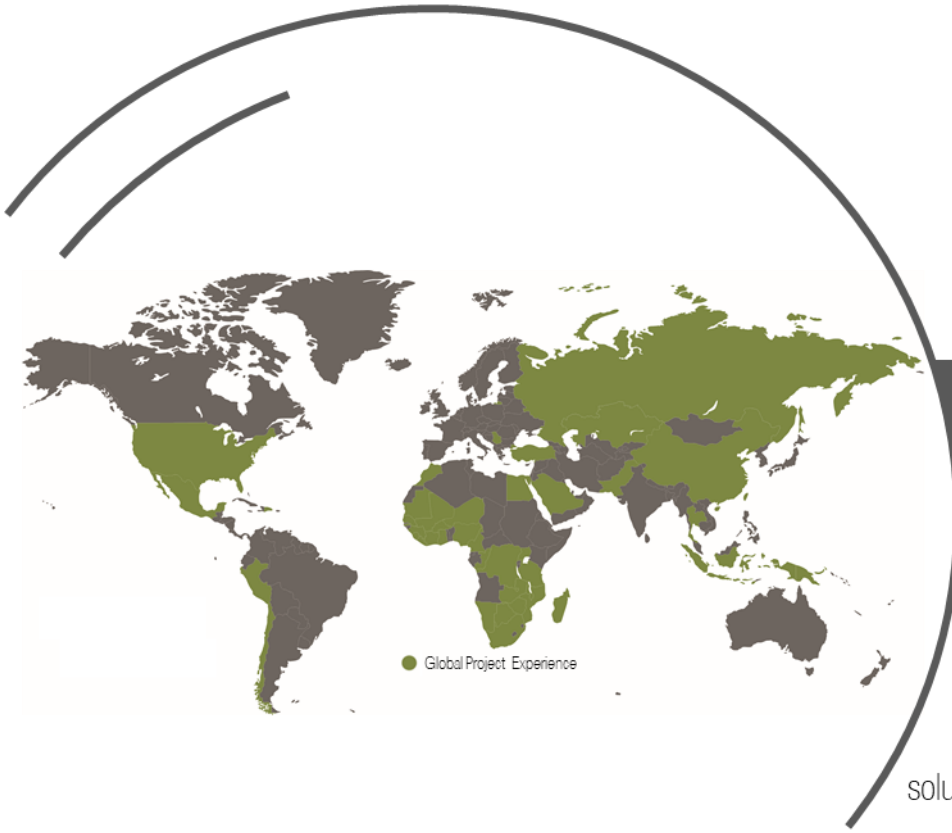

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Environmental Authorisation Process for the Expansion of the Copper Sunset Mining Right Area near Viljoensdrif, Free State Province

Aquatic Biodiversity and Impact Assessment

Prepared for:
Copper Sunset Sands (Pty) Ltd

Project Number:
COP6679

May 2021

Digby Wells and Associates
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Company Registration: 2010/008577/07

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This document has been prepared by Digby Wells Environmental.

Report Type:	Aquatic Biodiversity and Impact Assessment
Project Name:	Environmental Authorisation Process for the Expansion of the Copper Sunset Mining Right Area near Viljoensdrif, Free State Province
Project Code:	COP6679

Name	Responsibility	Signature	Date
Tebogo Khoza *Cand.Sci.Nat.*	Field survey, data collation and report writer		February 2021
Byron Bester *Pr.Sci.Nat.*	Technical review		February 2021
Danie Otto *Pr.Sci.Nat.*	Senior Review		February 2021

DETAILS AND DECLARATION OF THE SPECIALIST

Digby Wells and Associates (South Africa) (Pty) Ltd

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Specialist Background

Tebogo Khoza is an Aquatic Ecologist registered as a *Candidate Natural Scientist* with the South African Council for Natural Sciences Professions (Reg. no. 119651) and holder of an M.Sc. in Biodiversity and Conservation. He has recently joined the Digby Wells team as a Junior Ecologist, having two years' worth of experience in the environmental consulting industry with focus on aquatic-related studies, including the application of .various EcoClassificaiton Tools (e.g. SASS5, IHAS, IHIA, MIRAI, FRAI etc.). He is also an accredited SASS5 River Eco-Status Monitoring Programme practitioner with the Department of Water and Sanitation.

