses identified within the western and eastern portions of the proposed MRA, in relation to the proposed mining activities.

4.2 Field Verification Results

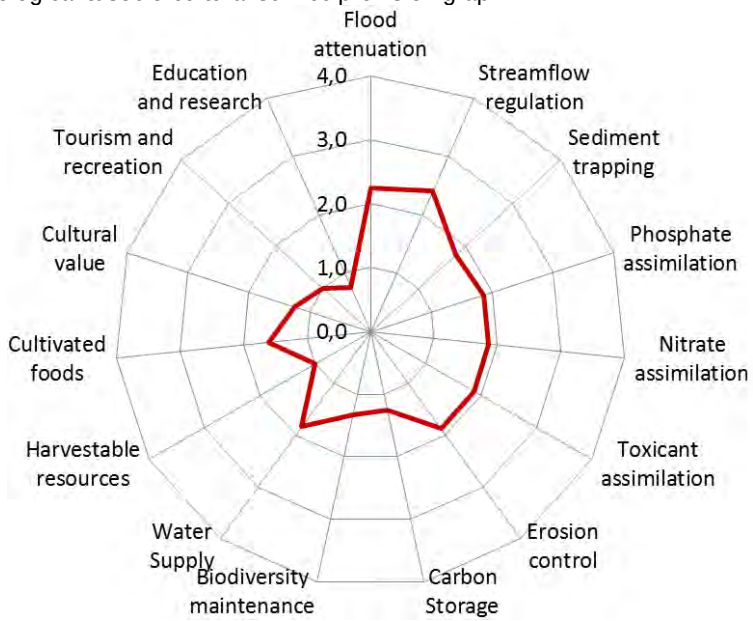
Following the site visits, various assessments were undertaken in order to determine the following:

- PES, incorporating aspects such as hydrology, vegetation and geomorphology;
- Service provision of the watercourses, which incorporates biodiversity maintenance, flood attenuation, streamflow regulation and assimilation, to name a few;
- The EIS is guided by the results obtained from the assessment of PES and service provision of the watercourses;
- An appropriate REC, RMO and BAS to guide the management of the watercourses with the intent of enhancing the ecological integrity of the watercourses where feasible; and
- Assessment of impacts of the construction and operation of the proposed activities associated with the proposed MRA on the watercourses.

The results of the assessments are presented in the dashboard style reports below.

Table 7: Summary of the assessment of the Klip River system located on the western boundary of the proposed MRA

Ecological & socio-cultural service provision graph:

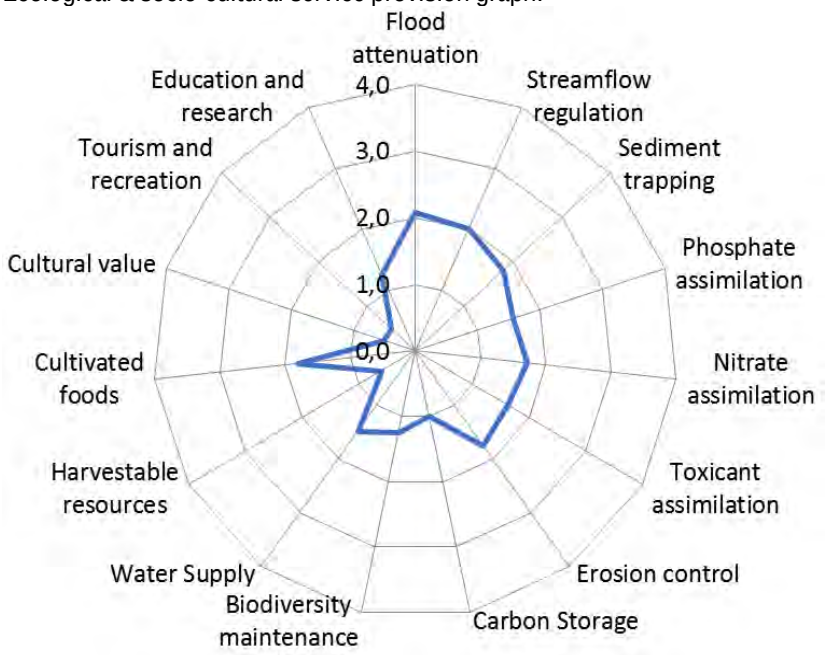


PES discussion	IHI Category: C/D (Moderately to largely modified) The Klip River receives polluted waters from its catchment which mainly consists of an urban-industrial-mining complex and is thus exposed to various anthropogenic activities from its source to its lower reaches where it meets the Vaal River. The types of stressors on the system vary to some extent along the different reaches of the river. Impacts on the system include current and historical mining activities, sewerage effluents and an ingress of large volumes of stormwater. These impacts have largely altered the hydrological regime of the river leading to the disturbance of the vegetation component and geomorphological integrity of the river.
Photograph notes	Top: Photographs depicting an upstream portion of the Klip River (Randfontein Road crossing), located within the north-western portion of the proposed MRA. Here, several infrastructure (road crossing, pipeline) crosses the system. Subsistence crop cultivation was observed along the edge of the river. Bottom: A downstream portion of the river (Main Street crossing) within the southern portion of the investigation area. Here, it was noted that the active channel of the river is eroded and the vegetation community extensively altered.

<table>
<tr><td>Ecoservice provision</td><td>Intermediate
Even though this river is considered largely degraded, it is still considered to provide an intermediate level of ecoservice provisioning. This is mostly attributed to the intermediate to moderately high level of regulating and supporting services (i.e. flood attenuation, streamflow regulation and the assimilation of nutrients and toxicants) being provided by this river. Additionally, this river plays an important role in providing suitable areas for cultivation, with the consequence being the removal of indigenous marginal vegetation along the river thus limiting its ability to provide faunal habitat.</td><td>EIS discussion</td><td>EIS Category: B (High)
The portion of the Klip River located within the proposed MRA was determined to fall within a High EIS category, which is attributed to the CBA it is classified in (by the Gauteng Conservation Plan (2013)). It is also of importance in terms of its hydro-functionality (as determined by the Ecoservice assessment) as it is not considered to be particularly sensitive to any further changes in floods and/or water quality. However, it is the opinion of the freshwater ecologist that this river should rather be considered to fall within a moderate EIS category which would be a more accurate reflection of the rivers ecological sensitivity due to its overall degraded nature.</td></tr>
<tr><td colspan="4">REC Category</td></tr>
<tr><td colspan="4">REC Category: D (Largely modified) / RMO: Maintain / BAS: Category C
Although no proposed surface infrastructure/open pit areas are within close proximity of the river (haul road associated with the Mona Lisa Bird Reef Pit approximately 505 m east of the river), the proposed activities could contribute to the cumulative impacts of the historical mining activities impacting on the river, and potential edge effects could occur on this system. Therefore, no further degradation should be permitted. Mitigation measures should be implemented during all phases of the proposed development to minimise the risk of further negative impacts to the river, especially with regards to edge effects from the proposed activities.</td></tr>
<tr><td colspan="4">Watercourse characteristics:</td></tr>
<tr><td colspan="2">a) Hydraulic regime
Although the Klip River may have been a perennial river before the extensive urbanisation and historical mining activities occurred, perenniality of the river is now dominated by discharge of water from treated sewage, treated and untreated discharges from industrial sources, water pumped from other mines in this vicinity in addition to stormwater runoff. These increased flows and flood peaks have significantly impacted on the hydrological regime of the river, however, since these impacts have been occurring over a long period of time, the quantity of water within the river could now be considered as the accepted/normal level. Nevertheless, during high flood peaks (during rainfall events), a significant volume of water enters the river system at a high velocity (a flash flood) from the surrounding impermeable surfaces and floods its banks as the infrastructure crossing the river limits the free-flow of water.</td><td colspan="2">b) Geomorphology and sediment balance
Due to the alteration in the flow regime of the river, changes that are brought about by numerous weirs and road infrastructure crossings, and most substantially by the ingress of large volumes of water and the increased velocity thereof, serious erosion and incision of the active channel of the river has occured and has led to the siltation of some portions of the river. Tailings from other mining activities that has been deposited with the catchment of the Klip River and within close proximity to the Klip River portion associated with the investigation area, are unlined and not vegetated and thus are a source of dust and additional sediment to this river system.</td></tr>
<tr><td colspan="2">c) Water quality
As mentioned above, the Klip River receives water input from a variety of point and non-point sources, including stormwater runoff. Despite this, the EC complies with the Resource Water Quality Objectives (RWQO) of South Africa (DWA, 2011) as it is within the stipulated acceptable range (< 50 mS/m). The pH varied between the summer and winter assessments (between acceptable and unacceptable limits). For more detail pertaining to the water quality of this system, please refer to Section 5.1.</td><td colspan="2">d) Habitat and biota
A variety of different types of marginal vegetation are present. Within the upstream portion of the river, tree species (albeit alien species) were identified within the marginal zone of the river (see photographs above), with some facultative grass species along the embankment of the river. However, extensive areas of vegetation have been removed and replaced with small patches of cultivated areas up to the edge of the river.
Within the downstream portion of the river, due to the placement of infrastructure within the active channel, upstream flooding occurs regularly where sediment is being deposited and has created a substrate for the establishment of robust reed species (*Phragmites australis* and *Typha capensis*). In this area, the river does provide habitat for a variety of small fauna and avifaunal species.
However, along other portions of the river, the marginal vegetation has been impacted upon by the grazing of livestock, thereby causing disturbance to the river and associated vegetation leading to opportunistic alien invasive species establishment.</td></tr>
<tr><td colspan="4">Possible significant impacts, business case, conclusion and mitigation requirements:</td></tr>
<tr><td colspan="4">As the haul road associated with the Mona Lisa Bird Reef Pit is located approximately 505 m east of the river and all other activities are situated approximately 760 m east of the river, the impact significance expected to occur from the construction activities and some of the operation activities is considered to be Low.</td></tr>
</table>

Table 8: Summary of the assessment of the Channeled Valley Bottom (CVB) Wetlands Group 1 (consisting of CVB 1 and 2) located within the north western portion of the proposed MRA

Ecological & socio-cultural service provision graph:

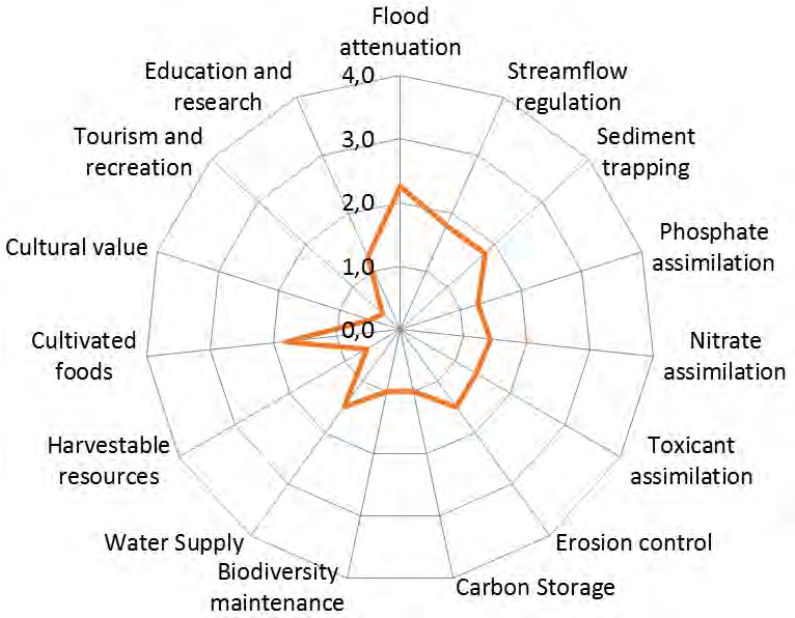


PES discussion	PES Category: D (moderately modified) Modifications to these wetlands have primarily impacted on the hydrological regime and the vegetation component which include the proliferation of alien and indigenous invasive flora, and the removal of natural vegetation. The construction of instream dams, the influx of stormwater runoff and the surrounding mining activities (with specific mention of seepage from a tailings dam into this wetland) has however significantly impacted the hydrological regime of these wetlands.

Photograph notes	Top left and right: An overview of CVB 2, which is dominated by reed species. Small agricultural fields (yellow arrow) have been developed within and up to the southern edge of this wetland. Bottom left: Within the downstream portion of CVB 2, disposal of building rubble and litter were extensive along the boundary of the wetland. Bottom right: CVB 1 is also dominated by reed species. Stormwater from upgradient developments is being discharged into this system.

Ecoservice provision	Intermediate Despite these wetlands having an overall reduced ecological integrity, functioning remains at an intermediate level, particularly in terms of eco-services such as flood attenuation, streamflow regulation and cultivated foods (mainly because of the surrounding agricultural activities). These wetlands are not considered important for education and research, or tourism and recreation, mainly due to the disposal of litter and evidence of surface water discoloration (potentially from the surrounding mining activities). Nevertheless, the robust reed species provides habitat for less sensitive faunal species.	EIS discussion	EIS Category: B (High) The EIS of these wetlands falls within Category B, which are wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. However, these wetlands are considered of high ecological importance based on the hydro-functional importance assessment (i.e. flood attenuation and stream flow regulation) and not necessarily on ecological sensitivity. Additionally, CVB 2 is considered to be located within a CBA, whilst CVB 1 is located within an ESA according to the Gauteng Conservation Plan (2011).
REC Category			
REC Category: D (Largely modified) / RMO: Maintain / BAS: Category C Despite the ecological functioning of these wetlands being considered relatively low, they are still considered to be of intermediate ecological importance. Thus, due to the degraded state, no further degradation should be permitted, with specific mention of CVB 2, as the proposed layout of the Mona Lisa Bird Reef Pit is located within close proximity (approximately 57 m upgradient/north of CVB 2). Mitigation measures should be implemented during all phases of the proposed development to minimise the risk of further negative impacts to this wetland, and wherever possible, to improve the condition of the portion of the wetland associated with the development. Based on the layout provided by the proponent, it is very unlikely that the Roodepoort Main Reef Pit will have a direct impact on CVB 1, thus, retaining the PES is considered very feasible with minimal effort by the proponent.			
Watercourse characteristics:			
a) Hydraulic regime These wetlands are mainly driven by surface water runoff from the surrounding catchment (runoff from impermeable surfaces and mining related activities). It was also evident that seepage from a tailings dam located north of CVB 2 enters this wetland. Therefore, the hydraulic regime of these wetlands could be considered significantly altered as the quantity of water inflow has been increased and an alteration of its flood peaks (increased flood peaks) has occurred, however, instream dams act as energy dissipating structures which aids in decreasing the velocity of flow into the downstream Klip River system.		c) Geomorphology and sediment balance The construction of instream dams and road crossings without through flow structures (i.e. culverts) has impacted on the frequency of downstream flooding and the sediment cycle of the downstream portions of the wetlands, even though it does aid in the dissipation of high-velocity stormwater flows. Dams impound large sediment loads that would have previously naturally replenished the downstream wetland portions, thus these upstream dams are heavily silted. Nevertheless, the sediment deposits within the dams have also created additional substrate for vegetation to establish within the wetlands, increasing the surface roughness of the wetlands.	
b) Water quality Water quality of these wetlands is considered to be poor. As water within the wetlands originates from runoff from the surrounding residential areas, it is likely to transport domestic effluent, sediment, hydrocarbons and litter, thus polluting surface water which in turn is transported into the downstream Klip River system. Furthermore, the degraded water quality could also be exacerbated by the inflow of contaminated stormwater from the surrounding mining areas. For more information regarding the surface water quality of CVB 2, refer to Section 5.1 below.		d) Habitat and biota The vegetation component of these wetlands is dominated by reed species (*Phragmites australis* and *Typha capensis*). The excessive sediment substrate and poor water quality allowed for the invasion of a monoculture of *Phragmites australis*, dominating the largest extents of the wetlands and reducing the available substrate for other indigenous species to establish. Due to this monoculture, floral diversity is low, but the wetlands still have the potential to provide habitat for less sensitive faunal species. Proliferation of alien and invasive floral species was also in evidence at the outer edges of the wetlands, and where infrastructure (i.e. road crossings) has been constructed. The removal of the surrounding wetland and terrestrial vegetation (due to agricultural fields up to the boundary of the wetland (CVB 2) and construction of infrastructure within and on the boundary of the wetland (CVB 1)) has also eliminated any potential buffer area which could aid in maintaining biodiversity in the wetlands.	
Possible significant impacts, business case, conclusion and mitigation requirements:			
Since CVB 1 is located on the boundary of the investigation area and the Roodepoort Main Reef Pit is located at least 400 m from this wetland, no direct impacts are anticipated. Although the natural topography of the area should prevent runoff from the mining area into the wetland, other developments in the area may influence the topography and therefore suitable precautions must be taken. As noted in the REC discussion, mining activities will not encroach on or traverse the wetland directly, thus no direct impacts are anticipated. Despite the waste rock dump being located approximately 57 m and the open pit area approximately 214 m upgradient/north of this wetland, no significant impacts are expected to occur on this wetland, with the implementation of the recommended mitigation measures (Low impact significance). Specific mention is made to manage the waste rock dump north of the wetland to minimise infiltration of contaminants to the downgradient wetland. Mitigation methods that should be considered include development of a downgradient berm and trench system to collect seepage which can be re-used in the mining processes.			

Table 9: Summary of the assessment of the Channeled Valley Bottom (CVB) Wetland Group 2 (consisting of the CVB 3 system) located within the eastern portion of the proposed MRA

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:
 
</td><td colspan="2">  </td></tr>
<tr><td>PES discussion</td><td>PES Category: D (Largely modified)
The surrounding activities to this wetland system include historical and current mining activities (within its western portions) and high-density residential developments. Impacts arising from these developments include (but are not limited to): increase in contaminated surface water runoff, removal of surrounding natural habitat (buffer zone), and disposal of litter/rubble. These impacts have significantly altered the hydrological and vegetation components of the wetland system, whilst the construction of instream dams within the upstream and downstream portions has impacted on the geomorphological and hydrological components of the wetland.</td><td>Photograph notes</td><td>Top left: This portion of this CVB system is located in an area comprising historical mining activities, where disposal of building and mining rubble were encountered. Here, the wetland is also dominated by reed species. Top right: A large section of this wetland has been canalised, however some wetland vegetation has established in the canals. Bottom: The vegetation component of the wetland portion below the Fleurhof Dam has been significantly impacted by the surrounding residential developments. This has resulted in the extensive removal of terrestrial and wetland vegetation, and thus the buffer surrounding the wetland is significantly degraded.</td></tr>
<tr><td>Ecoservice provision</td><td>Moderately Low/Intermediate
As this wetland system is mainly located within an urbanised area, it does play an intermediate role in attenuating floods and regulating the flow of water, especially since high flood peaks are expected during high rainfall events. Most of the other direct benefits (such as biodiversity maintenance and tourism and recreational value) are considered moderately low, as the surrounding anthropogenic activities have degraded the overall wetland ecological state and thus is the wetland system not considered important for tourism (low scenic value) or for recreational activities.</td><td>EIS discussion</td><td>EIS Category: B (High)
The EIS of these wetlands falls within Category B, which are wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. However, the CVB 3 wetland system are only considered of high ecological importance based on the hydro-functional importance assessment (i.e. flood attenuation and stream flow regulation) and not necessarily for its ecological sensitivity. Therefore, it is the opinion of the freshwater ecologist that this wetland system should rather be considered to fall within an EIS C category (Moderate), which would better represent the importance and sensitivity of the system.</td></tr>
</table>

<table>
<tr><td colspan="2">REC Category</td></tr>
<tr><td colspan="2">REC Category: D (Largely modified) / RMO: Maintain / BAS: Category C
Despite the ecological functioning of this system being considered low, it is still considered to be of intermediate ecological importance in terms of its hydrological functioning. Thus, due to its degraded state, no further degradation should be permitted, as the proposed layout of the 11 Shaft Main Reef Pit is located approximately 54 m north of the wetland and the Kimberley Reef East Pit is located approximately 390 m west of the wetland. Although existing road infrastructure and open areas are in between these proposed mining activities and the wetland, the potential for edge effect and impacts on the groundwater hydrological functioning of this system is possible.
Mitigation measures should be implemented during all phases of the proposed development to minimise the risk of further negative impacts to this system, and wherever possible, to improve the condition of the wetland as a whole.</td></tr>
<tr><td colspan="2">Watercourse characteristics:</td></tr>
<tr><td>a) Hydraulic regime
The hydraulic regime of this wetland system has been altered as a result of historical and current modifiers, including altered flow patterns as a result of infrastructure such as weirs and bridge crossings, significantly increased water inputs and stormwater velocity resulting from extensive hardening of the catchment (specifically within the area surrounding the headwaters of this system), altered channel capacity due to bank incision, and debris and solid wastes transported from upstream areas causing blockages and impeding flow. As the area surrounding the headwaters of this wetland is largely built-up impermeable surfaces, currently, the main driver of this wetland system is considered to be stormwater being discharged into the system. The upstream Florida Lake dam attenuates the velocity thereof prior to it being conveyed through canals into the downstream Fleurhof Dam and wetland system.</td><td>b) Geomorphology and sediment balance
As with the hydraulic regime, the impounding of the system has resulted in significant alterations to the geomorphology of the system. Nevertheless, the impoundments have been in place for a number of years, and therefore the system is likely to have adapted to these circumstances to a certain degree. The installation of the canal between the upstream Florida Lake and the downstream Fleurhof Dam has also altered the geomorphology and possibly the extent of the wetland in that portion where water is now being concentrated in a channel. Additionally, disturbances in the catchment relating to ongoing and rapid urbanisation of the area are deemed highly likely to contribute to increased sediment inputs, which may result in scouring, or increased sediment deposition, leading to – for example - altered flow patterns or changes to the vegetation community.</td></tr>
<tr><td>c) Water quality
Water quality of these wetlands is considered to be poor. As water within these wetlands originates from runoff from the surrounding residential areas, it is likely to transport domestic effluent, sediment, hydrocarbons and litter, thus polluting surface water which in turn is transported into the downstream system. Furthermore, the degraded water quality may be exacerbated by the inflow of contaminated stormwater from the surrounding mining areas.
For more information pertaining to detailed water quality parameters, please refer to Section 5.</td><td>d) Habitat and biota
A large degree of vegetation removal has occurred within and along this wetland system due to the development of road infrastructure and residential developments. Even though the permanent zone of the wetland could be considered well vegetated, the outer edges of the wetland have very little to no indigenous vegetation remaining, and thus no suitable buffer zone to aid in protecting the wetland from the surrounding activities. The western portion of this wetland system was however dominated by reed species (Phragmites australis and Typha capensis), which provides habitat and refugia for a number of less sensitive avifaunal and smaller faunal species.</td></tr>
<tr><td colspan="2">Possible significant impacts, business case, conclusion and mitigation requirements:</td></tr>
<tr><td colspan="2">Despite the waste rock dump associated with the 11 Shaft Mani Reef Pit being located approximately 54 m and the open pit area approximately 220 m upgradient/north of this wetland, no significant impacts are expected to occur on this wetland, with the implementation of the recommended mitigation measures (Very Low impact significance). Specific mention is made to manage the waste rock dump north of the wetland to minimise infiltration of contaminants to the downgradient wetland. Mitigation methods that should be considered include development of a downgradient berm and trench system to collect seepage which can be re-used in the mining processes.</td></tr>
</table>

4.3 Delineation and Sensitivity Mapping

4.3.1 Delineation

Due to the access limitations experienced during the site assessment as previously discussed, the watercourses were partially delineated in the field, and the delineations subsequently refined with the use of aerial photographs and historical and current digital satellite imagery. Additionally, as noted in Section 4.2 of this report, extensive areas of the watercourses have been historically disturbed as a result of historical and existing mining activities, construction of the instream dams and transport infrastructure crossing the systems within very close proximity to the watercourses, which have in turn altered the topography, soil profiles and vegetation communities within and surrounding the watercourses. The delineations as presented in this report are thus regarded as the best estimate of the watercourse boundaries based on the site conditions present at the time of assessment.