Full name:	Tebogo Khoza
Title/ Position:	Junior Aquatic Ecologist
Qualification(s):	MSc Biodiversity & Conservation
Experience (years):	2
Registration(s):	South African Council for Natural Scientific Professionals: Candidate Natural Scientist (Reg. No. 119651)

I, Tebogo Khoza, 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 Act, Regulations and any guidelines that have relevance to the proposed activity;

- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, 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; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

February 2021

Signature of the Specialist *Date*

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

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Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Copper Sunset (Pty) Ltd as the independent Environmental Assessment Practitioner (EAP) to conduct the required Environmental Authorisation (EA) process to expand their existing and approved Mining Right for the mining of sand over adjacent properties to extend the Life of Mine (LoM).

This document serves as the Aquatic Specialist Study in support of the EA process being undertaken for the proposed Mining Right Expansion Area (MREA). The goal of the Aquatic Study was to describe the baseline conditions within the aquatic ecosystems associated with the MREA prior to the commencement of construction activities. Foreseeable aquatic-related impacts were also identified, and appropriate mitigation measures were provided for the preservation of the assessed aquatic ecosystems.

The Copper Sunset Project Area is located within Viljoensdrif, a coal-mining village, under the jurisdiction of the Metsimaholo Local Municipality, which is located in the Fezile Dabi District Municipality, Free State Province near the Vaal River and Lethabo Power Station. The main aquatic ecosystems of focus in the Aquatic Study are three quaternary catchments, namely C22F, C22G and C22K which are drained by 4 Sub-Quaternary Reaches (SQRs): the Taaibosspruit SQR C22K-01795 and the Vaal River SQRs C22F-01737, C22F-01725 and C22F-01654.

The timing of the baseline aquatic survey coincided with the wet season (or high flow) for the Project Area. At the time of the survey, instream channels along some of the assessed sites were too deep to sample without a boat. As such, these negatively affected the depth of sampling as suitable habitat for aquatic biota could not be accessed and sampling was limited to the marginal banks of the defined river channel where it was deemed safer to sample. This is reflected in the ecological health indices utilised during the baseline determination.

Baseline Ecological Conditions

Amongst the water quality results, temperature values were recorded within typical summer season temperatures in South Africa. The pH values recorded exhibited close to neutral to slightly alkaline conditions, with a single site exceeding the recommended guideline, Site COP1 which is located along the Vaal River upstream of the proposed MREA. The recorded alkaline pH was likely attributed to the use of chemicals/fertilizers at the surrounding farms. Conductivity values were predominantly low, only Site COP2 recorded above the recommended guideline. This site lies along the Vaal River at a river crossing flanked by residential, industrial and mining areas in close proximity, as such, the water quality at this site is likely influenced by cumulative impacts. Dissolved oxygen levels were predominantly low throughout the sampled sites, however, only recorded below the recommended guidelines at sites COP2 and COP4 (downstream site at the Taaibosspruit). A high abundance of marginal vegetation and some aquatic vegetation were observed at both sites (COP2 and COP4) during the survey, therefore the low dissolved oxygen at these sites may have been attributed to a

myriad of sources including anthropogenic activities stemming from the nearby residential, industrial and mining areas.

The findings from the Index for Habitat Integrity assessments conducted during the current survey indicate that the habitat integrity along the assessed Vaal River reaches was *Moderately Modified* (Ecological Category C) and *Largely Modified* (Ecological Category D) at the assessed Taaibosspruit reaches. Major impacts of the instream habitat were water quality deterioration and exotic fauna. Residential areas including he upstream Zamdela township, the surrounding mining and farming activities observed at the time of the survey, are potential sources for these impacts.

The availability and integrity of aquatic macroinvertebrate biotopes were predominantly *Poor* across the sampled river reaches. The sites were dominated by deep, still and/or slow-flowing water with marginal vegetation, sand and mud being the most prevalent biotopes along the Vaal River. Similarly, along the Taaibosspruit, the sampled sites were dominated by shallow to deep and slow-flowing water with marginal vegetation, sand and mud being the most dominant biotopes. Similarly, the results of the South African Scoring System version 5 (SASS5) and Macroinvertebrate Response Assessment Index (MIRAI) indicate that conditions at the sampled reaches ranged between *Seriously Modified* (Ecological Category E) and *Seriously to Critically Modified* (Ecological Category E/F) with macroinvertebrate community assemblages largely composed of taxa that have "*Low"* water quality requirements.

Results of the fish community assessment indicated that the sampled River Reaches ranged from *Largely Modified* (Ecological Category D) conditions at the upstream sites to *Seriously Modified* condition (Ecological Category E) conditions at the downstream sites. Five fish species were collected (or observed), of which one was regarded as alien invasive species (*Gambussia affinis* or Mosquitofish). Along the Vaal River, three species were recorded whilst all five species were recorded at the Taaibosspruit. A dominant feature among the sample fish assemblage is the tolerance to modified water quality. The absence of the species *Enteromius pallidus* and *Labeobarbus kimberleyensis,* which are moderately intolerant to modified water quality suggests the impacted state of the water quality associated with the sampled reaches within the Project Area. However, it should be noted that some sites lacked potential habitat for fish and sampling was restricted to the margins within the Vaal River sites and the Taaibosspruit downstream site.

Following integration of the defined ecological conditions obtained for the instream biological integrity and the riparian component, it was determined that all assessed sites represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

Impact Assessment and Mitigation Measures

The potential surface related impacts associated with the proposed MREA were determined to be *Minor* for the associated Riverine systems and *Negligible* upon adequate implementation of mitigation measures. With gentle slopes for both systems, the Vaal River is approximately 960 m away from the closest point of the proposed MREA boundary, whilst the Taaibosspruit is approximately 900 m away.

An aquatic biomonitoring programme has been provided for the monitoring and preservation of the aquatic ecosystems associated with the Project. This programme is aimed at better determining the ecological health of the ecosystems as well as to act as an early detection tool for impacts that might significantly affect aquatic biota.

Reasoned Opinion Whether Project Should Proceed

In light of the distances and gentle slope between the proposed MREA boundary and the aquatic ecosystems under study, highlighted foreseeable negative impacts are likely to occur following rainfall events. Furthermore, impacts of the proposed MREA onto the associated water courses are predicted to be *Negligible* upon implementation of mitigation measures.

No notable fatal flaws were identified during the current study, thus the proposed MREA may proceed with the restriction that mitigation measures and the aquatic biomonitoring programme are implemented throughout the operation and Decommissioning phases to ensure no deterioration of the associated watercourses occur.

Recommendations

Based on the results of the current study, the following recommended are proposed:

- The depth of the Vaal River presents challenges in sampling the instream habitat; therefore, diatom assemblage assessments should be undertaken to provide a better indication of the PES and determine the potential drivers of change; and
- The developed Aquatic Biomonitoring Programme must be adopted on an annual basis after commencement of the Establishment Phase of the Project. This programme should continue for the life of the Project and for at least three years post the Decommissioning Phase.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

ASPT	Average Score Per Taxa
CBA	Critical Biodiversity Area
CSIR	Council for Scientific and Industrial Research
DEFF	Department of Environment, Forestry and Fisheries
DO	Dissolved Oxygen
DWS	Department of Water and Sanitation
EA	Environmental Authorisations
EAP	Environmental Assessment Practitioner
EC	Ecological Category
EMPr	Environmental Management Programme
ESA	Ecological Support Area
FRAI	Fish Response Assessment Index
IHAS	Invertebrate Habitat Assessment System
IHI	Index for Habitat Integrity
LoM	Life of Mine
MIRAI	Macro-Invertebrate Response Assessment Index
MPRDA	Mineral and Petroleum Resources Development
MRA	Mining Rights Area
MREA	Mining Right Expansion Area
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PA	Protected Area
PES	Present Ecological State
PPP	Public Participation Process
REMP	River EcoStatus Monitoring Programme
RHP	River Health Programme
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute

SANParks	South African National Parks
SASS5	South African Scoring System version 5
SQR	Sub-Quaternary Reach
STP	Sewage Treatment Plant
TWQR	Target Water Quality Range
WMA	Water Management Area
WRC	Water Research Commission
WTP	Water Treatment Plant
WUL	Water Use Licenses
WWF	Worldwide Fund for Nature