During the assessment, the following indicators were used to delineate the boundaries of the watercourses:

- Topography of the surrounding landscape has been altered within the proposed MRA as a result of erosion, infilling and the establishment of tailings dams; thus, although terrain units were utilised as a guideline, this was not always considered reliable;
- The vegetation indicator could not be extensively utilised, as only the permanent zone of the wetlands contained vegetation indicative of wet or moist conditions. Due to the extent of vegetation clearing surrounding various watercourses (due to the establishment of residential development within close proximity to the watercourses etc.), the vegetation community composition has been notably transformed. Therefore, the extent of natural vegetation is limited, in turn reducing the dependence on this indicator in this area. However, in areas where the vegetation is considered to be intact, this indicator proofed to be useful; and
- Due to the above-mentioned alterations to topography, soil profiles and vegetation communities, historical and current digital satellite imagery were also utilised to aid in the delineation.

4.3.2 Legislative Requirements, national and provincial guidelines pertaining to the application of buffer zones

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however, in summary, it is considered to be “a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts

from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted however that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

Legislative requirements were first taken into consideration when determining a suitable buffer zone for the freshwater resources. The definition and motivation for a regulated zone of activity as well as a buffer zone for the protection of the freshwater resource can be summarised as follows:

Table 10: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Listed activities in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations	32 m from the edge of a watercourse.
Water Use License Application in terms of the National Water Act, 1998 (Act 36 of 1998) (NWA)	In accordance with GN509 of 2016 as it relates to the NWA, a regulated area of a watercourse for Section 21 (c) and 21 (i) of the NWA is defined as: • the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500 m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation. Therefore, the following regulated areas as per GN509 of 2016 described above, apply to the different watercourses located within the proposed MRA: • A 500 m zone of regulation applies to all wetlands; and • A 100 m zone of regulation applies to the Klip River.
	In accordance with GN704 of the NWA, 1998 (Act no. 36 of 1998) which contains regulations on use of water for mining and related activities aimed at the protection of water resources. GN704 states that: *No person in control of a mine or activity may:* *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on*

	waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked; According to the above, the activity footprint must fall outside of the 1:100 year floodline of the aquatic resource or 100 m from the edge of the resource, whichever distance is the greatest.

In addition to the above, according to the GDARD Minimum Requirements for Biodiversity Assessments (2014), a specific buffer zone is recommended for watercourses, depending on the location of the watercourses in relation to Urban Areas. Although the Urban Edge was rescinded as a policy document in the Gauteng Spatial Development Framework in 2011, many municipalities retain an urban edge as part of their municipal spatial development frameworks (Gauteng Growth Management Perspective, 2014) and it is thus considered to provide a useful indicator of where concentration [of development] should occur[2]. Therefore, for the purposes of this report, the Urban Edge and Gauteng Environmental Management Framework boundaries as defined by the Gauteng Conservation Plan Version 3 (2011) and the Gauteng EMF (2015) are utilised as a guideline to inform decision making when recommending or stipulating a suitable setback area around the watercourses.

According to the GDARD Minimum Requirements for Biodiversity Assessments (2014), a specific buffer zone is recommended for watercourses, depending on the location of the watercourses in relation to Urban Areas. According to the Gauteng C-Plan (2011), the proposed MRA is located within an Urban Area, thus in terms of the GDARD guidelines, the following setback areas apply:

- A 30 m buffer or setback is applicable to all wetlands; and
- A 32 m buffer or setback is applicable to the Klip River.

The 1:100 year floodline of CVB 2 and a portion of CVB 3 was determined. As per Table 10 above, the GN509 Zone of Regulation for these wetlands are their determined 1:100 year floodlines. Based on the outcome of the floodline study, no surface infrastructure from the Mona Lisa Bird Reef Pit nor the 11 Shaft Main Reef Pit are located below the 1:100 year floodlines of these wetlands.

The delineated watercourses and their applicable zones of regulation in terms of GDARD, GN704 and the NWA are conceptually depicted in Figures 15 to 18 below.

[2] *Gauteng Growth Management Perspective, 2014*. Retrieved from http://www.gautengonline.gov.za/Publications/Gauteng%20Spatial%20Development%20Framework%20-%202011.pdf on 15th January 2015

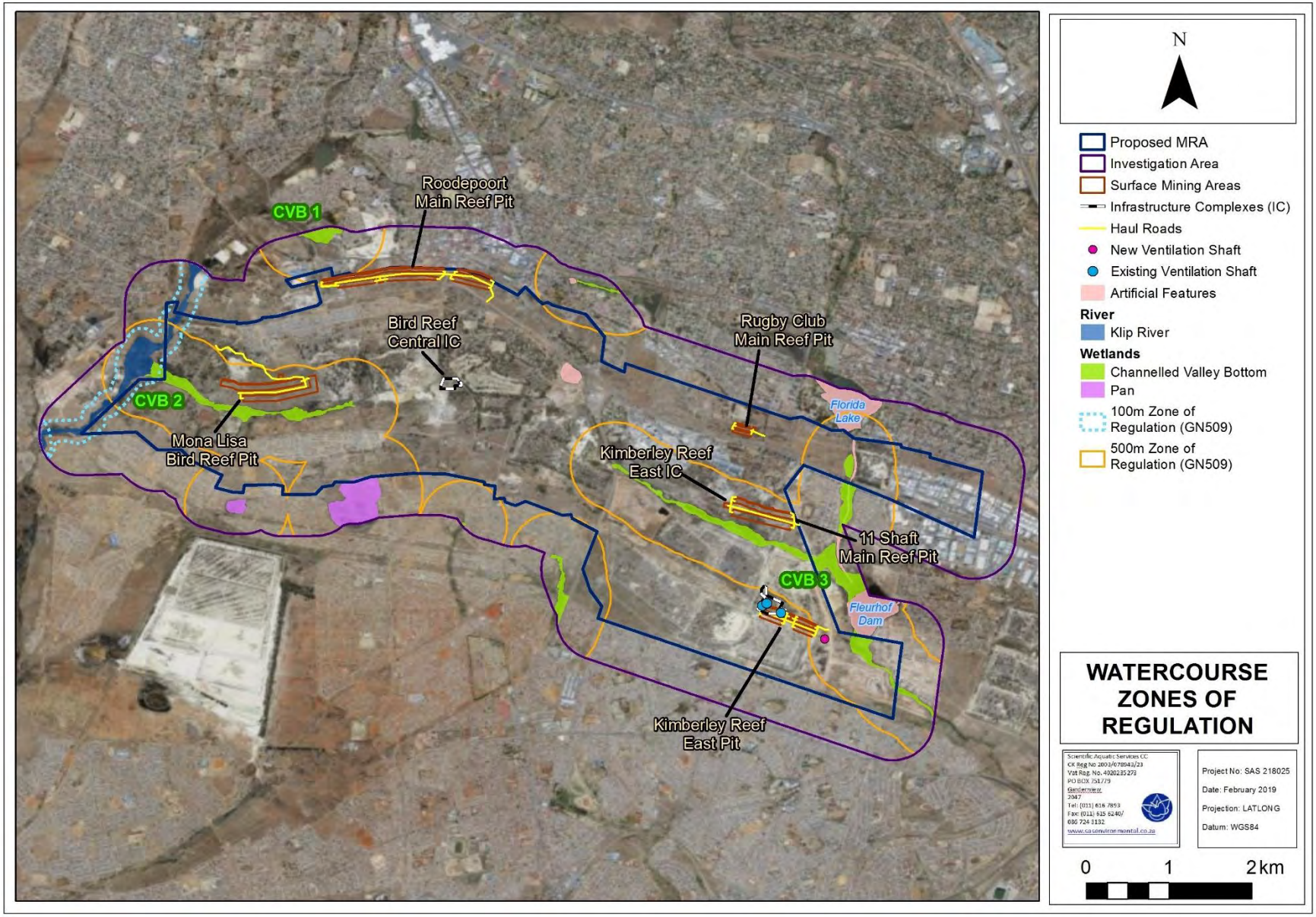


Figure 15: Conceptual presentation of the zones of regulation in terms of GN509 of 2016 as it relates to the NWA, in relation to the proposed MRA.

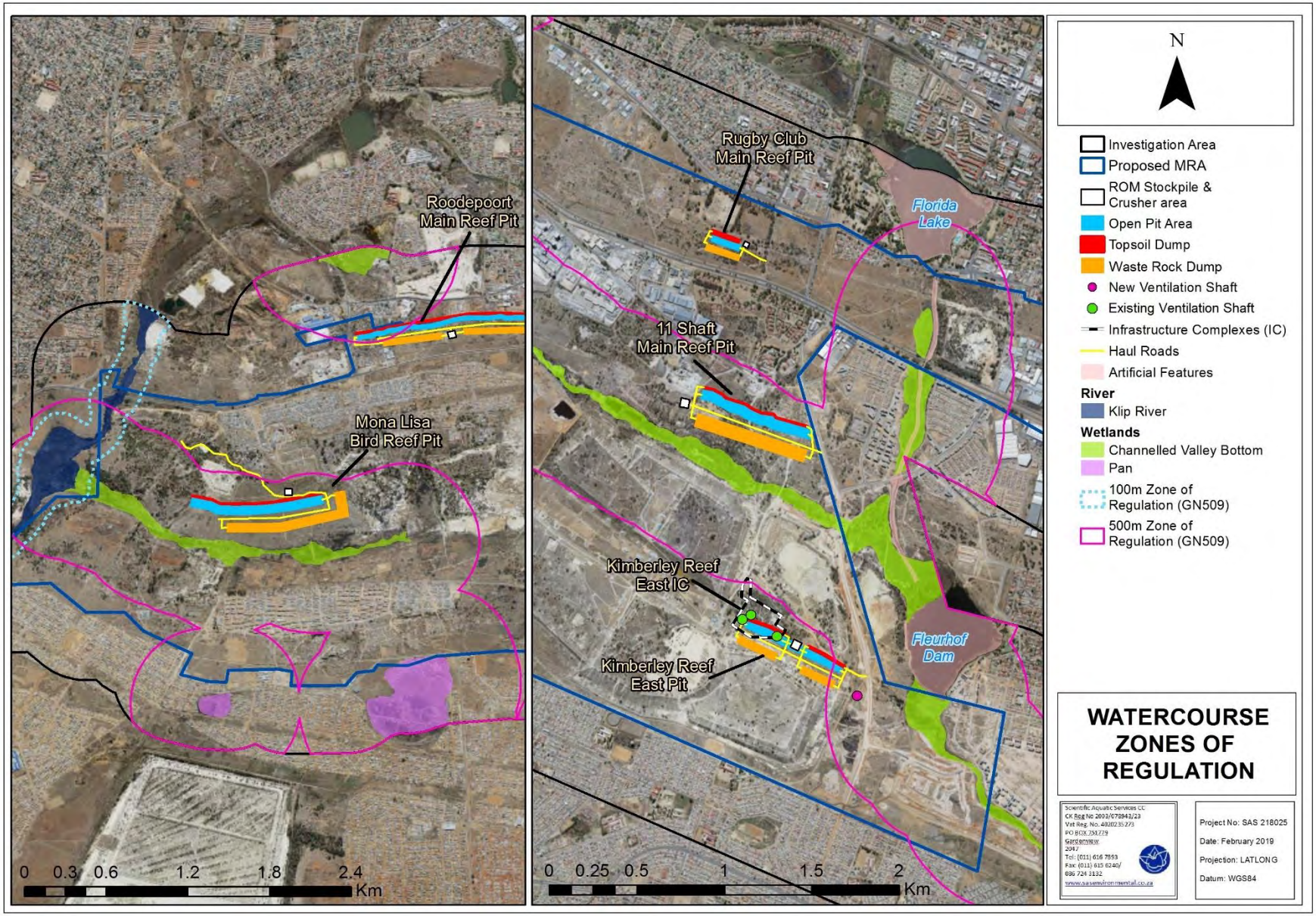


Figure 16: Conceptual presentation of the zones of regulation in the western and eastern portions of the proposed MRA in terms of GN509 of 2016 as it relates to the NWA.

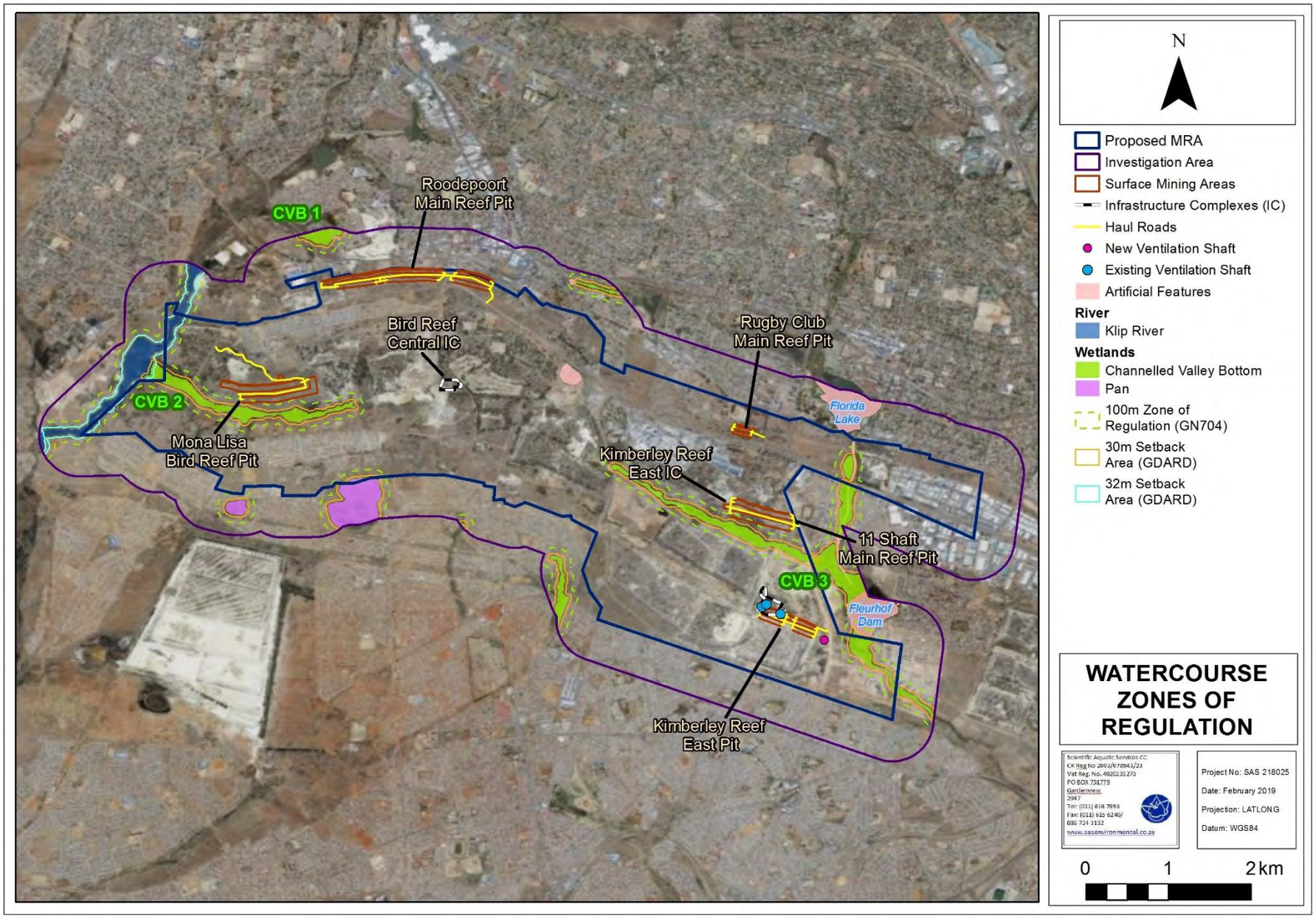


Figure 17: Conceptual presentation of the zones of regulation in terms of GN704 and GDARD, in relation to the proposed MRA.

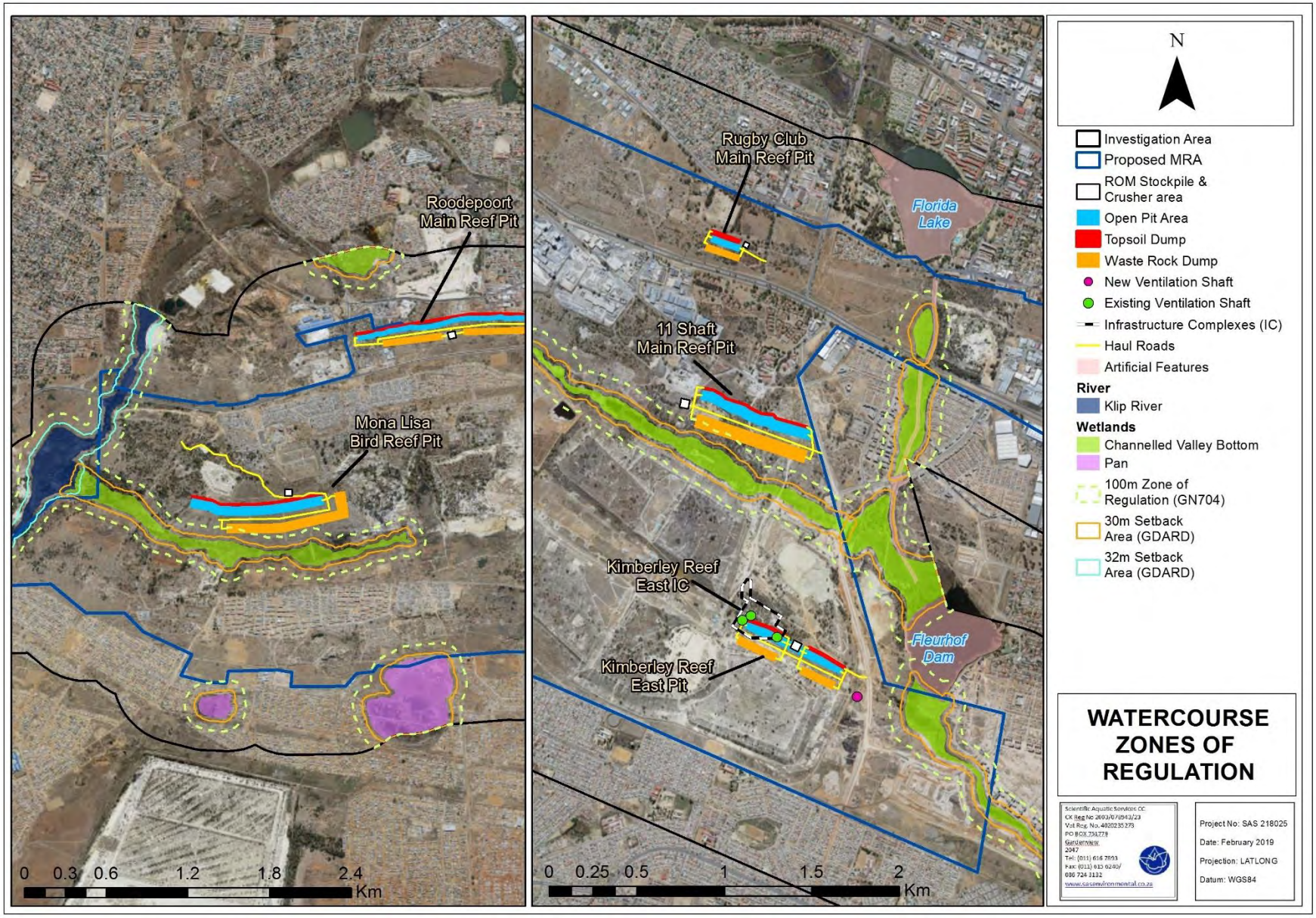


Figure 18: Conceptual presentation of the zones of regulation in terms of GN704 and GDARD in the western and eastern portions of the proposed MRA.