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page iii
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page iii
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
cA	And indication of the quality and age of the base data used for the specialist report;	Section 6
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7.5
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 6
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Section 4
(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;	N/A
(g)	an identification of any areas to be avoided, including buffers;	N/A
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	N/A
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6
(k)	any mitigation measures for inclusion in the EMPr;	Section 7
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Section 11.2
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 8
(n)	a reasoned opinion (Environmental Impact Statement) -	Section 11.1

Legal Requirement		Section in Report
	whether the proposed activity, activities or portions thereof should be authorised; and	
	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 9
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 10
(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

1. Introduction

Copper Sunset (Pty) Ltd (Copper Sunset) has an approved Mining Right (DMRE Ref. No. FS30/5/1/1/2/164 MR) and Environmental Management Programme (EMPr), in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), for the mining of sand on the Farm Bankfontein No. 9. Following the approval in 2008, the Mining Right Area (MRA) was amended to incorporate additional areas in 2011, 2016 and 2017. The existing operations are currently situated on the Farm Bankfontein No. 9, the Remaining Extent (RE) of the Farm Zandfontein No. 259, a Portion of the RE of the Farm Bankfontein No. 9, and a Portion of the Farm Rietfontein No. 152 near Viljeonsdrif in the Free State Province (Figure 1-1).

Copper Sunset currently holds the following Environmental Authorisations (EAs) and Environmental Management Programmes (EMPrs), which are applicable to the Mining Right boundary:

- The original EMPr associated with the application for a MR on the Farm Bankfontein No. 9, approved in 2008 (DMRE Ref. No. FS30/5/1/1/2/164 MR dated 28/04/2009);
- The 2011 EA and EMPr associated with the construction of a washing plant, a Return Water Dam (RWD), a settling dam and brick building (DMRE Ref. No. FS30/5/1/2/3/2/1 (164) EM dated 19/09/2011);
- The 2015 and 2016 EA and EMPr associated with the incorporation of additional areas into the MRA (DMRE Ref. No. FS30/5/1/2/3/2/1 (164) EM dated 08/03/2016 and 20/12/2016); and
- The 2017 EMPr associated with incorporation of additional areas into the MR (DMRE Ref. No. FS30/5/1/2/2 (164) MR dated 30/05/2018).