5 RESULTS: AQUATIC ECOLOGICAL ASSESSMENT

5.1 Results and Interpretation

The field assessment took place during High Flow (HF) in March 2018 and Low Flow (LF) in June 2018. Results are presented as “dashboard style” reports (Tables 11 to 23 as well as Figures 19 to 38). These dashboard reports aim to present concise summaries of the data on as few pages as possible, in order to allow for integration of results by the reader to take place. Where required, further discussion and interpretation are provided.

Table 11: Results of the assessment at site KLIP US (Located upstream of the proposed Mona Lisa Bird Reef Pit, adjacent to the proposed Main/South Reef IC area on the Klip River).

Site KLIP US

Figure 19: Upstream view of site KLIP US (left) during high flow in March 2018 and upstream view of site KLIP US (right) indicating the low flow conditions in June 2018.

In situ physico-chemical water quality

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% Temporal variation. from the baseline assessment (March 2018)	% Spatial variation. from the upstream site
pH	5.65	8.02	+41.9	No spatial reference site.
EC (mS/m)	32.4	48.5	+49.7	
DO (mg/L)	6.38	8.38	+31.3	
DO (% sat)	87.2	85.6	NA	
Temp (℃)	21.0	8.0	-61.9	

Invertebrate community assessment (SASS5 and IHAS)

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% of reference data (SASS5 and ASPT)		% Temporal variation from the high flow assessment (March 2018)	% Spatial variation from the upstream site
			HF	LF		
SASS5 score	71	57	-56.2	-64.8	-19.7	No spatial reference site.
ASPT score	4.4	3.8	-26.7	-36.7	-13.6	
IHAS score	52 (Poor)	60 (Adequate)			+15.4	
Instream IHI	71.1 (Category C)	57.3 (Category D)				
Riparian IHI	65.1 (Category C)	66.2 (Category C)				
MIRAI Score	63.4 (Category C)	61.2 (Category C)				

Water Quality: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.
Macro-invertebrates: A temporal deterioration exceeding 15% was considered significant; A spatial and temporal improvement exceeding 15% was considered significant.

Algal proliferation	Observed on rocks during both assessments.
Depth profiles	The river was relatively shallow at this point (generally ½ m), however, some deeper pool areas were observed.
Flow condition	The river consisted of a slow run and still pools.
Water clarity and odour	Water was clear during the HF assessment and turbid (once disturbed) during the LF assessment. No odours evident.
Riparian zone characteristics	Riparian vegetation is absent in some areas, which is likely to result in some erosion and bank instability under high flow conditions. Riparian zone is severely impacted as a result of trampling by livestock.

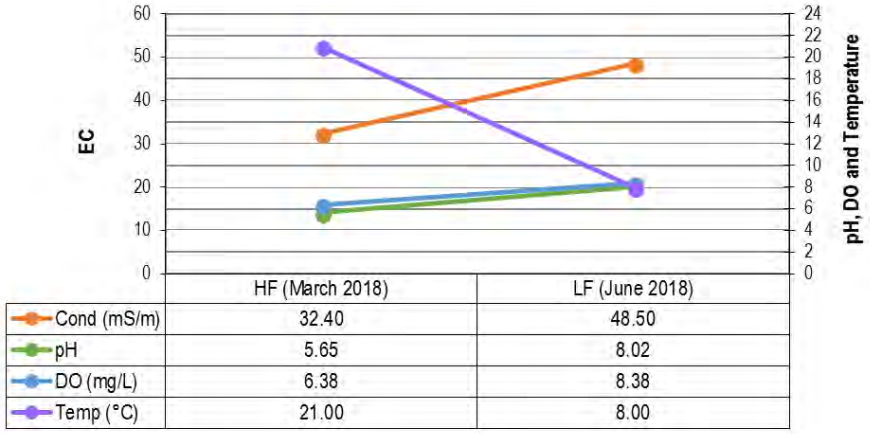
SITE ECOSTATUS CATEGORY

	High Flow	Low Flow
Dallas (2007)	Category E/F	Category E/F
MIRAI	Category C	Category C
Overall IHI	Category C	Category C

Current impacts:
- During the LF assessment, sedimentation was observed at the site with a fine silt layer blanketing the benthos. This is likely due to activities upstream;
- Flow modification as a result of weirs and impoundments along the length of the system;
- Lack of diversity of flow regimes, habitat cover and depth profiles also affect the aquatic communities occurring at this point and is considered the key ecological driver of change in the system at this point.

NA = Not Applicable; HF = High Flow; LF= Low Flow; SASS5 reference score = 160; ASPT reference score = 6.0.

Table 12: Temporal variations observed at site KLIP US during both the high flow and low flow assessments in 2018.



	HF (March 2018)	LF (June 2018)
Cond (mS/m)	32.40	48.50
pH	5.65	8.02
DO (mg/L)	6.38	8.38
Temp (°C)	21.00	8.00

Figure 20: Site specific temporal water quality variation at the upstream Klip River site (KLIP US).

	HF (March 2018)	LF (June 2018)
SASS	71.00	57.00
IHAS	52.00	60.00
ASPT	4.40	3.80

Figure 21: Site specific temporal macro-invertebrate community integrity at the upstream Klip River site (KLIP US).

Comment:

- The pH has significantly increased by 41.9% when compared to the HF assessment (March 2018) and this change exceeds the Target Water Quality Requirements (TWQR) which advocate a temporal change of no more than 5% (DWAF, 1996). During the low flow (LF) assessment, the pH can be regarded as largely natural and complies with the Resource Water Quality Objectives (RWQO) (DWA, 2011) acceptable range (≥ 6.5 - ≤ 8.0). However, the pH during the HF assessment is lower and within the unacceptable range limit (< 6.5 and > 8.0) according to the RWQO set out by the DWA (2011). Further assessments are needed to ascertain this trend in the future;
- Since the high flow (HF) assessment in March 2018, the Electrical Conductivity (EC) increased significantly by 49.7%. This change exceeds the TWQR, which advocates a temporal change of no more than 15% (DWAF, 1996). However, the EC during both assessments complies with the RWQO of South Africa (DWA, 2011) as it can be seen as acceptable (< 50 mS/m);
- EC is variable over time, likely due to impact from catchment-wide anthropogenic and agricultural activities, compounded by evapoconcentration during periods of low flow as is indicated by the significant temporal increase;
- Dissolved Oxygen (DO) levels at this upstream Klip River site can be considered as adequate (< 80% saturation) during both HF and LF assessments and impact on the aquatic community resulting from DO concentration is unlikely during both assessments;
- Temperature is considered natural for the time of day and season in which HF and LF sampling took place.

Comment:

- The aquatic community diversity and sensitivity at this point may be considered critically modified in relation to that expected for a pristine Highveld river during both the HF (March 2018) and LF (June 2018) assessments. This is observed by the 56.2% and 64.8% decrease in the SASS5 score and the 26.7% and 36.7% decrease in the ASPT score when compared to the reference ecoregion scores for each assessment (HF and LF, respectively);
- Since the HF assessment, the SASS5 score has significantly decreased by 19.7% and the ASPT score by 13.6%. However, the habitat suitability increased by 15.4%. The observed decrease in SASS and ASPT scores is likely due to the increased sedimentation observed during the LF assessment in June 2018, as well as the increase in EC concentration;
- It is deemed likely that the communities present along this section of the Klip River have been largely shaped and influenced by lack of suitable habitat, lack of flow continuity (compounded by weirs and impoundments within the system) and erratic rainfall patterns in the months preceding the March 2018 assessment, with many species remaining dormant until habitat and flow becomes suitable for aquatic life;
- Variations in water quality (EC and DO saturation) may be considered somewhat variable over time, compounded by the surrounding anthropogenic and agricultural activities and flow variability may result in some impacts on the aquatic communities present over the long term.

Table 13: Results of the assessment at site KLIP DS (Located in the south-west corner of the proposed MRA on the Klip River).

Site KLIP DS

Figure 22: Upstream view of site KLIP DS (above) during high flow in March 2018 and upstream view of site KLIP DS (below) during low flow conditions in June 2018.

In situ physico-chemical water quality

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% Temporal variation. from the baseline assessment (March 2018)	% Spatial variation. from the upstream site (KLIP US)
pH	6.01	8.02	+33.4	0.0
EC (mS/m)	34.6	73.4	+112.1	+51.3
DO (mg/L)	1.87	6.74	+260.4	-19.6
DO (% sat)	25.2	68.4	NA	NA
Temp (℃)	20.5	9.0	-56.1	+12.5

Invertebrate community assessment (SASS5 and IHAS)

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% of reference data (SASS5 and ASPT)		% Temporal variation from the high flow assessment (March 2018)	% Spatial variation from the upstream site (KLIP US)
			HF	LF		
SASS5 score	25	18	-84.6	-88.9	-28.0	-68.4
ASPT score	3.1	3.0	-48.3	-50.0	-3.2	-21.1
IHAS score	63 (Adequate)	64 (Adequate)			+1.6	+6.7
Instream IHI	57.5 (Category D)	60.1 (Category C)				
Riparian IHI	58.5 (Category D)	59.1 (Category D)				
MIRAI Score	58.0 (Category D)	53.5 (Category D)				

Water Quality: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.
Macro-invertebrates: A temporal deterioration exceeding 15% was considered significant; A spatial and temporal improvement exceeding 15% was considered significant.

Algal proliferation	Observed on rocks during the HF assessment. Observed in isolated clumps and stagnant pools during the LF assessment.
Depth profiles	The stream was relatively shallow at this point with some isolated deeper sections upstream.
Flow condition	The stream consisted of medium laminar flow, with some riffle habitat and still pools during both assessments.
Water clarity and odour	Water was clear at the time of the assessment. Some sewage odours evident during the HF assessment.
Riparian zone characteristics	Riparian vegetation dominated by grass and reeds during both assessments. Riparian zone is severely impacted as a result of trampling by livestock, traditional activities and burning during the LF assessment.

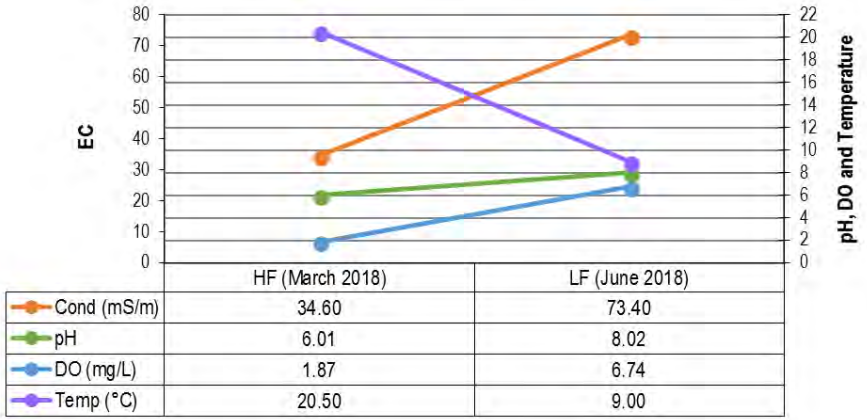
SITE ECOSTATUS CATEGORY

	High Flow	Low Flow
Dallas (2007)	Category E/F	Category E/F
MIRAI	Category D	Category D
Overall IHI	Category C	Category D

Current impacts:
- Regular traditional and ritual activities occurring at this site during both site assessments;
- Riparian zone is severely impacted as a result of trampling by livestock and dumping during both assessments;
- Burning of upstream vegetation was observed during the LF assessment as well as algae proliferation in the system at this point.

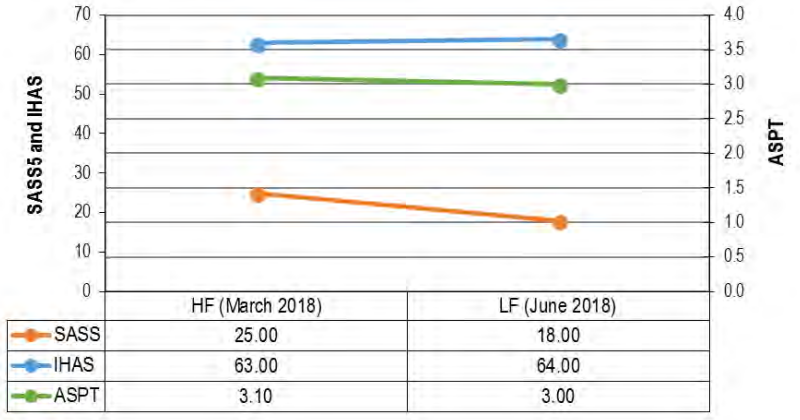
NA = Not Applicable; HF = High Flow; LF= Low Flow; SASS5 reference score = 160; ASPT reference score = 6.0.

Table 14: Temporal variations observed at site KLIP DS during both the high flow and low flow assessments in 2018.



	HF (March 2018)	LF (June 2018)
Cond (mS/m)	34.60	73.40
pH	6.01	8.02
DO (mg/L)	1.87	6.74
Temp (°C)	20.50	9.00

Figure 23: Site specific temporal water quality variation at the downstream Klip River site (KLIP DS).



	HF (March 2018)	LF (June 2018)
SASS	25.00	18.00
IHAS	63.00	64.00
ASPT	3.10	3.00

Figure 24: Site specific temporal macro-invertebrate community integrity at the downstream Klip River site (KLIP DS).

Comment:

- The pH has significantly increased by 33.4% when compared to the HF assessment and this change exceeds the TWQR which advocate a temporal change of no more than 5% (DWAF, 1996). The same trend is observed at the upstream Klip River site; during the LF assessment, the pH can be regarded as largely natural and complies with the RWQO (DWA, 2011) acceptable range (≥ 6.5 - ≤ 8.0) while the pH during the HF assessment is lower and in the unacceptable range limit (< 6.5 and > 8.0) according to the RWQO set out by the DWA (2011). Further assessments are needed to ascertain this trend in the future;
- The EC has increased significantly by 112.1% since the HF assessment in March 2018. This change significantly exceeds the TWQR which advocates a temporal change of no more than 15% (DWAF, 1996). The EC during the HF assessment is considered to be acceptable (< 50 mS/m) while during the LF assessment the EC can be considered tolerable (< 85 mS/m) (DWA, 2011) and slight impact as a result of EC is anticipated during the LF assessment;
- The DO levels at this site can be considered as inadequate (< 80% saturation) during both the HF and LF assessments and impact on the aquatic community resulting from DO concentration is likely during each assessment. DO is variable over time, and the under saturation is likely related to anthropogenic activities upstream and within the site;
- Temperature is considered natural for the time of day and season in which each assessment took place.

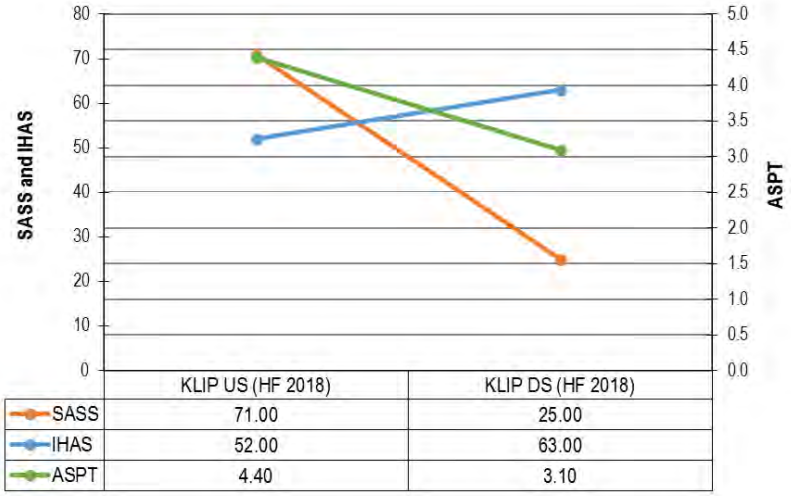
Comment:

- The aquatic community diversity and sensitivity at this point may be considered severely modified in relation to that expected for a pristine Highveld river during both the HF (March 2018) and LF (June 2018) assessments. This is observed by the 84.6% and 88.9% decrease in the SASS5 score and the 48.3% and 50% decrease in the ASPT score when compared to the reference ecoregion scores for each assessment (HF and LF, respectively);
- Since the HF assessment, the SASS5 score has significantly decreased by 28%, the ASPT score decreased by 3.2% and habitat suitability negligibly increased by 1.6%;
- The temporal decrease in macro-invertebrate community diversity and sensitivity compared to the HF assessment is likely related to the anthropogenic activities within the system such as livestock watering and the recent burning of the vegetation upstream (observed during the LF assessment), as well as the significant increase in EC concentration;
- As observed with the upstream Klip River site. variations in water quality (EC and DO saturation) may be considered somewhat variable over time, compounded by the surrounding anthropogenic and agricultural activities and flow variability may result in some impacts on the aquatic communities present over the long term.

Table 15: Spatial variations observed between site KLIP US and site KLIP DS during the high flow assessment in March 2018.

	KLIP US (HF 2018)	KLIP DS (HF 2018)
Cond (mS/m)	32.40	34.60
pH	5.65	6.01
DO (mg/L)	6.38	1.87
Temp (°C)	21.00	20.50

Figure 25: Spatial water quality variation between upstream (KLIP US) and downstream site (KLIP DS) during the HF assessment in March 2018.



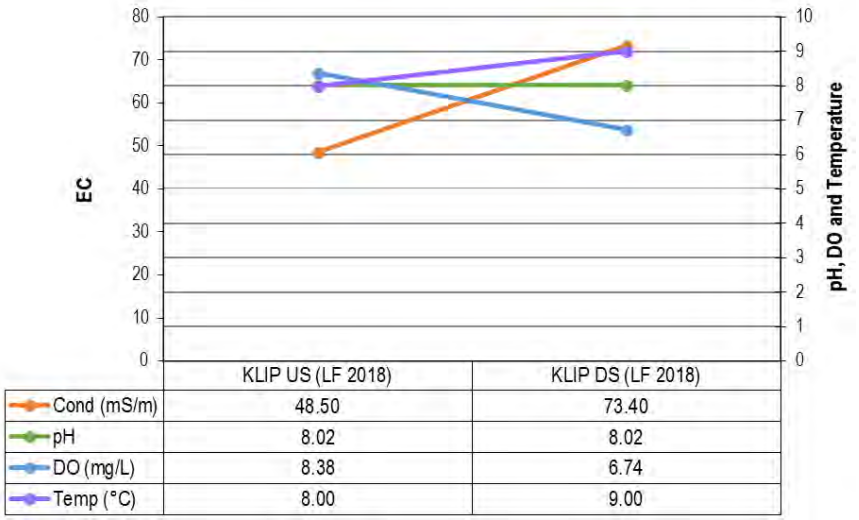
	KLIP US (HF 2018)	KLIP DS (HF 2018)
SASS	71.00	25.00
IHAS	52.00	63.00
ASPT	4.40	3.10

Figure 26: Spatial macro-invertebrate community integrity variation between upstream (KLIP US) and downstream site (KLIP DS) during the HF assessment in March 2018.

- The pH value increased significantly by 6.4% in a downstream direction. The percentage change exceeds the Department of Water and Sanitation (DWS), previously Department of Water Affairs and Forestry (DWAF), guidelines (< 5%; DWAF, 1996) and the pH values can be regarded as slightly acidic during the March 2018 assessment and in the unacceptable range limit (< 6.5 and > 8.4) as defined by the RWQO's (DWA, 2011);
- Spatially, during the HF assessment, the EC increased insignificantly in a downstream direction by 6.8%. This change complies with the DWS guideline recommendation (< 15% spatial change) for aquatic ecosystems (DWAF, 1996);
- The EC values of both sites can be regarded as acceptable (< 50 mS/m) as stipulated by the RWQO's (DWA, 2011);
- The DO concentration significantly decreases spatially by 70.7% in a downstream direction. Changes between sites were significant (> 15%), however, saturation of more than 80% was not reached at both sites and thus do not comply with the DWS (DWAF, 1996) guideline;
- Temperature variation between sites and is normal considering seasonal and diurnal cycles during the HF assessment.

- Spatially, during the HF assessment, the SASS5 score decreased significantly by 64.8%, and the ASPT score by 29.5% in a downstream direction. However, the macro-invertebrate habitat availability and suitability increased in a downstream direction by 21.2%;
- The decrease in macro-invertebrate community diversity and sensitivity is likely related to the impacted water quality as well as the observed anthropogenic activities surrounding the Klip River;
- The instream and riparian zones can be regarded as largely to seriously modified at the time of the assessment. The upstream riparian zone is largely impacted by erosion and sedimentation while the downstream riparian zone is impacted by rural subsistence farming, traditional activities (rituals) and grazing by livestock;
- During the HF assessment, a significant impact is observed on the macro-invertebrate community diversity and sensitivity and this indicates that the Klip River is severely degraded before any potential mining activity commences.

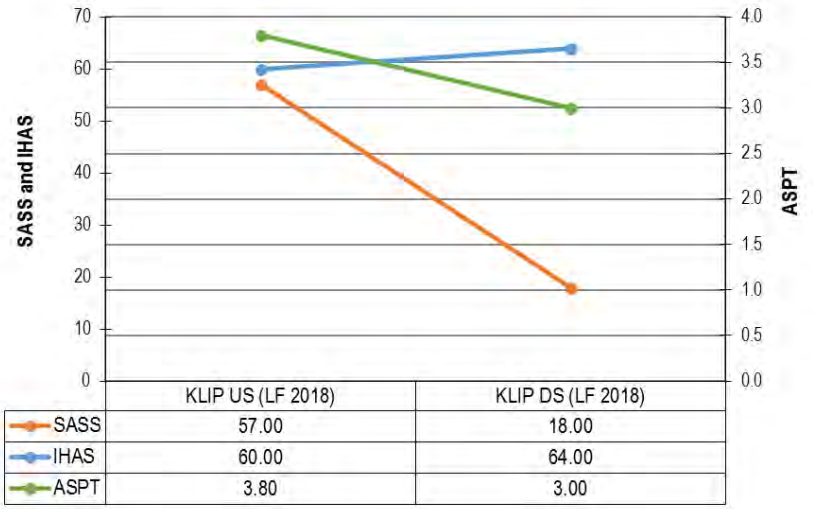
Table 16: Spatial variations observed between site KLIP US and site KLIP DS during the low flow assessment in June 2018.



	KLIP US (LF 2018)	KLIP DS (LF 2018)
Cond (mS/m)	48.50	73.40
pH	8.02	8.02
DO (mg/L)	8.38	6.74
Temp (°C)	8.00	9.00

Figure 27: Spatial water quality variation between upstream (KLIP US) and downstream site (KLIP DS) during the LF assessment in June 2018.

- The pH value remained unchanged at 8.02 in a downstream direction, hence the percentage change does not exceed the DWS guideline recommendation (< 5%; DWAF, 1996) and thus the values during the LF assessment comply with the acceptable range (> 8.0 - ≤ 8.4) as defined by the RWQO's (DWA, 2011);
- Spatially, during the LF assessment, the EC has increased significantly in a downstream direction by 51.3%. This change does not comply with the DWS target water quality guideline recommendation (< 15% spatial change) for aquatic ecosystems (DWAF, 1996);
- However, the EC value for the upstream Klip River site can be considered as acceptable (< 50 mS/m) while the EC at the downstream Klip River site can be considered as tolerable (< 85 mS/m) according to the RWQO's (DWA, 2011) during the LF assessment;
- The concentration of DO significantly decreases spatially by 19.6% in a downstream direction. Changes between sites were significant (< 15%), however, saturation of more than 80% was not reached at the downstream Klip River site during the LF assessment and thus does not comply with the DWS (DWAF, 1996) guideline;
- Temperature variation between sites were normal considering seasonal and diurnal cycles during the LF assessment.



	KLIP US (LF 2018)	KLIP DS (LF 2018)
SASS	57.00	18.00
IHAS	60.00	64.00
ASPT	3.80	3.00

Figure 28: Spatial macro-invertebrate community integrity variation between upstream (KLIP US) and downstream site (KLIP DS) during the LF assessment in June 2018.

- Spatially, during the LF assessment, the SASS5 score significantly decreased by 68.4%, and the ASPT score by 21.1% in a downstream direction. However, the macro-invertebrate habitat availability and suitability increased in a downstream direction by 6.7%;
- The decrease in macro-invertebrate community diversity and sensitivity is likely related to the impacted water quality as well as the observed anthropogenic activities surrounding the Klip River;
- As was observed in the HF assessment, the instream and riparian zones during the LF assessment can be regarded as largely to seriously modified. The upstream riparian zone is largely impacted by erosion and sedimentation while the downstream riparian zone is impacted by rural subsistence farming, traditional activities (rituals) and grazing by livestock;
- During the LF assessment, a significant impact is observed on the macro-invertebrate community diversity and sensitivity and this indicates that the Klip River is severely degraded before any potential mining activity commences. Future monitoring is deemed essential to allow for mitigation measures to be put in place to limit further degradation of the Klip River.

Table 17: Results of the assessment at site UN-TRIB US (Located upstream and slightly west of the proposed Mona Lisa Bird Reef Pit on an unnamed tributary of the Klip River).

Site UN-TRIB US

Figure 29: Upstream view of site UN-TRIB US (above) during high flow in March 2018 and upstream view of site UN-TRIB US (below) during low flow conditions in June 2018.

In situ physico-chemical water quality

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% Temporal variation from the baseline assessment (March 2018)	% Spatial variation from the upstream site
pH	5.59	7.48	+33.8	No spatial reference site.
EC (mS/m)	72.8	77.6	+6.6	
DO (mg/L)	3.28	6.63	+102.1	
DO (% sat)	43.7	70.3	NA	
Temp (℃)	19.3	10.4	-46.1	

Invertebrate community assessment (SASS5 and IHAS)

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% of reference data (SASS5 and ASPT)		% Temporal variation from the high flow assessment (March 2018)	% Spatial variation from the upstream site
			HF	LF		
SASS5 score	29	4	-82.1	-97.5	-86.2	No spatial reference site.
ASPT score	4.8	1.0	-20.0	-83.3	-79.2	
IHAS score	67 (Good)	49 (Poor)			-26.9	
Instream IHI	55.4 (Category D)	52.3 (Category D)				
Riparian IHI	52.9 (Category D)	51.8 (Category D)				
MIRAI Score	60.3 (Category C)	38.1 (Category E)				

Water Quality: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.
Macro-invertebrates: A temporal deterioration exceeding 15% was considered significant; A spatial and temporal improvement exceeding 15% was considered significant.

Algal proliferation	None observed during either assessment.
Depth profiles	The water at this point is extremely shallow with little diversity of depth profiles during both assessments.
Flow condition	The flow of the site is a slow run. An informal road runs through the site.
Water clarity and odour	Water was clear during both assessments. Odours of detergent present during the HF assessment. No odours evident during the LF assessment.
Riparian zone characteristics	Riparian vegetation is absent in some areas, which is likely to result in some erosion and bank instability under high flow conditions. Riparian zone is severely impacted as a result of the informal road running through the site as well as human activities (e.g. washing of clothes and collecting of firewood).

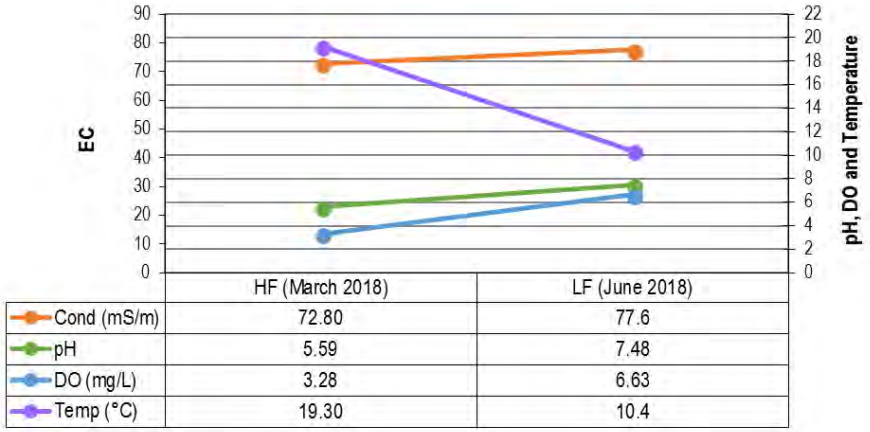
SITE ECOSTATUS CATEGORY

	High Flow	Low Flow
Dallas (2007)	Category E/F	Category E/F
MIRAI	Category C	Category E
Overall IHI	Category D	Category D

Current impacts:
- Highly disturbed site and possible impact of Acid Mine Drainage (AMD) observed upstream (during the LF assessment) on the aquatic biota;
- Lack of diversity of flow regimes, habitat cover and depth profiles also affect the aquatic communities occurring at this point and is considered the key ecological driver of change in the system at this point.

NA = Not Applicable; HF = High Flow; LF= Low Flow; SASS5 reference score = 160; ASPT reference score = 6.0.

Table 18: Temporal variations observed at site UN-TRIB US during both the high flow and low flow assessments in 2018.



	HF (March 2018)	LF (June 2018)
Cond (mS/m)	72.80	77.6
pH	5.59	7.48
DO (mg/L)	3.28	6.63
Temp (°C)	19.30	10.4

Figure 30: Site specific temporal water quality variation at the upstream unnamed tributary site (UN-TRIB US).

	HF (March 2018)	LF (June 2018)
SASS	29.00	4
IHAS	67.00	49
ASPT	4.80	1

Figure 31: Site specific temporal macro-invertebrate community integrity at the upstream unnamed tributary site (UN-TRIB US).

Comment:

- The pH has significantly increased by 33.8% when compared to the HF assessment and this change significantly exceeds the TWQR which advocate a temporal change of no more than 5% (DWAF, 1996);
- During the HF assessment, the pH can be regarded as slightly acidic and does not comply with the RWQO (DWA, 2011) acceptable range (≥ 6.5 - ≤ 8.0). However, the pH at this upstream site during the LF assessment can be considered as largely natural and complies with the RWQO (DWA, 2011) acceptable range;
- Since the HF assessment in March 2018, the EC has increased insignificantly by 6.6% and this change does not exceed the TWQR, which advocates a temporal change of no more than 15% (DWAF, 1996). However, the EC during both assessments complies with the RWQO of South Africa (DWA, 2011) and can be seen as tolerable (< 85 mS/m);
- DO levels at this site can be considered as inadequate (< 80% saturation) during both the HF and LF assessments and slight impact on the aquatic community resulting from DO concentration is likely at the time of each assessment;
- Temporally, since the HF assessment, the DO concentration has significantly increased by 102.2%. Although the change is considered positive and significant (> 15%), the saturation (> 80%) was not reached in either assessment and thus does not comply with the DWS (DWAF, 1996) guideline;
- Temperature is considered natural for the time of day and season in which each assessment took place.

Comment:

- The aquatic community diversity and sensitivity at this point may be considered critically modified in relation to that expected for a pristine Highveld river in both the HF assessment (March 2018) and the LF assessment (June 2018). This is observed by the 82.1% and 97.5% decrease in the SASS5 score and the 20% and 83.3% decrease in the ASPT score when compared to the reference ecoregion scores for each assessment (HF and LF, respectively);
- Since the HF assessment, the SASS5 score has significantly decreased by 86.2%, the ASPT score significantly decreased by 79.2% and the habitat suitability decreased by 26.9%. The observed decrease in SASS and ASPT scores are likely due to the decrease in habitat suitability between the two assessments;
- It is deemed likely that the communities present along this upstream section of this unnamed tributary have been largely shaped and influenced by lack of suitable habitat, lack of flow continuity (compounded by weirs and impoundments within the system) and erratic rainfall patterns in the months preceding the March 2018 assessment, with many species remaining dormant until habitat and flow becomes suitable for aquatic life;
- Variations in water quality (pH, EC and DO saturation) may be considered somewhat variable over time, compounded by the surrounding anthropogenic and agricultural activities and flow variability may result in some impacts on the aquatic communities present over the long term with particular impact on the macro-invertebrate sensitivity (of which ASPT is a measure).

Table 19: Results of the assessment at site UN-TRIB DS (Located downstream of the proposed Kimberly Reef East Pit and Infrastructure Complex on an unnamed tributary of the Klip River).

Site UN-TRIB DS

Figure 32: Upstream view of site UN-TRIB DS (above) during high flow in March 2018 and upstream view of site UN-TRIB DS (below) indicating low flow conditions in June 2018.

In situ physico-chemical water quality

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% Temporal variation from the baseline assessment (March 2018)	% Spatial variation from the upstream site (UN-TRIB US)
pH	5.72	7.31	+27.8	-2.3
EC (mS/m)	29.8	50.0	+67.8	-35.6
DO (mg/L)	3.84	6.53	+70.1	-1.5
DO (% sat)	55.3	78.4	NA	NA
Temp (℃)	23.5	14.5	-38.3	+39.4

Invertebrate community assessment (SASS5 and IHAS)

Parameter	High Flow Assessment (March 2018)	Low Flow Assessment (June 2018)	% of reference data (SASS5 and ASPT)		% Temporal variation from the high flow assessment (March 2018)	% Spatial variation from the upstream site (UN-TRIB US)
			HF	LF		
SASS5 score	58	40	-64.2	-75.3	-31.0	+900.0
ASPT score	4.5	4.0	-25.0	-33.3	-11.1	+300.0
IHAS score	70 (Good)	59 (Adequate)			-15.7	+20.4
Instream IHI	51.8 (Category D)	50.7 (Category D)				
Riparian IHI	51.8 (Category D)	50.7 (Category D)				
MIRAI Score	59.2 (Category D)	58.0 (Category D)				

Water Quality: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.
Macro-invertebrates: A temporal deterioration exceeding 15% was considered significant; A spatial and temporal improvement exceeding 15% was considered significant.

Algal proliferation	Observed on rocks during both assessments.
Depth profiles	The river was relatively shallow at this point (generally <½ m), however, some deeper pool areas were observed.
Flow condition	The stream consisted of still pools and a slow run during both assessments.
Water clarity and odour	Water was clear during both assessments, however, during the LF assessment the water became very turbid once disturbed. Slight sewage odour evident during both assessments.
Riparian zone characteristics	Riparian vegetation is dominated by reeds and grasses at this site during both assessments. Riparian zone is severely impacted as a result of construction activities surrounding the site during both assessments.

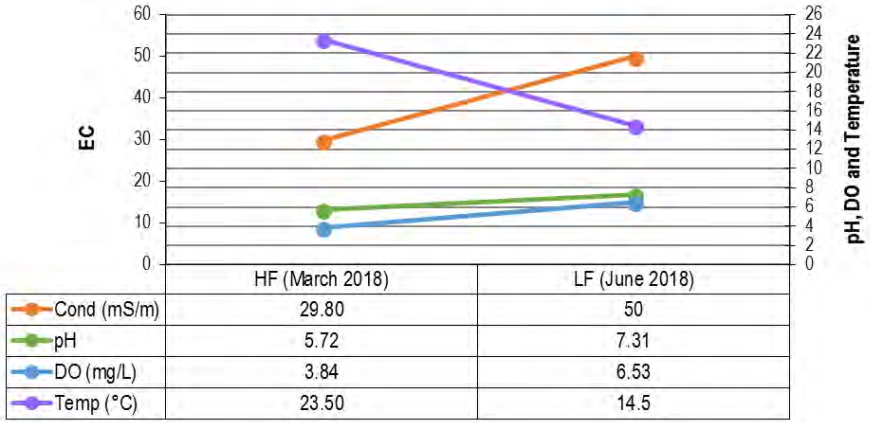
SITE ECOSTATUS CATEGORY

	High Flow	Low Flow
Dallas (2007)	Category E/F	Category E/F
MIRAI	Category D	Category D
Overall IHI	Category D	Category D

Current impacts:
- Impacts as a result of construction activities surrounding the site;
- Flow modification as a result of weirs and impoundments upstream of the site.

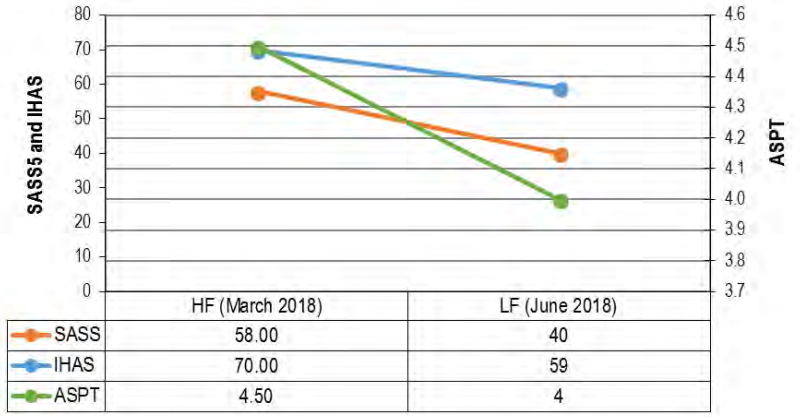
NA = Not Applicable; HF = High Flow; LF= Low Flow; SASS5 reference score = 160; ASPT reference score = 6.0.

Table 20: Temporal variations observed at site UN-TRIB DS during both the high flow and low flow assessments in 2018.



	HF (March 2018)	LF (June 2018)
Cond (mS/m)	29.80	50
pH	5.72	7.31
DO (mg/L)	3.84	6.53
Temp (°C)	23.50	14.5

Figure 33: Site specific temporal water quality variation at the downstream unnamed tributary site (UN-TRIB DS).



	HF (March 2018)	LF (June 2018)
SASS	58.00	40
IHAS	70.00	59
ASPT	4.50	4

Figure 34: Site specific temporal macro-invertebrate community integrity at the downstream unnamed tributary site (UN-TRIB DS).

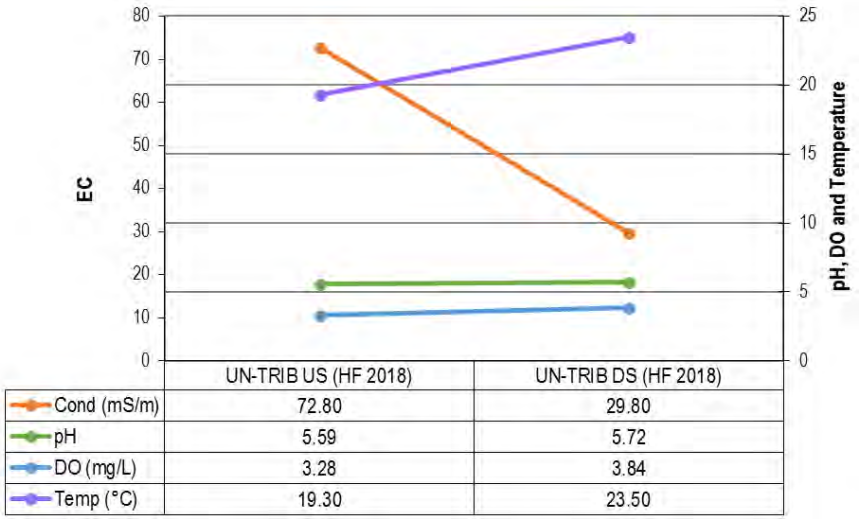
Comment:

- The pH has significantly increased by 27.8% when compared to the HF assessment and this change exceeds the TWQR which advocate a temporal change of no more than 5% (DWAF, 1996). However, during the LF assessment, the pH can be regarded as largely natural and complies with the RWQO's (DWA, 2011) acceptable range (≥ 6.5 - ≤ 8.0) while the pH recorded from the HF assessment can be considered as slightly acidic and does not comply with the RWQO's (DWA, 2011) acceptable range;
- Since the HF assessment in March 2018, the EC has increased significantly by 67.8% and this change exceeds the TWQR, which advocates a temporal change of no more than 15% (DWAF, 1996). However, the EC during both assessments comply with the RWQO of South Africa (DWA, 2011) and can be seen as acceptable (< 50 mS/m);
- The EC is variable over time, likely due to impact from catchment-wide anthropogenic activities, compounded by evapoconcentration during periods of low flow, which is indicated by the significant increase between the HF and LF assessments;
- The DO levels at this site can be considered as inadequate (< 80% saturation) during both the HF and LF assessments and slight impact on the aquatic community resulting from DO concentration is likely at the time of each assessment;
- Temporally, compared to the HF assessment, the DO concentration has significantly increased by 70.1% and this change is considered a positive change;
- Temperature is considered natural for the time of day and season in which each assessment took place.