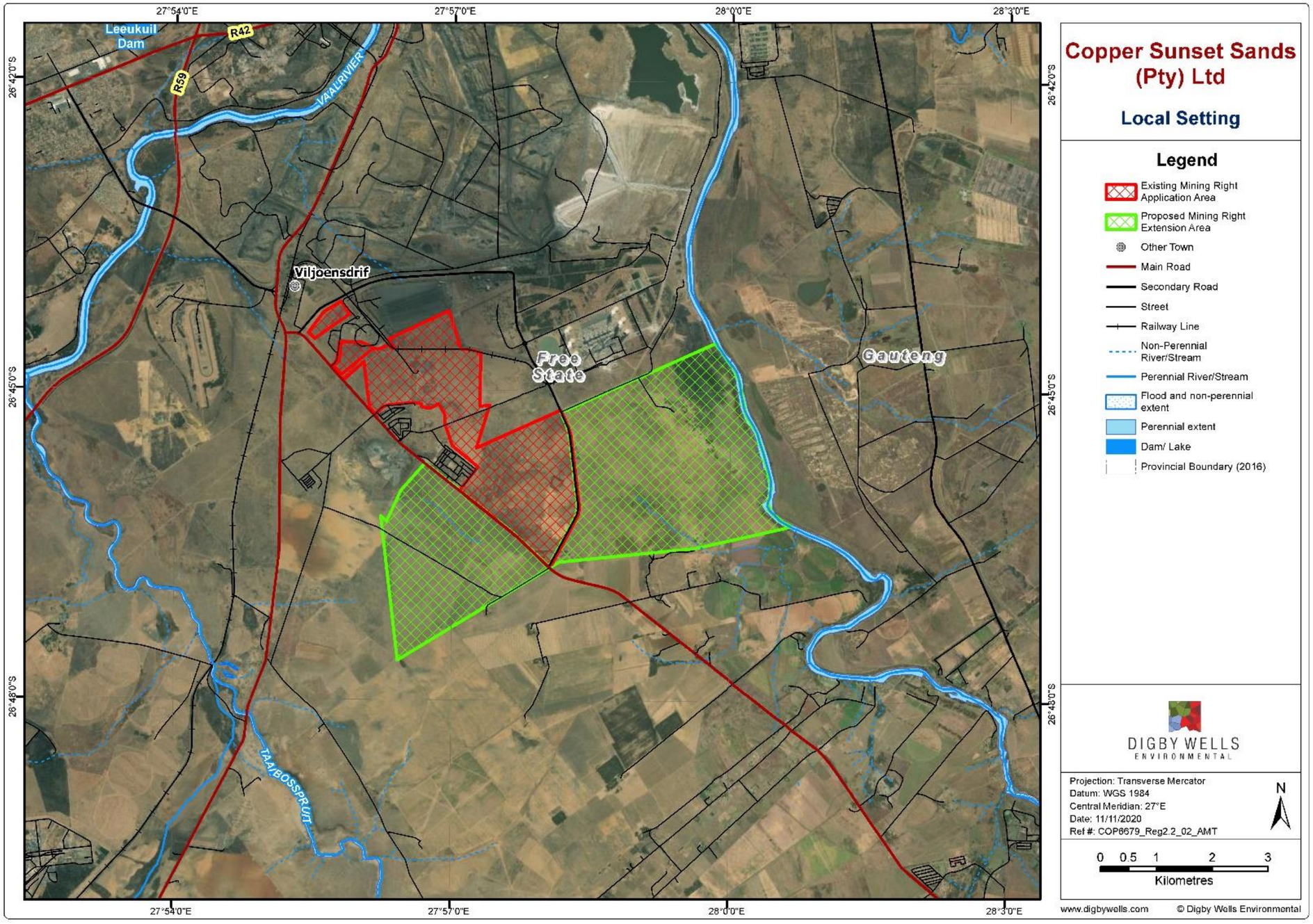

Figure 1-1: Copper Sunset Sands Local Setting

The applicant now intends to expand its MRA to incorporate adjacent properties to extend the Life of Mine (LoM). The intent is to expand the current mining operations to include additional portions of the RE of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Zandfontein No. 259. The proposed extension of the MRA amounts to approximately 1642 ha (Bankfontein) and 1153.6 ha (Zandfontein), for the mining of sand. The extension of the existing MRA triggers activities incorporated in Listing Notice 2 of the Environmental Impact Assessment (EIA) Regulations, 2014 (GN R982 of 04 December 2014 as amended), promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The Listed Activities require a Scoping and Environmental Impact Reporting (S&EIR) process to be carried out as part of the authorisation process.

Digby Wells Environmental (Digby Wells) has been appointed by Copper Sunset as the independent Environmental Assessment Practitioner (EAP) to conduct the required environmental authorisation process to expand their existing and approved Mining Right for the mining of sand over the proposed areas. Additionally, it is recommended that as part of this application, Digby Wells consolidate all EAs and EMPrs into one consolidated EMPr that is applicable to the approved MR and the new areas being incorporated. Therefore, the following processes will be conducted:

- A Section 102 amendment application process as per the MPRDA to amend the MR boundary;
- A S&EIR Process to authorise the new Listed Activities as per the NEMA;
- An Integrated Water Use Licence Application (IWULA) process in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) to mine the wetland areas found within the expansion area; and
- A Regulation 31 amendment process to consolidate the EAs and EMPrs into one consolidated report as per the NEMA.

1.1. Project Background and Description

Copper Sunset began sand mining in 2009, but at present, there is only about nine months left of the LoM. Therefore, Copper Sunset wishes to extend the MRA to include additional portions of the RE of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Zandfontein No. 259. The properties are located within Seriti's MRA. The intention of the Application is to maximise the mineral resource and to further extend the LoM.. The mining infrastructure, already present will be used for the expanded areas, however, mobile offices will be established at the entrance to the new mining areas.