Comment:

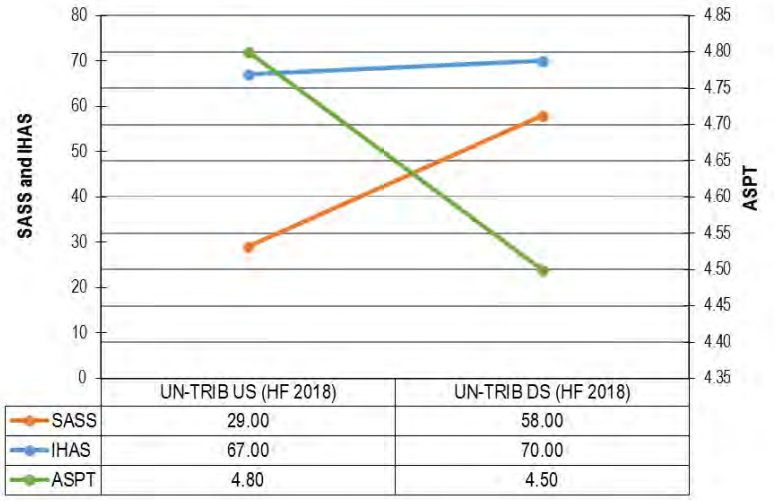
- The aquatic community diversity and sensitivity at this point may be considered critically modified in relation to that expected for a pristine Highveld river in both the HF assessment (March 2018) and the LF assessment (June 2018). This is observed by the 64.2% and 75.3% decrease in the SASS5 score and the 25% and 33.3% decrease in the ASPT score when compared to the reference ecoregion scores for each assessment (HF and LF, respectively);
- Since the HF assessment, the SASS5 score has significantly decreased by 31% and the ASPT score decreased by 11.1%. The habitat suitability decreased by 15.7% over the same period. The observed decrease in SASS and ASPT scores is likely due to the decrease in habitat suitability;
- As seen with the upstream site, it is deemed likely that the communities present along this downstream section of this unnamed tributary have been largely shaped and influenced by lack of flow continuity (compounded by weirs and impoundments within the system) and erratic rainfall patterns in the months preceding the March 2018 assessment, with many species remaining dormant until habitat and flow becomes suitable for aquatic life;
- Variations in water quality (pH, EC and DO saturation) may be considered somewhat variable over time, compounded by the surrounding anthropogenic activities and flow variability may result in some impacts on the aquatic communities present over the long term with particular impact on the macro-invertebrate sensitivity (of which ASPT is a measure).

Table 21: Spatial variations observed between site UN-TRIB US and site UN-TRIB DS during the high flow assessment in March 2018.



	UN-TRIB US (HF 2018)	UN-TRIB DS (HF 2018)
Cond (mS/m)	72.80	29.80
pH	5.59	5.72
DO (mg/L)	3.28	3.84
Temp (°C)	19.30	23.50

Figure 35: Spatial water quality variation between upstream (UN-TRIB US) and downstream site (UN-TRIB DS) during the HF assessment in March 2018.



	UN-TRIB US (HF 2018)	UN-TRIB DS (HF 2018)
SASS	29.00	58.00
IHAS	67.00	70.00
ASPT	4.80	4.50

Figure 36: Spatial macro-invertebrate community integrity variation between upstream (UN-TRIB US) and downstream site (UN-TRIB DS) during the HF assessment in March 2018.

- The pH value increased insignificantly by 2.3% in a downstream direction and the percentage change does not exceed the DWS guidelines (< 5%; DWAF, 1996). The pH value, at both sites during the HF assessment, is regarded as slightly acidic and in the unacceptable range limit (< 6.5 and > 8.0) as defined by the RWQO (DWA, 2011);
- Spatially, during the HF assessment, the EC has decreased significantly in a downstream direction by 59.1%. Although this change does not comply with the DWS guideline recommendation (< 15% spatial change) for aquatic ecosystems (DWAF, 1996), this change is considered a positive change and any impact as a result of EC on the aquatic biota is unlikely during the HF assessment in March 2018;
- The EC value of the upstream site can be regarded as tolerable (< 85 mS/m) as stipulated by the RWQO (DWA, 2011) while the EC of the downstream site can be regarded as ideal (< 30 mS/m) as stipulated by the RWQO (DWA, 2011) during the HF assessment;
- The DO concentration significantly increases by 17.1% in a downstream direction and this change is considered a positive change. However, although the change between sites was significant (< 15%), the saturation (> 80%) was not reached at either of the two sites and thus does not comply with the DWS (DWAF, 1996) guideline;
- Temperature variation between sites and is normal considering seasonal and diurnal cycles during the HF assessment.

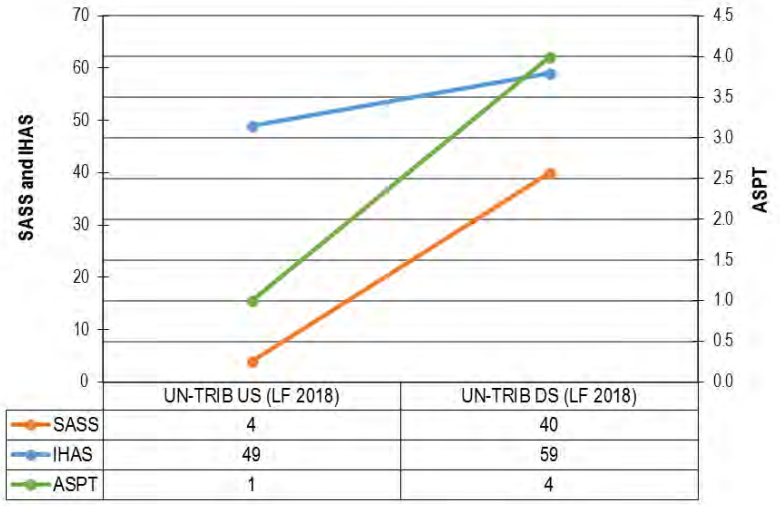
- Spatially, during the HF assessment, the SASS5 score decreased significantly by 100%, and the ASPT score decreased insignificantly by 6.3% in a downstream direction while the macro-invertebrate habitat availability and suitability increased negligibly in a downstream direction by 4.5%;
- The increase in macro-invertebrate diversity is likely due to the increase in available habitat diversity observed at the downstream unnamed tributary site during the HF assessment; During the HF assessment, the instream and riparian zones can be regarded as largely modified at both the upstream and the downstream sites. The upstream riparian zone is impacted by an informal road running through the site as well as anthropogenic activities within the site (washing of clothes and collection of firewood) and the downstream riparian zone is impacted as a result of construction activities surrounding the site at the time of the HF assessment;
- During the HF assessment, a significant impact is observed on the macro-invertebrate community diversity and sensitivity and this indicates that the unnamed tributary is severely degraded before any potential mining activity commences.

Table 22: Spatial variations observed between site UN-TRIB US and site UN-TRIB DS during the low flow assessment in August 2018.

	UN-TRIB US (LF 2018)	UN-TRIB DS (LF 2018)
Cond (mS/m)	77.60	50.00
pH	7.48	7.31
DO (mg/L)	6.63	6.53
Temp (°C)	10.40	14.50

Figure 37: Spatial water quality variation between upstream (UN-TRIB US) and downstream site (UN-TRIB DS) during the LF assessment in June 2018.

- Spatially, during the LF assessment, the EC has decreased significantly in a downstream direction by 35.6%. This change does not comply with the DWS guideline recommendation (< 15% spatial change) for aquatic ecosystems (DWAF, 1996), however, this change is considered a positive change;
- The EC value of the upstream site can be regarded as tolerable (< 85 mS/m) while the EC of the downstream site can be regarded as acceptable (≤ 50 mS/m) as stipulated by the RWQO's (DWA, 2011) during the LF assessment;
- The pH value decreased insignificantly by 2.3% in a downstream direction. The percentage change complies with the DWS guidelines (< 5%; DWAF, 1996) and the pH values for both sites during the LF assessment can be regarded as largely natural and within the ideal range limit (≥ 6.5 and ≤ 8.0) as defined by the RWQO (DWA, 2011);
- The DO concentration insignificantly decreases by 1.5% in a downstream direction. Changes between sites were insignificant (< 15%), however, saturation of more than 80% was not reached at both sites and thus does not comply with the DWS (DWAF, 1996) guideline;
- Temperature variation between sites and is normal considering seasonal and diurnal cycles during the LF assessment.



	UN-TRIB US (LF 2018)	UN-TRIB DS (LF 2018)
SASS	4	40
IHAS	49	59
ASPT	1	4

Figure 38: Spatial macro-invertebrate community integrity variation between upstream (UN-TRIB US) and downstream site (UN-TRIB DS) during the LF assessment in June 2018.

- Spatially, during the LF assessment, the SASS5 score increased significantly by 900%, the ASPT score by 300% and the macro-invertebrate habitat availability and suitability by 20.4% in a downstream direction;
- The increase in macro-invertebrate community diversity and sensitivity is likely related to the spatial increase in habitat suitability during the LF assessment;
- The overall lack of biotope diversity along with the shallow slow flow, limits the macro-invertebrate community diversity and sensitivity at the upstream site during the LF assessment;
- As with the HF assessment, the instream and riparian zones during the LF assessment can be regarded as largely modified. The upstream riparian zone is impacted by an informal road running through the site as well as anthropogenic activities within the site (washing of clothes and collection of firewood) and the downstream riparian zone is impacted as a result of construction activities surrounding the site at the time of the LF assessment;
- During the LF assessment, a significant impact is observed on the macro-invertebrate community diversity and sensitivity and this indicates that the unnamed tributary is severely degraded before any potential mining activity commences. Future monitoring is deemed essential to allow for mitigation measures to be put in place to limit further degradation of the unnamed tributary.

Table 23: Summary data table for assessment of the Klip River and the unnamed tributary with available ecostatus data comparisons

Ecostatus desktop assessment data summary			
Criteria	Kleynhans 1999	DWS RQIS database	Upper Vaal Resource Quality Objectives (DWS 2014)
Applicable catchment/SQRC	C22A	C22A-01315	C22A (UI. 1 – WRC Study)
EIS	Moderate	-	-
Mean EI class	-	Moderate	-
Mean ES class	-	Moderate	-
PEMC	E/F: (Seriously/Critically Modified)	-	-
PES	E/F: (Seriously/Critically Modified)	E (Seriously modified)	E (Seriously modified)*
DEMC	C: Moderate Risk Allowed	-	-
Default EC	-	C	-
REC	-	-	D (Largely modified)*

Biomonitoring assessment results summary										
Criteria	Ecological Category classification achieved for the following sites as well as overall rating for the Klip River:								
	KLIP US		KLIP DS		UN-TRIB US		UN-TRIB DS		Overall
	HF	LF	HF	LF	HF	LF	HF	LF	
SASS5	E/F	E/F	E/F	E/F	E/F	E/F	E/F	E/F	E/F
MIRAI	C	C	D	D	C	E	C	E	D
Instream IHI	C	D	D	C	D	D	D	D	D
Riparian IHI	C	C	D	D	D	D	D	D	D
FRAI	-	-	-	-	-	-	-	-	-
VEGRAI	-	-	-	-	-	-	-	-	-

Average Ecological Category**	D

SQRC = Sub-quaternary catchment; EIS = Ecological Importance and Sensitivity; PEMC = Present Ecological Management Class; DEMC = Desired Ecological Management Class; PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors; EI = Ecological Importance; ES = Ecological Sensitivity; EC = Ecological Category; default based on median PES and highest of EI or ES means; REC = Recommended Ecological Category; HF = High Flow; LF = Low Flow

* The Present Ecological State (PES) and Recommended Ecological Category (REC) were extracted from DWA (2012) for the Upper Vaal Resource Quality Objectives.

** Ecological Category classification was applied from all sites during both assessments.

5.2 Ecological Importance and Sensitivity Assessment

The Ecological Importance and Sensitivity (EIS) method (DWAF, 1999) was applied to the Klip River and the unnamed tributary in order to ascertain the current sensitivity and importance of the system. The results of the assessments are presented in the tables below:

Table 24. Results of the EIS assessment for the Klip River within the study area.

Biotic Determinants	Score
Rare and endangered biota	0
Unique biota	0
Intolerant biota	1
Species/taxon richness	2
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	2
Refuge value of habitat type	1
Sensitivity of habitat to flow changes	2
Sensitivity of flow-related water quality changes	1
Migration route/corridor for instream and riparian biota	1
Nature Reserves, Natural Heritage sites, Natural areas, Protected Natural Environments (PNEs)	0
RATINGS	1.0
EIS CATEGORY	Low

Table 25. Results of the EIS assessment for the unnamed tributary within the study area.

Biotic Determinants	Score
Rare and endangered biota	0
Unique biota	0
Intolerant biota	1
Species/taxon richness	1
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	1
Refuge value of habitat type	1
Sensitivity of habitat to flow changes	1
Sensitivity of flow-related water quality changes	1
Migration route/corridor for instream and riparian biota	0
Nature Reserves, Natural Heritage sites, Natural areas, PNEs	0
RATINGS	0.6
EIS CATEGORY	Low

The Ecological Importance and Sensitivity Assessment analysis of the Klip River provided a score of 1.0 and the unnamed tributary provided a score of 0.6 which are both regarded as **low importance and sensitivity**. The low importance and sensitivity of the rivers means that the rivers are not unique on any scale. The biota and habitat of these rivers are generally not very sensitive to flow modifications and usually have substantial capacity for use. The presence of the rare and endangered *Austroglanis sclateri*, the Common Rock Catfish, was not observed during both assessments in either the Klip River or the unnamed tributary and is more likely to be present further downstream in rockier / riffle habitat. The systems have a low

importance with regards to sensitivity to alterations in flow and flow-related water quality changes as well as species richness (Kleynhans, 1999).

6 IMPACT ASSESSMENT

This section presents the significance of potential impacts on the ecology of the watercourses which are associated with the proposed MRA. In addition, it also indicates the required mitigatory measures needed to minimise the perceived impacts of the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

The impact assessment was only conducted for the proposed mining activities which are located within 500 m of the identified watercourse. These activities are summarised in the table below.

Table 26: Summary of the watercourses and their 500 m surrounding area being intersected by the proposed mining activities.

Watercourse		Proposed mining activity within 500 m of a watercourse
Klip River system		Mona Lisa Bird Reef Pit (Haul road associated with this open pit area is approximately 505 m east of the river, whilst all other activities are approximately 760 m east of the river).
CVB Wetlands Group 1	CVB 1	Roodepoort Main Reef Pit (The western portion of the open pit area and associated top soil dump is approximately 415 m upgradient/south of this CVB).
	CVB 2	Mona Lisa Bird Reef Pit (The waste rock dump associated with this open cast area is located approximately 57 m and the open pit area approximately 214 m upgradient/north of this CVB).
CVB Wetlands Group 2	CVB 3	11 Shaft Main Reef Pit (The waste rock dump associated with this open cast area is located approximately 54 m north of the wetland, and the open cast pit is approximately 219 m north of the wetland). Kimberley Reef East Pit & Infrastructure Complex (IC) (A portion of the haul road, open cast pit area and the waste rock dump is located approximately 412 m west of the wetland. Kimberley Reef (KR) new ventilation shaft (Located approximately 280 m west of the wetland).

Table 27: Timing associated with the implementation of the proposed mining activities (as per the EIA & EMP, March 2019 (SLR))

Activity		Timeline																							
		Year 1				Year 2				Year 3	Year 4			Year 5			Year 6 -25			year 26			Year 27 - 28	
Opencast mining and concurrent rehabilitation																									
Rugby Club Main Reef Pit	Mining																								
	Rehabilitation																								
Roodepoort Main Reef Pit	Mining																								
	Rehabilitation																								
11 Shaft Main Reef Pit	Mining																								
	Rehabilitation																								
Mona Lisa Bird Reef Pit	Mining																								
	Rehabilitation																								
Kimberley Reef East Pit	Mining																								
	Rehabilitation																								
Continued opencast rehabilitation and construction of infrastructure complexes																									
Underground mining operations																									
Steady state production achieved																									
Decommissioning and closure																									
Aftercare and maintenance																									

6.1 Impact Analyses

6.1.1 Consideration of impacts and application of mitigation measures

Following the assessment of the watercourses, an impact assessment methodology (as provided by SLR Consulting) was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the assessed watercourses associated with the proposed MRA.

Following the impact assessment, mitigation measures were compiled to serve as guidance throughout the construction, operational and decommissioning phases. The points below summarise the considerations undertaken:

- None of the activities associated with the proposed West Wits mining project are located directly within the identified watercourses, but the mining and associated activities will be located within the regulated zone (500m from a delineated boundary of any wetland or pan) (see Figures 15 - 18);
- The watercourses assessed as part of this study are considered impacted upon to various degrees by historic activities (moderately to largely modified). Existing impacts from current mining activities were observed during the field assessment, i.e. seepage from a tailings dam upstream of the CVB 2;

- Due to the small footprint area of the proposed Roodepoort Main Reef Pit within the 500 m GN509 Zone of Regulation of the CVB 1 and the Kimberley Reef East Pit within the 500 m GN509 Zone of Regulation of CVB 3 (the nearest watercourses to these open cast pit areas), limited impact from the proposed mining activities is expected, and if such impacts do occur, it is not expected to be of high significance;
- The proposed opencast mining activities will take place over a short period (4 years), during which concurrent rehabilitation of the surrounding natural areas (terrestrial and freshwater) is expected to occur;
- The simulated dewatering rates (as per the Hydrogeological Specialist Investigation, Noa Agencies (2019)) are as follows:
    - Kimberley Reef East: 225 – 466 m^3/d
    - 11 Shaft: 600 – 1215 m^3/d
    - Rugby Club: < 50 m^3/d
    - Roodepoort: 370 – 730 m^3/d
    - Mona Lisa: 1350 – 2700 m^3/d
        - The Mona Lisa pit could yield higher dewatering volumes due to the proximity to the Klip River and CVB 2. The simulated hydraulic gradient is shallower in this area due to the presence of these watercourses.

  Little to no mine dewatering is thus foreseen due to the shallow open pits proposed (i.e. < 30 m deep) (Noa Agencies, 2019).
- The Hydrogeological Specialist Investigation (Noa Agencies, 2019) investigated the impact associated with the cone of draw down expected from each of the open cast pit areas. Due to the low dewatering volumes, the expected drawdown associated with the open cast pit areas would not reach the delineated boundaries of the watercourses (see Figures 10 -6 to 10-15, Noa Agencies (2019)).
- The geochemical nature of the waste rock was assessed and reported on in detail in the West Wits Mining MLI (Pty) Ltd: (Kimberley Reef East, Mona Lisa, Roodepoort, 11 Shaft and Rugby Club) Open pit Mine Geochemical Specialist Assessment (GeoDyn, 2018). The following key conclusions from the report:
    - Acid Mine Drainage (AMD): The acid base accounting and geochemical modelling have indicated that due to the absence of iron sulphide minerals the risk of the development of AMD conditions in the waste rock environment is negligible;
    - Leaching of metal(loid) contaminants: The geochemical model showed that the risk of leaching of contaminants, especially the metalloid arsenic, from the waste rock is negligible. This is also due to the absence of iron sulphide as well as the high stability of the minerals comprising the waste rock at the mining conditions.

      Therefore, a negligible risk of the formation of AMD conditions as well as a

negligible risk of the leaching of contaminants from the waste rock material is expected to occur (Noa Agencies, 2019).

- Nevertheless, the simulated zone of impact from potential mass migration is provided in the Hydrogeological Specialist Investigation report (Noa Agencies, 2019). From these figures the following can be concluded:
  - There is a 5 – 10 % of potential seepage that may occur during the operational phase of the 11 Shaft Open Cast Pit on CVB 3; and
  - There is a 60 – 70 % of potential seepage that may occur during the operational phase of the Mona Lisa Open Cast Pit on CVB 2;
- The Hydrogeological Specialist Investigation report (Noa Agencies, 2019) did investigate the potential of the backfilled open pits to leach minerals into the receiving environment and negatively influencing the groundwater and surface water quality. During the operational phase, the potential mass migration from the open cast pit areas will migrate from the pit areas a maximum distance of 150 m. This is only potential percentage seepage since little to no leachate is possible (GeoDyn, 2018). The potential percentage seepage exiting the proposed infrastructure remains less than 20% and continues to dilute (Noa Agencies, 2019). Zero to little influence on the local groundwater regime was simulated due to the shallow pit and deep groundwater levels (Noa Agencies, 2019). Thus, decanting of water accumulating in the open pits is not foreseen.
- The simulated zone of impact of potential drawdown is also provided in the Hydrogeological Specialist Investigation report (Noa Agencies, 2019). From these figures, no level of drawdown is expected to occur within at least 80 m of any watercourse. Therefore, a negligible risk from the modelled cone of drawdown is expected to occur on the assessed watercourses; and
- As per the outcome of the Hydrogeological Specialist Investigation report (Noa Agencies, 2019), the development of AMD conditions as well as the leaching of contaminants from the waste rock is unlikely and the dewatering zone of influence indicates little to no impact on recorded users and the watercourses in the proposed MRA. Due to the low to negligible risk significance of these aspects, they were not further considered as part of the impact assessment. Nevertheless, mitigation measures are provided as a precautionary measure to detect if these aspects do occur.

6.1.2 Impact discussion and essential mitigation measures

There are five key ecological impacts on watercourses that are anticipated to occur namely,

- Loss of watercourse habitat and ecological structure;
- Changes to the sociocultural and service provision;
- Altered biotic integrity and disturbance to ecosystem function;
- Impacts on the hydrology and sediment balance of the watercourses; and
- Altered water quality.

Not all the proposed activities will impact on all five of the above ecological aspects, nevertheless, the potential of impact on all of these ecological aspects were assessed. Thus, impacts from a specific activity on these aspects was scored individually in the summary of the impact assessment below.

A summary of the impact assessment is provided below, following by the discussion thereof.

Table 28: Summary of the impact assessment undertaken as part of the assessment of the proposed West Wits Mining Project.

Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Site preparation as part of the development of the proposed surface infrastructure, and haul roads, including placement of contractor laydown areas and storage facilities, associated with the Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area (the closest surface infrastructure components to any of the watercourses, specifically CVB 2 and 3).							
* Removal of vegetation (terrestrial and wetland – albeit significantly disturbed) and associated disturbances (rubble and litter) to the watercourses and the watercourse soils; * Earthworks, leading to the exposure of soils, and thus to increased runoff, erosion and stream incision of the watercourses, and the potential for sedimentation of the downgradient watercourses; * Soil stockpiling; * Increased hardened surfaces and compacted soils thus reducing integrity of interflow; * Potential for increased sedimentation of the watercourse habitat, leading to changes in instream habitat and potentially altering surface water quality (if present); * Decreased ecoservice provision by the watercourses; and * Proliferation of alien vegetation due to disturbances.	Habitat & ecological structure	Unmanaged	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water Quaity		L	L	L	L	L	L
	Habitat & ecological structure	Managed	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water Quality		L	L	L	L	L	L
Impact Discussion	The impact significance of the site preparation activities will have a Low impact significance on the on all five of the ecological aspects. This can be attributed to the distance these activities are located from the watercourses. Allthough the site preparation activities does entail the removal of vegetation, this will primarily be terrestrial vegetation, and not the habitat assocaited with the watercourses. Additionally, due to the existing degraded state of the surrounding terrestrial habitat, the removal thereof is not considered to be significant. Impacts to the watercourse biotic integrity and water quality are expected to be very low, due to these activities located outside of the watercourses.							
Mitigation Measures	* Clean and dirty water separation systems must be developed prior to any other construction activity and maintained to ensure that any contaminated water does not reach the watercourses downgradient of the activities. The clean and dirty water separation systems must be developed in such a way along with the rest of the proposed mining activities to reduce the footprint of the dirty water area and thus minimise the impact on catchment yield; * Contractor laydown areas and material storage facilities to remain outside of the watercourses and the 100 m Zone of Regulation (GN704)/1:100 year floodlines (where applicable); * All vehicle re-fuelling is to take place outside of the watercourses; * All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is absolutely essential; * Retain as much indigenous vegetation as possible; * Excavated materials should not be contaminated, and it should be ensured that the minimum surface area is taken up, however, the stockpiles may not exceed 2 m in height; * All exposed soils must be protected for the duration of the mining and any other related activities in order to prevent erosion and sedimentation of the downgradient watercourses; * Temporary stockpiles must be protected to prevent contamination of runoff and sedimentation of the downgradient watercourses in the vicinity of the proposed activities; * It should be feasible to utilise existing roads to gain access to sites, and crossing of watercourse habitat in areas where no existing crossing is apparent should be unnecessary, but if it is essential crossings should be made at right angles; * Areas where bank failure is observed as a result of such watercourse crossings should be immediately repaired; and * The watercourses, and the 100 m Zone of Regulation (GN704) and the 1:100 year floodlines (where applicable), should be clearly demarcated with marked wooden poles by an ECO and marked as a no-go area unless authorised activities are allowed within this zone.							

Impact		Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Development of the Kimberley Reef (KR) new ventilation shaft (Located approximately 280 m west of the CVB 3)								
* Construction of surface infrastructure, leading to disturbance to surrounding vegetation and soil; * Excavation of shaft and stockpiling of removed materials; * A reduction of groundwater level and/or volumes of the wetland as a result of dewatering of the ventilation shaft, potentially resulting in the formation of a cone of depression.		Habitat & ecological structure	Unmanaged	L	L	L	L	L	L
		Ecoservices		L	L	L	L	L	L
		Biotic integrity		L	L	L	L	L	L
		Hydrology & sediment balance		L	L	L	L	L	L
		Water Quaity		L	L	L	L	L	L
		Habitat & ecological structure	Managed	L	L	L	L	L	L
		Ecoservices		L	L	L	L	L	L
		Biotic integrity		L	L	L	L	L	L
		Hydrology & sediment balance		L	L	L	L	L	L
		Water Quaity		L	L	L	L	L	L
Impact Discussion	The impact significance of the KR new ventilation shaft will have a Low impact significance on the on all five of the ecological aspects. This can be attributed to the distance this ventilation shaft is located from the watercourses. Allthough the construction of this shaft would entail the remaoval of vegetation and the stockpiling of soil, the footprint thereof is small, and thus the potential impact significance thereof is also regarded as low to very low.								
Mitigation Measures	* Despite the new proposed shaft located upgradient of CVB 3, it is located approximately 280 m west of the wetland. Thus, the potential of edge effects from the surface construction activities to impact on the wetland is very low, especially since the Helpmekaar Road is located between the wetland and the proposed construction area, which will act as a barrier for potential runoff from the construction site; * Nevertheless, in order to prevent the possibility of edge effects to impact on the wetland, the following is recommended: - The footprint areas of the stockpiles should take up a minimum area; - All topsoil removed should be used as part of the rehabilitation of the surrounding site to the ventilation shaft, and not be kept on site as it could potentially result in sedimentation of the wetland; - No construction personnel or vehicles may enter the 1:100 year floodline or the delineated edge of CVB 3 (whichever is the greatest); * Dewatering boreholes could be considered, if deemed necessary, in order to minimise the creation of dirty water within the ventilation shaft, and this clean water should be used to recharge the natural watercourses within close vicinity of any of the ventilation shaft.								

Impact		Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Establishment of the open cast pit areas (Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area) and operation thereof, as these are the open cast areas located the closest to any watercourses								
* Removal of topsoil and placing it along the open cast pit area, to create a topsoil berm, north of the open cast pits. Removal of overburden and stockpiling thereof on the waste rock dumps south of the open cast pits, but north of the wetlands. Runoff from these areas could enter the downgradient wetlands, potentially causing a decrease in the water quality of the surface water and adding to the sediment load within the wetlands; * Possible contamination of surface and ground water, leading to impaired water quality and salination of soils; and * Mining of ore and hauling thereof to the ore crusher, where after it would be transported off-site. Transportation of the ore would cause soil compaction and potential indiscriminate movement of the vehicles within close proximity to the watercourses.		Habitat & ecological structure	Unmanaged	L	M	L	L	M	M
		Ecoservices		L	M	L	L	M	M
		Biotic integrity		M	M	L	M	M	M
		Hydrology & sediment balance		M	M	L	M	M	M
		Water quality		M	M	L	M	M	M
		Habitat & ecological structure	Managed	L	M	L	L	L	L
		Ecoservices		L	M	L	L	L	L
		Biotic integrity		L	M	L	L	L	L
		Hydrology & sediment balance		L	M	L	L	L	L
		Water quality		L	M	L	L	L	L

Impact Discussion	The stockpiling of topsoil and waste rock can increase the sediment load that enters the downgradient watercourses. This in turn may potentially impact on the water quality and the bentic integrity of the watercourses. Runoff from the waste roack dumps and haul roack could further decreased the water quality of the watercourses. The ongoing operation of these activities may potentially impact the habitat provisioning and other ecoservice delivery of the watercourses if mitigation measures are not implemented.
Mitigation Measures	Any mining activities within the GN704 zone of regulation of the wetlands should ensure that downstream impacts on the ecology of these systems do not occur. Special mention is made of the following: * The waste rock dumps and topsoil stockpiles should be managed to minimise infiltration of contaminants to the downgradient wetlands. Mitigation methods that should be considered include development of a downgradient berm and trench system to collect seepage which can be re-used in the mining processes; * Pollution prevention through infrastructure design, in order to prevent, eliminate and/or control the potential of groundwater pollution, in accordance with any recommendations made by a suitably qualified geohydrologist and the stormwater management plan; * Implementation of a monitoring programme to detect and determine the formation and/or extent of any potential pollution of the groundwater; * Monitoring of the downgradient wetlands should take place to indicate whether contamination is leaching from the site. In the case of contamination being detected, the mine must install interception boreholes to remove and clean contaminated water; and * Clean and dirty water separation systems must be implemented and maintained to ensure that any contaminated water does not reach the wetlands downgradient of the activities.

Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Presence of clean and dirty water separation infrastructure within close proximity to the Zone of Regulation (GN704) of CVB 2 and CVB 3							
* Loss of catchment yield due to storm water containment is expected to occur which will affect the recharge of the wetlands; * Increased flood peaks of water reporting to the downgradient wetlands as a result of formalisation and concentration of surface runoff; and * Potential for erosion of terrestrial soils as a result of the formation of preferential flow paths, leading to sedimentation of the downgradient wetlands.	Habitat & ecological structure	Unmanaged	L	M	L	L	L	L
	Ecoservices		L	M	L	L	L	L
	Biotic integrity		M	M	L	M	M	M
	Hydrology & sediment balance		M	M	L	M	M	M
	Water quality		M	M	L	M	M	M
	Habitat & ecological structure	Managed	L	M	L	L	L	L
	Ecoservices		L	M	L	L	L	L
	Biotic integrity		L	M	L	L	L	L
	Hydrology & sediment balance		L	M	L	L	L	L
	Water quality		L	M	L	L	L	L
Impact Discussion	Loss of catchment yield due to storm water containment is expected to occur which will affect the hydrological regime of the watercourses, however, if water collected within the clean water system is released into the watercourses (and of suitable water quality), the significance of the impact would be low and the loss of catchment yield would be negligible. If the storm water containment structures fail, the dirty water that enters the watercourses can decrease the surface water quality of the watercourses and its biotic integrity. This can also lead to erosion and subsequent sedimentation of the watercourses if mitigation measures are not implemented.							
Mitigation Measures	* Clean and dirty water separation systems must be implemented at the beginning of construction and maintained to ensure that any contaminated water does not reach the downgradient wetlands; * Stormwater infrastructure should be regularly inspected in order to prevent the failure thereof and the spilling of contaminated water into the clean water areas or the wetlands; and * Where clean water is released into the wetlands, stormwater management outlets should be installed, with erosion prevention structures (such as reno-mattresses) to limit the velocity of stormwater inflow from eroding the wetland.							

CLOSURE AND DECOMMISSIONING PHASE									
Impact	Applicable ecological aspect	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity	Backfilling of the open cast pit areas with material from the WRD and topsoil stockpiles. These activities are the closest in proximity to CVB 2 and 3.							
* Removal and utilisation of materials from the WRD could cause sedimentation of the downgradient wetlands; * Vehicles used as part of the backfilling activities could potentially drive indiscriminately through the wetlands; * Topsoil used could contain seeds from invasive and alien plant species; and * The profile of the infilled opencast areas potentially allows for preferential flow paths to develop and erosion gullies to establish, transporting sediment-laden water into the downgradient wetlands.	Habitat & ecological structure	Unmanaged	M	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		M	L	L	L	L	L
	Water quality		L	L	L	L	L	L
	Habitat & ecological structure	Managed	L	L	L	L	L	L
	Ecoservices		L	L	L	L	L	L
	Biotic integrity		L	L	L	L	L	L
	Hydrology & sediment balance		L	L	L	L	L	L
	Water quality		L	L	L	L	L	L
Impact Discussion	The decommissioning of the surface infrastructure is expected to disturb the established vegetation, which in turn may potentially impact on the habitat and ecological structure of the watercourses. The potential for sediment to enter the watercourses is also increased, due to dust creation and vehicle movement. Nevertheless, the impacts are expected to be of low impact significance due to their distance from the watercourses.							
Mitigation Measures	* Material from the WRD to be used to fill the void and that the backfilled area be reprofiled so as to resemble that of the natural landscape pre-mining activities, in order to reinstate natural drainage patterns and to become free draining; * No indiscriminate movement of vehicles may be allowed within the wetlands, and all wetlands should be marked as no-go areas and their GN704 zone of regulation should be demarcated; * The topsoil should be reseeded with indigenous vegetation species; and * The mining footprint should also be revegetated with indigenous vegetation species, and monitoring for alien and invasive species establishment should be conducted every few months in line with an Alien and Invasive Species Control Plan and be overseen by the appointed Environmental Control Officers (ECO).							

Based on the outcome of the impact assessment, almost all of the activities associated with the construction and operational mining activities were determined to have a low impact significance on the watercourses, prior to the implementation of mitigation measures. The impact of the establishment of the open cast pit areas (Mona Lisa Bird Reef Pit Area and the 11 Shaft Main Reef Pit Area) and operation thereof (these are the proposed mining activities within the closest proximity to any watercourses) was determined to have a moderate impact significance on the CVB 2 and CVB 3 wetlands prior to the implementation of mitigation measures. The presence of clean and dirty water systems, and their impact on the hydrological regime of the wetlands (specifically CVB 2 and 3) was also determined to have a moderate impact significance prior to the implementation of mitigation measures.

The overall low impact significance is mainly due to the distance between the activities and the watercourses. With the implementation of the mitigation measures, all activities associated with the construction phase, and most of the activities associated with the operational phase

would pose a very low impact significance to the watercourses. In this regard, specific mitigation measures to be implemented to ensure a very low impact significance include to limit driving through the watercourses (use only existing watercourse road crossings) and all temporary stockpiles should be located outside of the GN704 Zone of Regulation.

The loss of catchment yield is considered to have a low impact significance on the watercourses, with the implementation of the recommended mitigation measures. If water collected within the clean water system is released into the watercourses (and of suitable water quality), the significance of the impact would be low and the loss of catchment yield would be negligible. It is important that the stormwater infrastructure is regularly inspected to prevent any dirty water from entering the watercourses and to prevent erosion and sedimentation of the watercourses, and to prevent impacts on their water quality.

During the closure phase of the proposed mining project, backfilling of the open cast pit areas with the implementation of mitigation measures is anticipated to have a low impact significance on the watercourses. It is recommended that material from the waste rock dumps be used to fill the open cast pits and that the backfilled areas be reprofiled so as to resemble that of the natural landscape pre-mining activities, in order to reinstate natural drainage patterns and to become free draining. This area should also be revegetated with indigenous vegetation species, and monitoring for alien and invasive species establishment should be conducted every few months in line with an Alien and Invasive Species Control Plan and be overseen by the appointed ECO.

It is recommended that all the provided mitigation measures as presented in Table 28 be implemented in order to reduce the overall impact significance of the proposed mining activities on the receiving environment. Additional “good practice” mitigation measures applicable to a project of this nature are provided in Appendix F of this report.

6.1.3 Cumulative impacts

The proposed mining project occurs in an area where mining and urban activities are placing ever increasing strain on the watercourses present. Cumulative impacts as a result of this increased land use is resulting in both loss of surface water recharge and subsequently a loss in total catchment yield, as well as loss of sensitive watercourse habitat and loss of aquatic biodiversity on both a local and a regional scale. Impacts to surface water quality as a result of inputs related to runoff from impermeable surfaces and other activities in the catchment have resulted in a loss of biota.

7 CONCLUSION

The Klip River and three channelled valley bottom wetlands were identified within the investigation area associated with the proposed West Wits Mining project. The Klip River system is located approximately 740 m west of the closest open cast mining area (Mona Lisa Bird Reef). Other open cast mining areas (such as the 11 Shaft Main Reef and the Mona Lisa Bird Reef open cast mining area) are located within at least 50 m of the assessed channelled valley bottom wetlands. These watercourses have both been impacted upon to some degree, with specific mention of the historical and ongoing surrounding agricultural and mining activities.

These watercourses were assessed in order to determine the PES and EIS and was found to be in a largely modified condition, and of intermediate ecological importance and sensitivity, as summarised in the table below.

Table 29: Summary of results of the field assessment as discussed in Section 4.

Watercourse	Locality within proposed MRA	PES	Ecoservices	EIS	REC
Klip River	Located on the western boundary of the proposed MRA. The Mona Lisa Bird Reef Pit is approximately 760 m east of the river.	C/D (Moderately to Largely Modified)	Intermediate	B (High)	D (Largely Modified)
CVB 2	Located within the western portion of the proposed MRA. The Mona Lisa Bird Reef Pit is located approximately 57 m north of this CVB.	D (Largely Modified)	Intermediate	B (High)	D (Largely Modified)
CVB 3	Located within the eastern portion of the proposed MRA and investigation area. The 11 Shaft Main Reef Pit is located approximately 54 m north of the wetland.	D (Largely Modified)	Moderately Low/ Intermediate	B (High)	D (Largely Modified)

During the aquatic ecological assessments, results from the available biomonitoring data allowed adequate assessment of the PES and EIS of the watercourses in the vicinity of the proposed West Wits mining project development. Provided below is a summary of the results of the aquatic ecological assessment based on biomonitoring program data as described previously, as well as relevant desktop data:

Table 30: Summary of results of the field assessment as discussed in Section 5.

Biomonitoring assessment results summary							
Criteria	Ecological Category classification achieved for the following sites as well as overall rating for the Klip River:						
	KLIP US		KLIP DS		UN-TRIB US		Overall
	HF	LF	HF	LF	HF	LF	
SASS5	E/F	E/F	E/F	E/F	E/F	E/F	E/F
MIRAI	C	C	D	D	D	E	D
Instream IHI	C	D	D	C	D	D	D
Riparian IHI	C	C	D	D	D	D	D
FRAI	-	-	-	-	-	-	-
VEGRAI	-	-	-	-	-	-	-
Ecological Integration Tool result							D
Ecological Importance and Sensitivity Assessment							Low

Desktop assessment result summary:	
Desktop EIS (Kleynhans 1999, DWS RQIS)	Moderate
Desktop PEMC (Kleynhans 1999)	E/F
Desktop DEMC (Kleynhans 1999)	C
Desktop PES (DWS RQIS)	E
Desktop REC (DWS 2016)	C

NA = Not applicable; EIS = Ecological Importance and Sensitivity; PEMC = Present Ecological Management Class; DEMC = Desired Ecological Management Class; PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors; EI = Ecological Importance; ES = Ecological Sensitivity; EC = Ecological Category; default based on median PES and highest of EI or ES means; REC = Recommended Ecological Category.

The water quality of the three sites may be considered largely altered during both the high flow (March 2018) and low flow (June 2018) assessments. Significant catchment-wide anthropogenic, mining and agricultural activities have caused the deviations observed in the dissolved salt concentration, lowered DO concentration and pH. The EC at all three sites increased temporally from the high flow (HF) to the low flow (LF) assessment and slight potential for adverse effects on the aquatic ecology is anticipated. Monitoring of the pH values in future assessments is considered essential as the pH value is an indication of potential AMD occurring and it is likely that during the HF assessment in March 2018, AMD could have lowered the pH within the catchment. The DO concentration of the KLIP DS and UN-TRIB US sites during the both assessments was below the 80% saturation level and considered inadequate in supporting diverse and sensitive aquatic biota. Temperature variation between sites can be explained by diurnal variation and water volume at the time of each assessment.

Spatially, the three sites were assessed to determine the present ecological state prior to the proposed West Wits mining project development. The two upstream sites, KLIP US and UN-TRIB US, are considered to be largely modified regarding the water quality and from spatial analysis it is clear that the upstream Klip River site is in slightly better condition than its unnamed tributary site. The EC is significantly higher at the UN-TRIB US site, while the DO concentration and pH is lower, indicating the degraded state of the system before any potential

activity from the proposed West Wits mining project development. When the upstream and downstream sites of the Klip River were compared, it showed catchment-wide anthropogenic activities as well as point and diffuse sources of pollution between the two sites and therefore existing impacts can be anticipated. Due to the distance between the two points, it is suggested that an additional monitoring point be added closer to the proposed West Wits mining project development on the Klip River to minimise the potential point and diffuse sources of pollution affecting the results of future studies.

From the results of the application of the IHI to the three sites during the two assessments, it is evident that there is moderate to large impact on the assessment areas of the unnamed tributary of the Klip River and the Klip River. Instream impacts were limited to impacts from lack of strong flow, limited aquatic vegetation habitat and channel modifications such as roads and river crossings. Riparian zone impacts were due to a lack of vegetation diversity such as indigenous riparian forests, invasive vegetation presence, livestock grazing, informal agriculture and rubbish dumping in certain sections of the sites.

The biomonitoring data from both the high and low flow assessments shows that the catchment is already impacted on by point and diffuse sources of pollution. Should the proposed mining activities proceed, addition of similar infrastructure will likely lead to similar impacts (or risks thereof), potentially resulting in a cumulative effect. Therefore, should the proposed mining project be authorised, very well planned and executed mitigation is required to avoid and minimise potential impacts on the receiving environment, in line with the requirements of the mitigation hierarchy (prevention, reduction, remediation and offset/compensation) as advocated by the Department of Environmental Affairs (DEA) *et al* (2013).

Based on findings of this study, overall the proposed mining activities are anticipated to pose a low impact significance (without the implementation of mitigation measures). The project is deemed to have lower levels of impact if well managed.