The sand deposit lies between 0.4 – 5 m below the surface. Strip mining will be utilised to recover the resource, with the sand mined in strips of 30 – 35 m in width and 0.4 – 5 m in depth. The length of the strips is dependent on the area to be mined but approximate lengths are in the region are 180 – 600 m. The type of sand present at the mining area includes building sand, plaster sand and clay.

The mining method to be applied includes:

- Stripping and stockpiling of topsoil;
- Construction of a temporary haul road (20 m wide and length approximately 10 km);
- Mining of the sand resource including screening;
- Backfilling of the mined excavations with stockpiled topsoil; and
- Concurrent rehabilitation.

Copper Sunset is applying for an extension to their MRA to include adjacent farms to continue mining general sand (90% plaster and 10% building sand), clay will also be mined.

The deposit extends over an area of 2795.7 ha. The deposit is known to have an average thickness of 5 m. The current mining rate for Copper Sunset is approximately 2 000 m^3 per day. This is expected to continue, and at this rate the proposed extension area will extend the LoM for Copper Sunset by approximately 20 years.

1.1.1. Establishment Phase

During the Establishment phase of the proposed project, the following activities will be undertaken:

- Site Clearance: Vegetation and topsoil will be removed with a bulldozer and stockpiled along the mined-out strip; and
- Construction of a haul road (20 m width) to gain access to the sand mining area. The haul road will move as mining progresses through life of mine.

No permanent infrastructure will be constructed on site for the sand mining operation. All machinery will be mobile and brought in by Copper Sunset. This will include:

- Placement of mobile office;
- Establishment of parking area;
- Establishment mobile screening plant; and
- Placement of portable toilets, a hydrocarbon storage tank and water bowser

1.1.2. Operational Phase

The operation will make use of a fleet of tipper trucks, front-end loaders, excavators, water trucks, tractors, and bulldozers. Mining will commence with the removal of vegetation by means of a bulldozer. The topsoil will be removed by a bulldozer to a depth of about 0.3 – 0.4 m and stockpiled in a separate area for use during rehabilitation. The commencement of mining in the extension areas will initially be on the sand deposit on the eastern portion of the RE of Bankfontein No. 9 RE (Eastern Block), thereafter on the western portion of the RE of Bankfontein No. 9 RE (Western Block) and lastly on a portion of the RE of Zandfontein No.

259. During the Operational phase of the proposed project, the following activities will be undertaken:

- Strip mining will take place in sequences of 30 – 50 m wide to extract the sand by means of light weight excavators;
- A screening process will be utilised where required should sand become contaminated with unusable particles;
- The customer trucks (100-200 trucks per day) will enter via the haul road into the mining area. The haul road will be constructed as a loop to allow continuous flow of traffic. The mined-out sand / screened sand will be placed directly onto the customers trucks;
- The refuelling of equipment will take place at the mobile office areas within the expanded mining area;
- Water will be abstracted from an authorised borehole, located at the existing Copper Sunset MRA. This borehole is authorised by the Department of Water and Sanitation (DWS) under Water Use Licence (WUL) No. 08/C22F/AG/2315 granted 18 September 2013. It is anticipated that water will only be required for potable water and dust suppression on the expansion area. The amount of water used will remain within the limits of the existing license; and
- No mining will take place within a 100 m buffer from the edge of the Vaal River.

1.1.3. Closure and Rehabilitation Phase

Sand mining will cease once the resource has been extracted. Concurrent rehabilitation will be implemented during the sand mining process. The areas which have been mined of sand will be backfilled with the waste material from the screening plant which will be covered with topsoil stockpiled during the Operational phase. The area will be levelled and then contoured to avoid ponding of water. The topography is anticipated to be slightly lower, as a result of the removal of sand. The area will then be allowed to naturally re-vegetate. Where vegetation is not being well established, an indigenous seed mix will be utilised to improve vegetation establishment.

1.2. Terms of Reference and Purpose of this Report

The terms of reference for the current study were as follows:

- Conduct an updated baseline aquatic biodiversity assessment within the receiving watercourses associated with the proposed extension areas at the Copper Sunset sand mining operation:
  - Determine the Present Ecological State (PES; or Ecological Category) of the associated watercourses, where possible; and

- Assess the Ecological Importance and Sensitivity (EIS) associated with each of the selected watercourses.