The objective of this study was to provide sufficient information on the freshwater ecology of the area, together with other studies on the physical and socio-cultural environment, in order for the Environmental Assessment Practitioner (EAP) and the relevant authorities to apply the principles of Integrated Environmental Management (IEM) and the concept of sustainable development. The need for conservation as well as the risks to other spheres of the physical and socio-cultural environment need to be compared and considered along with the need to ensure economic development of the country. It is the opinion of the ecologists that this study

provides the relevant information required in order to implement IEM and to ensure that the best long-term use of the resources associated with the proposed West Wits Mining Project will be made in support of the principle of sustainable development.

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APPENDIX A – Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.
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APPENDIX B – Legislative Requirements

The National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA)	The National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
The National Water Act, 1998 (Act No. 36 of 1998) (NWA)	The National Water Act, 1998 (Act No. 36 of 1998) (NWA) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to activities as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998)	As per Government Notice 509 of 2016 as it relates to activities as stipulated in the National Water Act, 1998 (Act No. 36 of 1998), a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; b) In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice replaces GN1199 and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
Government Notice 704 as promulgated in Government Gazette 20119 of 1999 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)	These regulations, forming part of the National Water Act, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining. It is recommended that the project complies with Government Notice 704 as promulgated in Government Gazette 20119 of 1999 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) which contains regulations on use of water for mining and related activities aimed at the protection of water resources. GN 704 states that: *No person in control of a mine or activity may:* *(b) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres (m) from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;* According to the above, the activity footprint must fall outside of the 1:100 year floodline of the drainage feature or 100m from the edge of the feature, whichever distance is the greatest, unless authorised by DWS.

APPENDIX C – Method of Assessment

FRESHWATER RESOURCE METHOD OF ASSESSMENT

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the freshwater features present or in close proximity of the proposed MRA are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA, 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of or within the proposed MRA.

1.2 *Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2012)*

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourse traversed by the proposed MRA.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa

The freshwater features encountered within the proposed MRA were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013), hereafter referred to as the "Classification System". A summary of Levels 1 to 4 of the classification system are presented in Table C1 and C2, below.

Table C1: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Unit for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	B	C
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland Systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[3] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the National Freshwater Ecosystem Priority Areas (NFEPA) project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting

At Level 3 of the Classification System, for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/creSAS (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table C2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;

[3] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** 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. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

3. WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

Level of Evaluation
Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment
A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment
Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

Quantification of Present State of a Wetland
The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores, and Present State categories are provided in the table below.

Table C3: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (table below).

Table C4: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

4. Wetland Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[4] The assessment of the ecosystem services supplied by the identified freshwater features was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the freshwater features. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the freshwater features.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

5. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C8) of the wetland system being assessed.

Table C6: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

6. Recommended Management Objective (RMO) and Recommended Ecological Category (REC) Determination)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the freshwater resource (sections above), with the objective of either maintaining, or improving the ecological integrity of the freshwater resource in order to ensure continued ecological functionality.

Table C7: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unnacceptable (Malan and Day, 2012) and therefore, should a freshwater resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A freshwater resource may receive the same class for the REC as the PES if the freshwater resource is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the freshwater resource.

Table C8: Description of Recommended Ecological Category (REC) classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

7. Wetland Delineation

The freshwater resource delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" published by DWAF in 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators, and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

C2: Aquatic Ecological Assessment

The sections below describe the methodology used to assess the aquatic ecological integrity of the two sites selected based on water quality, instream and riparian habitat condition and biological impacts and integrity as well as toxicological analysis.

8. Visual Assessment

Each site was investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, were identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area; and
- Other life forms reliant on aquatic ecosystems.

9. Physico Chemical Water Quality Data

On-site testing of biota specific water quality parameters including pH, Electrical Conductivity (EC), dissolved oxygen concentration (DO) and temperature. The results aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for

aquatic ecosystems (DWAF 1996 vol. 7) as well as the Resource Water Quality Objectives (RWQO) of South Africa (DWA, 2011).

10. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C8 below.

Table C9: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

11. Habitat for aquatic macro-invertebrates

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores with regard to the suitability of habitat at sampling sites for aquatic macroinvertebrates (Ollis *et al*., 2006). Furthermore, the performance of the IHAS seems to vary between geomorphologic zones and between biotope groups (Ollis *et al*., 2006). It has, however; become clear that IHAS requires further validation and testing, although the basic data remains of value (Thirion, 2007).

Table C10: IHAS Scores and their corresponding description of overall condition (quality and quantity) of available aquatic macroinvertebrate habitat (McMillan, 1998)

IHAS Score (%)	Description
>75	Excellent
65 – 74	Good
55 – 64	Adequate / Fair
<55	Poor

12. Aquatic Macro-Invertebrates: South African Scoring System version 5 (SASS5)

Aquatic Macro-invertebrates were sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2002). The SASS5 method has been specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the protocol, as defined by Dickens & Graham (2002). All work was undertaken by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the

presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas 2007).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1 000 micron mounted on a 300 mm square frame, over the churned up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2 meters. Identification of the organisms was made to family level (Thirion *et al*., 1995; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score, would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system took place by comparing the present community status to reference conditions, which reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time.

13. Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly, habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly, habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result, expected and actual patterns can be evaluated to achieve an Ecostatus Category rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to the sites following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point were derived both from the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database, as well as habitat, flow and water parameters (Thirion, 2007).

Table C11: Description of the discussion points used for the discussion of data for each site

ASPECT	DEFINITION
Biotopes sampled	Refers to the various biotopes sampled for aquatic macro-invertebrates during the collection of the SASS5 samples.
Sensitive taxa present	A list of the taxa that were captured during SASS5 sampling regarded as being sensitive taxa relevant to the conditions in the area.
Sensitive taxa absent	A list of the taxa that were not captured during SASS5 sampling of the site but that were captured at other sites in the program and regarded as sensitive taxa.
Adjusted SASS5 score	The adjusted SASS5 value based on the adjustment figure in the IHAS index for variances in habitat conditions.
SASS5 % of reference score	The result compared to the reference SASS5 score of 180.
ASPT % of reference score	The result for the site compared to the reference ASPT score of 7.0.
Dallas; 2007 classification	The classification of the site into ecological bands/categories based on data from the Western Bankenveld ecoregion.
Dickens and Graham, 2001 SASS5 classification	The classification of each site into one of five classes, based on the degree of impairment observed in the aquatic macro-invertebrate community.
McMillan, 1998 IHAS description	Description of the adequacy of habitat according to the guidelines of McMillan 1998
IHAS stones biotopes results	Discussion of the suitability of the stones biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS vegetation biotopes results	Discussion of the suitability of the vegetation biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS other biotopes results	Discussion of the suitability of the gravel, sand and mud biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS general stream characteristics	A summary of the notes made from the general stream characteristics section of the IHAS index.
Previous assessment IHAS score	The IHAS score obtained in the previous assessment.
Current IHAS score	The current score.
Current IHAS Adjustment score	The adjustment score from the IHAS index based on stream conditions.

14. Ecological Importance and Sensitivity (EIS) Method of assessment

The EIS method considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table C12). The median of the resultant score is calculated to derive the EIS category (Table C13).

Table C12: Definition of the four-point scale used to assess biotic and habitat determinants presumed to indicate either importance or sensitivity

Four point scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table C13: Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General Description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/ marg -inal	Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

APPENDIX D – Impact Assessment Methodology

Impacts are assessed based on consideration of the impact severity, spatial scale and duration of impacts, which together determine the impact consequence. The impact consequence together with the probability of the impact occurring determine the overall impact significance.

The criteria for determining the severity, spatial scale and duration of potential impacts are presented in Table D1. The criteria are based on the criteria detailed in *Department of Environmental Affairs and Tourism (DEAT, 2002) Specialist Studies, Integrated Environmental Management Information Series 4, Department of Environmental Affairs and Tourism (DEAT), Pretoria*; *DEAT (2002) Impact Significance, Integrated Environmental Management Information Series 5, Department of Environmental Affairs and Tourism (DEAT)* and the criteria and methodology developed by Theo Hacking[5]. Table D1 also provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact).

Table D1: Criteria for the assessment of impacts.

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE	Significance = consequence x probability	
Definition of CONSEQUENCE	Consequence is a function of severity, spatial extent and duration	
Criteria for ranking of the SEVERITY of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

Impact consequence and significance are determined from Table D2 and Table D3. The interpretation of the impact significance is presented in Table D4.

[5] Hacking, Theo (1999) An innovative approach to structuring environmental impact assessment reports. Anglo American Corporation-Envirolink. Unpublished.

Table D2: Method of determining impact consequence.

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	H	Medium	Medium	Medium
	Medium term	M	Low	Low	Medium
	Short term	L	Low	Low	Medium
SEVERITY = M					
DURATION	Long term	H	Medium	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Low	Medium	Medium
SEVERITY = H					
DURATION	Long term	H	High	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Medium	Medium	High
			L	M	H
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

Table D3: Method of determining impact and significance.

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	H	Medium	Medium	High
	Possible/ frequent	M	Medium	Medium	High
	Unlikely/ seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

Table D4: Interpretation impact significance.

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
High	Influences the decision regardless of any possible mitigation.
Medium	Should have an influence on the decision unless it is mitigated.
Low	Will not have an influence on the decision.

*H = high, M= medium and L= low and + denotes a positive impact.

Control Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed project:

- Mitigation and performance improvement measures and actions that address the risks and impacts[6] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - The minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

[6] Mitigation measures should address both positive and negative impacts

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources in traversed by or in close proximity of the proposed infrastructure.

APPENDIX E – Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES), ECOSERVICES AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the ecosystem services provided by the watercourses located within the proposed MRA

Ecosystem service	Klip River	CVB 1 & 2	CVB 3
Flood attenuation	2,3	2,1	2,3
Streamflow regulation	2,4	2,0	1,8
Sediment trapping	1,8	1,8	1,8
Phosphate assimilation	1,9	1,6	1,3
Nitrate assimilation	1,9	1,7	1,4
Toxicant assimilation	1,9	1,6	1,4
Erosion control	1,9	1,8	1,5
Carbon Storage	1,3	1,0	1,0
Biodiversity maintenance	1,3	1,3	1,0
Water Supply	1,8	1,5	1,5
Harvestable resources	1,0	0,6	0,6
Cultivated foods	1,6	1,8	1,8
Cultural value	1,3	0,5	0,5
Tourism and recreation	1,0	0,5	0,4
Education and research	0,8	1,3	1,3
SUM	23,9	20,9	19,5
Average score	1,6	1,4	1,3

Table E2: Presentation of the results of the PES (WET-Health) assessment of CVB 1 and 2 located within the north western portion of the proposed MRA

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation		Overall PES score
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
1	20	100	5,0	-1	4,2	-1	5,5	-1	4,8
Area weighted impact scores*			5,0	-1,0	4,2	-1,0	5,5	-1,0	
PES Category			D	↓	D	↓	D	↓	D

Table E3: Presentation of the results of the PES (WET-Health) assessment of CVB 3 located within the eastern portion of the proposed MRA

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation		Overall PES score
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
1	20	100	5,0	-1	4,2	-1	5,5	-1	4,8
Area weighted impact scores*			5,0	-1,0	4,2	-1,0	5,5	-1,0	
PES Category			D	↓	D	↓	D	↓	D

Table E4: Presentation of the results of the EIS assessment of the watercourses assessed within the proposed MRA

Watercourse:			Klip River	CVB 1 & 2	CVB 3
Ecological Importance and Sensitivity			Score (0-4)		
Biodiversity support			A (average)		
			1,00	0,33	0,00
Presence of Red Data species			0	0	0
Populations of unique species			1	0	0
Migration/breeding/feeding sites			2	1	0
Landscape scale			B (average)		
			1,60	1,60	1,40
Protection status of the wetland			2	2	1
Protection status of the vegetation type			2	3	3
Regional context of the ecological integrity			1	1	1
Size and rarity of the wetland type/s present			1	1	1
Diversity of habitat types			2	1	1
Sensitivity of the wetland			C (average)		
			1,00	1,33	1,00
Sensitivity to changes in floods			1	2	1
Sensitivity to changes in low flows/dry season			1	1	1
Sensitivity to changes in water quality			1	1	1
ECOLOGICAL IMPORTANCE & SENSITIVITY (max of A,B or C)			B	B	B
Hydro-Functional Importance			Score (0-4)		
Regulating & supporting benefits	Flood attenuation		2	2	1
	Streamflow regulation		2	2	2
	Water Quality Enhancement	*Sediment trapping*	2	2	2
		Phosphate assimilation	2	2	2
		Nitrate assimilation	2	2	2
		Toxicant assimilation	2	2	2
		Erosion control	2	2	1
	Carbon storage		1	1	1
HYDRO-FUNCTIONAL IMPORTANCE (average score)			2	2	2
Direct Human Benefits			Score (0-4)		
Subsistence benefits	*Water for human use*		2	1	1
	Harvestable resources		1	0	0
	Cultivated foods		2	2	0
Cultural benefits	*Cultural heritage*		1	1	1
	Tourism and recreation		0	0	0
	Education and research		1	1	1
DIRECT HUMAN BENEFITS (average score)			1,17	0,83	0,50

AQUATIC ASSESSMENT RESULTS

IHAS SCORESHEETS – HIGH FLOW (MARCH 2018)

Site KLIP US

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: KLIP RIVER
Site Name: KLIP U/S
Date: 06.03.2018

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**5**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					**9**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**12**	
HABITAT TOTAL (MAX 55):					**26**	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX						**26**
TOTAL IHAS SCORE (%):					**52**	

Site KLIP DS

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: KLIP RIVER
Site Name: KLIP D/S
Date: 06.03.2018

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**14**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					**11**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**13**	
HABITAT TOTAL (MAX 55):					**38**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 25						
TOTAL IHAS SCORE (%):					**63**	

Site UN-TRIB US

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: UNNAMED TRIBUTARY OF KLIP RIVER						
Site Name: UNNAMED TRIBUTARY U/S	**Date**: 06.03.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**18**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**7**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**11**	
	HABITAT TOTAL (MAX 55):				**36**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					**31**
	TOTAL IHAS SCORE (%):				**67**	

Site UN-TRIB DS

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: UNNAMED TRIBUTARY OF KLIP RIVER						
Site Name: UNNAMED TRIB D/S	**Date**: 06.03.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**12**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**15**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**17**	
	HABITAT TOTAL (MAX 55):				**44**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX				**26**	
	TOTAL IHAS SCORE (%):				**70**	

IHAS SCORESHEETS – LOW FLOW (JUNE 2018)

Site KLIP US

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: KLIP RIVER						
Site Name: KLIP U/S	**Date**: 14.06.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**14**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**11**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**15**	
	HABITAT TOTAL (MAX 55):				**40**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 20					
	TOTAL IHAS SCORE (%):				**60**	

Site KLIP DS

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: KLIP RIVER						
Site Name: KLIP D/S	**Date**: 14.06.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**16**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**10**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**11**	
	HABITAT TOTAL (MAX 55):				**37**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					**27**
	TOTAL IHAS SCORE (%):				**64**	

Site UN-TRIB US

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: UNNAMED TRIBUTARY OF KLIP RIVER						
Site Name: UNNAM TRIB U/S	**Date**: 14.06.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**12**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**6**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**13**	
	HABITAT TOTAL (MAX 55):				**31**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					**18**
	TOTAL IHAS SCORE (%):				**49**	

Site UN-TRIB DS

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: UNNAMED TRIBUTARY OF THE KLIP RIVER						
Site Name: UNNAM TRIB D/S	**Date**: 14.06.2018					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**12**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**12**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**11**	
	HABITAT TOTAL (MAX 55):				**35**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX				**24**	
	TOTAL IHAS SCORE (%):				**59**	

IHI SCORESHEETS – HIGH FLOW (MARCH 2018)

Site KLIP US

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.0
Nutrients	2.5
Water Temperature	2.5
Water clarity	2.5
Oxygen	2.5
Toxics	3.0
PC RATING	
Sediment	2.5
Benthic Growth	2.5
BED RATING	**2.5**
Marginal	2.5
Non-marginal	2.5
BANK RATING	**2.5**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**71.1**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**3.0**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.0
Physico-Chemical (non-marginal)	1.0
Marginal	2.0
Non-marginal	2.0
BANK STRUCTURE RATING	**2.0**
Longitudinal Connectivity	2.0
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.0**
RIPARIAN IHI %	**65.1**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.2**

Site KLIP DS

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.5
Nutrients	3.0
Water Temperature	2.5
Water clarity	2.5
Oxygen	3.0
Toxics	3.0
PC RATING	**3.0**
Sediment	2.5
Benthic Growth	2.5
BED RATING	**2.5**
Marginal	2.5
Non-marginal	2.5
BANK RATING	**2.5**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**57.5**
INSTREAM IHI EC	**C/D**
INSTREAM CONFIDENCE	**3.0**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.5
Physico-Chemical (non-marginal)	2.0
Marginal	2.5
Non-marginal	2.5
BANK STRUCTURE RATING	**2.5**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.5
CONNECTIVITY RATING	**2.5**
RIPARIAN IHI %	**58.5**
RIPARIAN IHI EC	**C/D**
RIPARIAN CONFIDENCE	**3.0**

Site UN-TRIB US

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	2.0
Salts	2.5
Nutrients	3.0
Water Temperature	2.0
Water clarity	2.0
Oxygen	2.5
Toxics	2.5
PC RATING	**2.4**
Sediment	3.0
Benthic Growth	2.5
BED RATING	**2.7**
Marginal	3.5
Non-marginal	3.0
BANK RATING	**3.3**
Longitudinal Connectivity	3.0
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.0**
INSTREAM IHI %	**55.4**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.3**

RIPARIAN IHI
Base Flows
Zero Flows
Moderate Floods
Large Floods
HYDROLOGY RATING
Substrate Exposure (marginal)
Substrate Exposure (non-marginal)
Invasive Alien Vegetation (marginal)
Invasive Alien Vegetation (non-marginal)
Erosion (marginal)
Erosion (non-marginal)
Physico-Chemical (marginal)
Physico-Chemical (non-marginal)
Marginal
Non-marginal
BANK STRUCTURE RATING
Longitudinal Connectivity
Lateral Connectivity
CONNECTIVITY RATING
RIPARIAN IHI %
RIPARIAN IHI EC
RIPARIAN CONFIDENCE

Site UN-TRIB DS

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.5
Nutrients	3.0
Water Temperature	2.0
Water clarity	2.0
Oxygen	2.5
Toxics	2.5
PC RATING	**2.6**
Sediment	3.0
Benthic Growth	3.0
BED RATING	**3.0**
Marginal	3.5
Non-marginal	3.0
BANK RATING	**3.3**
Longitudinal Connectivity	3.5
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.3**
INSTREAM IHI %	**51.8**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.3**

RIPARIAN IHI	MRU
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	3.0
Physico-Chemical (non-marginal)	2.5
Marginal	3.0
Non-marginal	3.0
BANK STRUCTURE RATING	**3.0**
Longitudinal Connectivity	3.0
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.0**
RIPARIAN IHI %	**51.8**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.0**

IHI SCORESHEETS – LOW FLOW (JUNE 2018)

Site KLIP US

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.0
Nutrients	2.5
Water Temperature	2.5
Water clarity	2.5
Oxygen	2.5
Toxics	3.0
PC RATING	**2.6**
Sediment	4.0
Benthic Growth	2.5
BED RATING	**4.0**
Marginal	2.5
Non-marginal	2.5
BANK RATING	**2.5**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**57.3**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.0**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.0
Physico-Chemical (non-marginal)	2.0
Marginal	2.0
Non-marginal	2.0
BANK STRUCTURE RATING	**2.0**
Longitudinal Connectivity	2.0
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.8**
RIPARIAN IHI %	**66.2**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.0**

Site KLIP DS

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.5
Nutrients	3.0
Water Temperature	2.5
Water clarity	2.5
Oxygen	3.0
Toxics	3.0
PC RATING	**3.0**
Sediment	2.0
Benthic Growth	2.0
BED RATING	**2.0**
Marginal	2.5
Non-marginal	2.0
BANK RATING	**2.3**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**60.1**
INSTREAM IHI EC	**C/D**
INSTREAM CONFIDENCE	**3.0**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.5
Physico-Chemical (non-marginal)	2.0
Marginal	2.5
Non-marginal	2.0
BANK STRUCTURE RATING	**2.3**
Longitudinal Connectivity	3.0
Lateral Connectivity	2.5
CONNECTIVITY RATING	**2.8**
RIPARIAN IHI %	**59.1**
RIPARIAN IHI EC	**C/D**
RIPARIAN CONFIDENCE	**3.0**

Site UN-TRIB US

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	2.0
Salts	2.5
Nutrients	3.0
Water Temperature	2.0
Water clarity	2.0
Oxygen	2.5
Toxics	2.5
PC RATING	**2.6**
Sediment	3.0
Benthic Growth	3.0
BED RATING	**3.0**
Marginal	4.0
Non-marginal	3.0
BANK RATING	**3.6**
Longitudinal Connectivity	3.0
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.0**
INSTREAM IHI %	**52.3**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.3**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	3.0
Physico-Chemical (non-marginal)	3.0
Marginal	3.0
Non-marginal	3.0
BANK STRUCTURE RATING	**3.0**
Longitudinal Connectivity	3.0
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.0**
RIPARIAN IHI %	**51.8**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.2**