- Assess the potential impacts upon the associated watercourses likely to originate from the proposed activities and associated infrastructure:
  - Identify potential impacts (incl. direct, indirect and cumulative) upon the associated watercourses implicated by the proposed infrastructure and mining operations to be undertaken within the Project Area;
  - Provide a professional opinion and assessment of the potential impacts (including assessment of duration, extent, magnitude, nature, etc.) of each of the identified potential impacts; and
  - Recommend appropriate mitigation measures, management objectives and interventions, as well as identify any potential fatal flaws associated with the proposed activities, if and when applicable.

1.3. Details of Specialist

The following Digby Wells' staff were involved in the study:

- **Tebogo Khoza** holds a M.Sc. (Biodiversity and Conservation) and is registered as a *Candidate Natural Scientist* with the South African Council for Natural Sciences Professions (Reg. no. 119651). He is an accredited SASS5 River Eco-Status Monitoring Programme practitioner with the Department of Water and Sanitation. He has recently joined the Digby Wells team as a Junior Ecologist, having 2 years' worth of experience in the environmental consulting industry with focus on aquatic-related studies wherein the various eco-status determination indices (including SASS5, IHAS, IHIA, MIRAI, FRAI etc.).
- **Byron Bester** is registered as a Professional Natural Scientist (Reg. No. 400662/15), holds a M.Sc. in Aquatic Health, is SASS-accredited practitioner and versed in the EcoStatus Determination process preferred by the RHP/REMP. He has approximately ten years' experience in environmental consulting, including astute project management and specialist resource management, as well as a broad specialist knowledge of various aspects of aquatic and wetland ecosystem assessment throughout South Africa and abroad (i.e. Botswana, Cote d'Ivoiré Democratic Republic of Congo, Ghana, Mali, Namibia, Senegal, Tanzania, and Zambia), including water quality assessment, sediment composition, aquatic macroinvertebrate community monitoring, fish biometric indices determination, histopathological fish health assessments and human health risk assessments via the consumptive pathway. He has completed numerous specialist aquatic biodiversity assessments in a wide range of sectors, including mining (e.g. coal, gold, platinum, titanium, etc.), industrial (e.g. smelters, brick-making projects, special economic zones, etc.), transport infrastructure upgrades (e.g. roads, airports, etc.), services infrastructure (e.g. powerline

installations, bulk water pipelines, etc.), as well as mixed-use, residential and commercial developments.

1.4. Assumptions, Limitations and Exclusions

To obtain a comprehensive understanding of the dynamics of the biota present within a watercourse (e.g. migratory pathways, seasonal prevalence, etc.), studies should include investigations conducted during different seasons, over a number of years and through extensive sampling efforts. Given the time constraints of the present study, such long-term research could not be conducted. Instead, conclusions provided within this report are based on data collected during a single wet season (or high-flow) sampling event, a literature review, and professional experience.

Findings presented in this report should be reviewed cautiously and in collaboration with the wetland and soils reports, as well as through a follow-up study, if possible. The following constraints were experienced during the current assessment:

- One site along the Taaibosspruit system was dry. This is a non-perennial tributary of the Taaibosspruit and likely only flows following periods of rainfall; and

Sampling along the Vaal River sites and a single site along the lower reaches of the Taaibosspruit were restricted to the marginal areas due to the excessive depth, which presented instream inaccessibility issues. This may have limited the number of collected biota as some aquatic biota prefer the deeper instream habitats and as such, a lower confidence is assigned to the data obtained

2. Relevant Legislation, Standards and Guidelines

The table below summarises the legal framework applicable to this Aquatic Biodiversity and Impact Assessment. The assessment includes the establishment, Operational, Decommissioning, Rehabilitation, and Closure for the proposed mining activities in the Copper Sunset Mining Right Expansion Area (MREA).

Table 2-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) All water uses listed in terms of Section 21 of the National Water Act (NWA) need to be licenced, unless it is a permissible water use in terms of Section 22 of the NWA	The proposed activities at the Copper Sunset Mine do not constitute a permissible water use in terms of Section 21 of the NWA. Therefore, a Water Use Licence (WUL) for Section 21 is required.