Site UN-TRIB DS

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.8**
pH	3.5
Salts	2.5
Nutrients	3.0
Water Temperature	2.0
Water clarity	2.0
Oxygen	2.5
Toxics	2.5
PC RATING	**2.7**
Sediment	3.5
Benthic Growth	3.0
BED RATING	**3.2**
Marginal	3.5
Non-marginal	3.0
BANK RATING	**3.3**
Longitudinal Connectivity	3.5
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.3**
INSTREAM IHI %	**50.7**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.3**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	0.0
Moderate Floods	2.0
Large Floods	1.0
HYDROLOGY RATING	**1.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	3.0
Physico-Chemical (non-marginal)	2.5
Marginal	3.0
Non-marginal	3.0
BANK STRUCTURE RATING	**3.0**
Longitudinal Connectivity	3.5
Lateral Connectivity	3.0
CONNECTIVITY RATING	**3.3**
RIPARIAN IHI %	**50.7**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.0**

MIRAI SCORESHEETS – HIGH FLOW (MARCH 2018)

Site KLIP US

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	62.9	*0.182*	11.4395	3	60
HABITAT	H	48.5	*0.242*	11.7602	4	80
WATER QUALITY	WQ	65.8	*0.273*	17.9386	2	90
CONNECTIVITY & SEASONALITY	CS	73.3	*0.303*	22.2222	1	100
						330
INVERTEBRATE EC				63.3605		
INVERTEBRATE EC CATEGORY				C		

Site UN-TRIB US

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	32.7	*0.174*	5.67894	3	40
HABITAT	H	28.2	*0.087*	2.45374	4	20
WATER QUALITY	WQ	57.0	*0.304*	17.3406	2	70
CONNECTIVITY & SEASONALITY	CS	80.0	*0.435*	34.7826	1	100
						230
INVERTEBRATE EC				60.2559		
INVERTEBRATE EC CATEGORY				C		

Site KLIP DS

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	28.7	*0.182*	5.21634	4	60
HABITAT	H	61.9	*0.273*	16.8915	2	90
WATER QUALITY	WQ	56.3	*0.242*	13.6463	3	80
CONNECTIVITY & SEASONALITY	CS	73.3	*0.303*	22.2222	1	100
						330
INVERTEBRATE EC				57.9763		
INVERTEBRATE EC CATEGORY				D		

Site UN-TRIB DS

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	53.3	*0.235*	12.5349	3	80
HABITAT	H	50.5	*0.206*	10.3975	4	70
WATER QUALITY	WQ	57.2	*0.265*	15.137	2	90
CONNECTIVITY & SEASONALITY	CS	71.8	*0.294*	21.1073	1	100
						340
INVERTEBRATE EC				59.1767		
INVERTEBRATE EC CATEGORY				D		

MIRAI SCORESHEETS – LOW FLOW (JUNE 2018)

Site KLIP US

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	50.8	*0.214*	10.8866	3	60
HABITAT	H	42.2	*0.143*	6.02884	4	40
WATER QUALITY	WQ	63.4	*0.286*	18.1235	2	80
CONNECTIVITY & SEASONALITY	CS	73.3	*0.357*	26.1905	1	100
						280
INVERTEBRATE EC				61.2294		
INVERTEBRATE EC CATEGORY				C		

Site UN-TRIB US

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	44.3	*0.265*	11.7232	2	90
HABITAT	H	10.0	*0.206*	2.05882	4	70
WATER QUALITY	WQ	37.1	*0.235*	8.72726	3	80
CONNECTIVITY & SEASONALITY	CS	52.9	*0.294*	15.5462	1	100
						340
INVERTEBRATE EC				38.0555		
INVERTEBRATE EC CATEGORY				E		

Site KLIP DS

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	40.0	*0.235*	9.41176	3	80
HABITAT	H	34.0	*0.206*	6.99965	4	70
WATER QUALITY	WQ	58.7	*0.265*	15.5289	2	90
CONNECTIVITY & SEASONALITY	CS	73.3	*0.294*	21.5686	1	100
						340
INVERTEBRATE EC				53.509		
INVERTEBRATE EC CATEGORY				D		

Site UN-TRIB DS

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	59.3	*0.235*	13.9494	3	80
HABITAT	H	31.5	*0.206*	6.48829	4	70
WATER QUALITY	WQ	62.2	*0.265*	16.4616	2	90
CONNECTIVITY & SEASONALITY	CS	71.8	*0.294*	21.1073	1	100
						340
INVERTEBRATE EC				58.0065		
INVERTEBRATE EC CATEGORY				D		

SASS5 SCORESHEETS – HIGH FLOW (MARCH 2018)

Site KLIP US

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 06.03.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3	1	B	A	B	Athericidae	10				
E:°	**TURBELLARIA**	3	B	A	A	B	Corixidae*	3		1		1	Blepharoceridae	15				
SITE CODE: KLIP U/S	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: KLIP RIVER	Oligochaeta	1			A	A	Hydrometridae*	6					Chironomidae	2		B	B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 21.0 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 5.65	Potamonautidae*	3	1	1	O 1	A	Pleidae*	4					Ephydridae	3				
DO: 6.28 mg/l / 87.2 %	Atyidae	8					Veliidae/M..veliidae*	5		A		A	Muscidae	1				
Cond: 32.4 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5		A		A
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEGIC: DOM SP:	Baetidae 1sp	4	•	•	•		Hydropsychidae 1sp	4	1	1	1	A	Ancylidae	6				
M VEGOOC: DOM SP:	Baetidae 2 sp	6	A	B	A	B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
DUMPING	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
RUBBLE	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
BRIDGE	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		37	61	39	71
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6	A	A		B	**NO OF TAXA:**		8	14	10	16
DUMPING	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		5	4.4	4	4.4
RUBBLE	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	52%				
	Coenagrionidae	4		B		B	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5			A	A	**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	1		1	A	NO STONES					
	Zygoptera juvs.	6					Gyrinidae*	5					SOME HARD SURFACES BUT NOT BEDROCK					
	Aeshnidae	8		A		A	Halipidae*	5					DEEP POOLS					
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5		A		A	VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site KLIP DS

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 06.03.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3		A	1	A	Corixidae*	3					Blephariceridae	15				
SITE CODE: KLIP DS	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: KLIP RIVER	Oligochaeta	1	A		B	B	Hydrometridae*	6					Chironomidae	2	B	B	B	C
SITE DESCRIPTION:	Leeches	3		B		B	Naucoridae*	7					Culicidae*	1			B	B
WEATHER CONDITION: OVERCAST	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 20.5 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 6.01	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 1.87 mg/l / 25.2 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 34.6 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	B	B		B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4		A		A	Hydropsychidae 1sp	4					Ancylidae	6		1		1
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: MED-FAST	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: MED	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
RITUALS	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
WASHING	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
CATTLE GRAZING	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
LITTER	ODONATA:						Lepidostomatidae	10					SASS SCORE:		8	23	7	25
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		3	6	4	8
RITUALS	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		3	3.8	2	3.1
LITTER	Chlorolestidae	8					Pisuliidae	10					IHAS:	63%				
DETERGENT/SEWERAGE INFLOW	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
WASHING	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
ABOVE	Protoneuridae	8					Elmidae/Dryopidae*	8										
	Zygoptera juvs.	6					Gyrinidae*	5										
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
LIM GSM	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
RITUALS AT TIME OF ASSESSMENT	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site UN-TRIB US

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 06.03.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: UNNAMED TRIB U/S	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB OF KLIP RIVER	Oligochaeta	1		1	A	A	Hydrometridae*	6					Chironomidae	2	B	B		B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1	B	B		B
WEATHER CONDITION: OVERCAST	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 19.3 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 5.59	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 3.28 mg/l / 43.7 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 72.8 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: MED	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: V.LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
DUMPING	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
WASHING	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
RITUALS	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
SANDBAGS	ODONATA:						Lepidostomatidae	10					SASS SCORE:		16	29	1	29
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		4	6	1	6
SANDBAGS	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		4	4.8	1	4.8
ROAD RUNNING THROUGH	Chlorolestidae	8					Pisuliidae	10					IHAS:	67%				
WASHING	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
DUMPING	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5	A	B		B	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	A	B		B	NO SM ONLY GRAVEL					
	Zygoptera juvs.	6					Gyrinidae*	5					STONES DOMINANT					
	Aeshnidae	8					Halipidae*	5					SOME GRASS AS AQ. VEG SLIGHT ODOUR					
	Corduliidae	8					Helodidae	12		B		B	* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site UN-TRIB DS

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 06.03.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3		B	B	B	Blephariceridae	15				
SITE CODE: UNNAMED TRIB D/S	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB OF KLIP RIVER	Oligochaeta	1	1	A	B	B	Hydrometridae*	6					Chironomidae	2			B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: OVERCAST	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 23.5 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 5.72	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 3.84 mg/l / 55.3 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 29.8 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A	A	A	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5		1		1
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4	A	A		B	Hydropsychidae 1sp	4					Ancylidae	6		1		1
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3		A		A
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
BUILDING AND CONSTRUCTION	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
LITTER	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
RUBBLE	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		16	41	32	58
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6	1	1	A	A	NO OF TAXA:		4	9	8	13
LITTER	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		4	4.6	4	4.5
	Chlorolestidae	8					Pisuliidae	10					IHAS:	70%				
	Coenagrionidae	4			1	1	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
LITTER	Protoneuridae	8					Elmidae/Dryopidae*	8		B		B	LIM STONES					
	Zygoptera juvs.	6					Gyrinidae*	5			1	1	GOOD AQ. VEG					
	Aeshnidae	8					Halipidae*	5					SURROUNDED BY BUILDINGS AND COMPLEXES					
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

SASS5 SCORESHEETS – LOW FLOW (JUNE 2018)

Site KLIP US

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14.06.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E:°	**TURBELLARIA**	3	**A**	**A**		**B**	Corixidae*	3	**A**	**B**	**B**	**B**	Blepharoceridae	15				
SITE CODE: KLIP US	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5			**A**	**A**
RIVER: KLIP RIVER	Oligochaeta	1	**A**			**A**	Hydrometridae*	6					Chironomidae	2	**A**		**A**	**B**
SITE DESCRIPTION:	Leeches	3		**A**		**A**	Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 8.0°C	Amphipoda	13					Notonectidae*	3		**A**		**A**	Empididae	6				
pH: 8.02	Potamonautidae*	3	**A**			**A**	Pleidae*	4					Ephydridae	3				
DO: 8.83 mg/l / 85.6 %	Atyidae	8					Veliidae/M..veliidae*	5		**B**		**B**	Muscidae	1				
Cond: 48.5 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5		**1**		**1**
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5		**1**		**1**
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4		**1**	**A**		Hydropsychidae 1sp	4	**A**			**A**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**B**			**B**	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
RITUALS	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
PIPELINE	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
ROAD / BRIDGE	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		27	35	18	57
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		8	9	5	15
HEAVY SEDIMENT DEPOSITION	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		3	3.9	4	3.8
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	60%				
	Coenagrionidae	4		**A**	**B**	**B**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5	**A**			**A**	**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					ALL SUBSTRATE/VEG COVERED IN FINE MUD/SIL					
	Zygoptera juvs.	6					Gyrinidae*	5					LIM AQ VEG - MIN MARG VEG					
	Aeshnidae	8					Halipidae*	5					STONES BURIED BY SUBSTRATE					
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site KLIP DS

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14.06.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3	B	A	B	B	Corixidae*	3					Blephariceridae	15				
SITE CODE: KLIP DS	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: KLIP RIVER	Oligochaeta	1	A	A	A	B	Hydrometridae*	6					Chironomidae	2	A	A	A	B
SITE DESCRIPTION:	Leeches	3		1	B	B	Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 9.0 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 8.02	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 6.74 mg/l / 68.4 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 73.4 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		B		B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4	A	A	1	B	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
BURNING	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
RITUALS	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
DUMPING	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		10	18	13	18
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		4	6	5	6
ALGAE ON ROCKS	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		3	3.0	3	3.0
RITUALS	Chlorolestidae	8					Pisuliidae	10					IHAS:	64%				
DUMPING	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					LIM GSM - UNDER					
	Zygoptera juvs.	6					Gyrinidae*	5					ALGAE ON ROCKS					
	Aeshnidae	8					Halipidae*	5					LOTS OF RITUAL ACTIVITY					
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site UN-TRIB US

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14.06.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blephariceridae	15				
SITE CODE: UNNAM TRIB U/S	ANNELIDA:			A		A	Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIBUTARY OF KLIP RIVE	Oligochaeta	1			A	A	Hydrometridae*	6					Chironomidae	2	1	B	B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1		1		1
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 10.4 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 7.48	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 6.63 mg/l / 70.3 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 77.6 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEGIC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEGOOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
BURNING	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
RUBBLE	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
WASHING	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
DUMPING / ROAD	ODONATA:						Lepidostomatidae	10					SASS SCORE:		2	3	3	4
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		1	3	2	4
ROADD THROUGH	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		2	1.0	2	1.0
SEWEAGE SMELL	Chlorolestidae	8					Pisuliidae	10					IHAS:	49%				
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						HIGHLY DISTURBED - MIN INVERTS					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					LIM VEG					
	Zygoptera juvs.	6					Gyrinidae*	5					LIM GSM - SOME GRAVEL					
	Aeshnidae	8					Halipidae*	5					STONES DOMINANT					
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Site UN-TRIB DS

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14.06.2018	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3			A	A	Corixidae*	3	1	1		A	Blephariceridae	15				
SITE CODE: UNNAMED TRIB D/S	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB - KLIP	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A		A	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 14.5 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
pH: 7.31	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 6.53 mg/l / 78.4 %	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 50.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		A		A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4	A	1	A	B	Hydropsychidae 1sp	4	A	A	A	B	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3	A	A		A
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
BUILDING COMPLEX	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
RUBBLE	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
LITTER	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		27	29	19	40
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		7	7	5	10
LITTER	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		4	4.1	4	4.0
RUBBLE	Chlorolestidae	8					Pisuliidae	10					IHAS:	59%				
CULVERT	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5	1	1		A	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8										
	Zygoptera juvs.	6					Gyrinidae*	5		1		1						
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12										
OTHER OBSERVATIONS:	Gomphidae	6	1		1	A	Hydraenidae*	8					* = airbreathers					
	Libellulidae	4					Hydrophilidae*	5					SWC = South Western Cape T = Tropical					
	LEPIDOPTERA:						Limnichidae	10					VG = all vegetation ST = Sub-tropical					
	Pyralidae	12					Psephenidae	10					GSM = gravel, sand & mud S = Stone & rock					
													1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

APPENDIX F – Impact Analysis and Mitigation Measures

General construction management and good housekeeping practices
Latent and general impacts which may affect the freshwater ecology and biodiversity, will include any activities which take place in close proximity to the proposed development that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the wetland system identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should not encroach into freshwater habitat unless absolutely essential. It must be ensured that the freshwater habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid freshwater areas and be restricted to existing roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction and operational phases and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should be permitted in or near the construction or mining areas; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. The vegetation component within the freshwater habitat is already transformed to an extent as a result of alien plant invasion; therefore these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species; and
  - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Soils

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soils;
- No stockpiling of topsoils is to take place within the associated NEMA zone of regulation (i.e. 32 m) around the freshwater feature and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the watercourses; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction materials must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

APPENDIX G – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISAS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden MSc Environmental Management (University of Johannesburg)

Christel du Preez MSc Environmental Sciences (North West University)

Kelly Dyamond MSc Aquatic Health (University of Johannesburg)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Natural Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health Practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP);
Accredited River Health practitioner by the South African River Health Program (RHP);
Member of the South African Soil Surveyors Association (SASSO);
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for Wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leone
Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining: Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd
  Tel: +27 (0) 11 465 2163
  Email: terryc@icem.co.za

- Alex Pheiffer
  African Environmental Management Operations Manager
  SLR Consulting
  Tel: +27 11 467 0945
  Email: apheiffer@slrconsulting.com

- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Junior Wetland Ecologist
Date of Birth	22 March 1990
Nationality	South African
Languages	English, Afrikaans
Joined SAS	January 2016

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2016
BSc (Hons) Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

COUNTRIES OF WORK EXPERIENCE

South Africa – KwaZulu Natal, Northern Cape, Gauteng, Mpumalanga, Free State

SELECTED PROJECT EXAMPLES

Wetland Assessments

- Baseline freshwater assessment as part of the environmental assessment and authorisation process for the proposed National Route 3 (N3) Van Reenen Village Caltex Interchange, KwaZulu Natal
- Basic assessment for the proposed construction of supporting electrical infrastructure for the Victoria West Wind Farm, Victoria West, Northern Cape Province
- Freshwater Ecological Assessment in Support of the WULA Associated with the Rehabilitation of the Wetland Resources in Ecopark, Centurion, Gauteng
- Wetland Ecological Assessment for the Proposed Mixed Land Use Development (Kosmosdal Extension 92) on the remainder of Portion 2 of the farm Olievenhoutbosch 389 Jr, City of Tshwane Metropolitan Municipality, Gauteng Province
- Freshwater Ecological Assessment for the Mokate Pig Production and Chicken Broiler Facility on the farm Rietvalei Portion 1 and 6 near Delmas, Mpumalanga
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Relocation of a Dragline from the Kromdraai Section to Navigation Section of the Anglo American Landau Colliery in Mpumalanga
- Freshwater Assessment as part of the Environmental Assessment and Authorisation Process for a proposed 132kv powerline and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces
- Freshwater Ecological Assessment of the Freshwater Prospect Stream in the AEL Operational Area, Modderfontein, Gauteng
- Specialist Freshwater Scoping and Environmental Impact Assessment for the Proposed Development of the Platberg and Teekloof Wind Energy Facility and Supporting Electrical Infrastructure near Victoria West, Northern Cape Province
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Development of Wilgedraai, Vaaldam Settlement 1777, Free State Province

- Freshwater Resource Delineation and Assessment as part of the consolidation of four Environmental Management Plans at the Graspan Colliery, in Middelburg, Mpumalanga Province
- Freshwater Assessment as part of the Water Use Authorisation for the proposed Copperton Wind Energy Facility, Northern Cape.
- Freshwater Resource and Water Quality Ecological Assessment for the Lakefield Manor Residential project, Boksburg, Gauteng Province
- Wetland Assessment as part of the Environmental Assessment and Authorisation Process for the proposed Vredenburg Wind Energy Facility Development near Saldanha, Western Cape Province
- Freshwater Ecological Assessment as part of the Environmental Assessment and Authorisation process for the proposed upgrade of a portion of Allandale Road Midrand, Gauteng Province
- Baseline Freshwater Resource Delineation and Assessment for the Gedex Project, in Brakpan, Gauteng
- Aquatic and Wetland Assessment as part of the Environmental Assessment and Authorisation Process for the Leslie 2 Underground Coal Mining Operation, Gauteng Province
- Biodiversity Assessment with focus on Freshwater Ecology as part of the S24G Application for 136 Plane Road in Kempton Park, Gauteng Province

Rehabilitation and Management Plans

- Wetland Rehabilitation and Management Plan for the proposed Residential Development on Portion 19 of Farm 653 (Vergenoegd) within the Western Cape Province
- Freshwater Resource Rehabilitation and Management Plan for the proposed Copperton Wind Energy Facility, Northern Cape
- Surface Water Rehabilitation and Management Plan as part of the Water Use Authorisation process for the proposed upgrade of a portion of Allandale Road and associated culverts, Midrand, Gauteng Province

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF KELLY DYAMOND

PERSONAL DETAILS

Position in Company	Junior Field Biologist with specific focus on Aquatic and Wetland Ecology
Date of Birth	8th April 1991
Nationality	South African
Languages	English
Joined SAS	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Accredited River Health practitioner by the South African River Health Program (RHP)
SASAqS Member (South African Society of Aquatic Scientists)

EDUCATION

Qualifications

MSc Aquatic Health (University of Johannesburg)	2017
BSc Zoology (Hons) (University of Johannesburg)	2014
BSc Zoology and Environmental Management (University of Johannesburg)	2010

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, Kwa-Zulu Natal

SELECTED PROJECT EXAMPLES

Aquatic Biomonitoring

- Aquatic biomonitoring programs for SAPPI Entra Paper Mill.
- Aquatic biomonitoring programs for Uitkomst Mine.
- Aquatic biomonitoring programs for Sibanye Stillwater Burnstone Operation.
- Aquatic biomonitoring programs for SCAW Metals.
- Aquatic biomonitoring programs for NECSA.
- Aquatic biomonitoring programs for Pilansberg Platinum Mine and Sedibelo Mine.
- Aquatic biomonitoring for Rhovan Mine.
- Aquatic biomonitoring for Assmang Chrome Machadodorp Works.
- Aquatic biomonitoring for Bakubung Platinum Mine.

Water Quality and Toxicity Monitoring

- Annual and Quarterly Water Monitoring and Management for the SAPPI Enstra Paper Mill.
- Toxicological monitoring programs for SCAW Metals.
- Toxicological monitoring programs for NECSA.
- Toxicological monitoring programs for Pilansberg Platinum Mine and Sedibelo Mine.
- Toxicological monitoring for Rhovan Mine.
- Toxicological monitoring for Assmang Chrome Machadodorp Works.
- Toxicological monitoring for Bakubung Platinum Mine.

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- 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 application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.

Signature of the Specialist