Legislation, Regulation, Guideline or By-Law	Applicability
GN R. 982: Environmental Impact Assessment Regulations, 2014 (as amended) These three listing notices set out a list of identified activities which may not commence without an Environmental Authorisation from the relevant Competent Authority through one of the following processes: • Regulation GN R. 983 (as amended) - Listing Notice 1: This listing notice provides a list of various activities which require environmental authorisation and which must follow a basic assessment process. • Regulation GN R. 984 (as amended) – Listing Notice 2: This listing notice provides a list of various activities which require environmental authorisation and which must follow an environmental impact assessment process. • Regulation GN R. 985 (as amended)) – Listing Notice 3: This notice provides a list of various environmental activities which have been identified by provincial governmental bodies which if undertaken within the stipulated provincial boundaries will require environmental authorisation. The basic assessment process will need to be followed.	Refer to the EIA report for a full description of the Listed Activities triggered by the proposed Project. • To comply with the regulations, an EIA process must be completed in support of the EA application. This Wetland Impact Assessment was completed to inform the EIA process to comply with Section 24 of the NEMA.
National Freshwater Ecosystems Priority Areas (NFEPA), Invalid source specified. The NFEPA project was a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water and Sanitation (DWS) formerly known as the Department of Water Affairs and Forestry (DWAF)), Department of Environment, Forestry and Fisheries (DEFF), Worldwide Fund for Nature (WWF), South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The NFEPA project aimed to: • Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and • Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.	The maps and data provide information regarding protected areas and was used as guidance for the strategic development of water resources and to support sustainable development.

Legislation, Regulation, Guideline or By-Law	Applicability
The NFEPA study responded to the high levels of threat prevalent in a river, wetland, and estuary ecosystems of South Africa. It provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or 'FEPAs'.	

3. Description of the Environment

The following sections will briefly describe the biophysical attributes and provide a regional context for the proposed Mining Right Expansion area (*hereafter the MREA*) and associated infrastructure.

3.1. Project Locality

The Copper Sunset Project Area is located within Viljoensdrif, a coal-mining village, under the jurisdiction of the Metsimaholo Local Municipality, which is in the Fezile Dabi District Municipality, Free State Province near the Vaal River and Lethabo Power Station. The site is located approximately 8 kilometres (km) south of Vereeniging, 10 km south-east from Vanderbijlpark and 13 km north-east from Sasolburg.

Table 3-1 provides the location of the mine in relation to the nearest towns.

Table 3-1: Project Locality

Town	Distance from Copper Sunset	Direction from Town
Vereeniging	8 km	South
Vanderbijlpark	10 km	South-East
Sasolburg	13 km	North-East

3.2. Associated Watercourses

The water resources of South Africa are divided into quaternary catchments, which are regarded as the principal water management units in the country (Department of Water Affairs and Forestry, 2011). These catchments represent the fourth order of the hierarchical classification system, in which the primary catchments are the major units. The primary drainages are further grouped into or fall under Water Management Areas (WMA). The Department of Water and Sanitation (DWS) has established nine WMAs as contained in the National Water Resource Strategy 2 (2013) in terms of Section 5 subsection 5 (1) of the National Water Act, 1998 (Act No. 36 of 1998).

The proposed MREA falls within primary drainage region C of the Vaal WMA and spans across three quaternary catchments, namely C22F, C22G and C22K, which are drained by four Sub-Quaternary Reaches (SQRs):

- The Taaibosspruit SQR C22K-01795; and
- The Vaal River SQRs C22F-01737, C22F-01725 and C22F-01654.

The Vaal River reach associated with the proposed MREA (SQR C22F-01737) is a fifth order stream approximately 46 km in length. This stream flows northwards along the eastern boundary of the proposed MREA and drains into the relatively short (approximately 2.2 km) C22F-01725 SQR, which flows westwards before draining into the C22F-01654 SQR, an approximately 13.9 km long stream flowing in the south-west direction. The Taaibosspruit SQR, approximately 22.9 km, flows parallel to the Vaal River SQR C22F-01737 on the western side of the proposed MREA.

Figure 3-1 presents the quaternary catchments and freshwater resources associated with the Project Area.

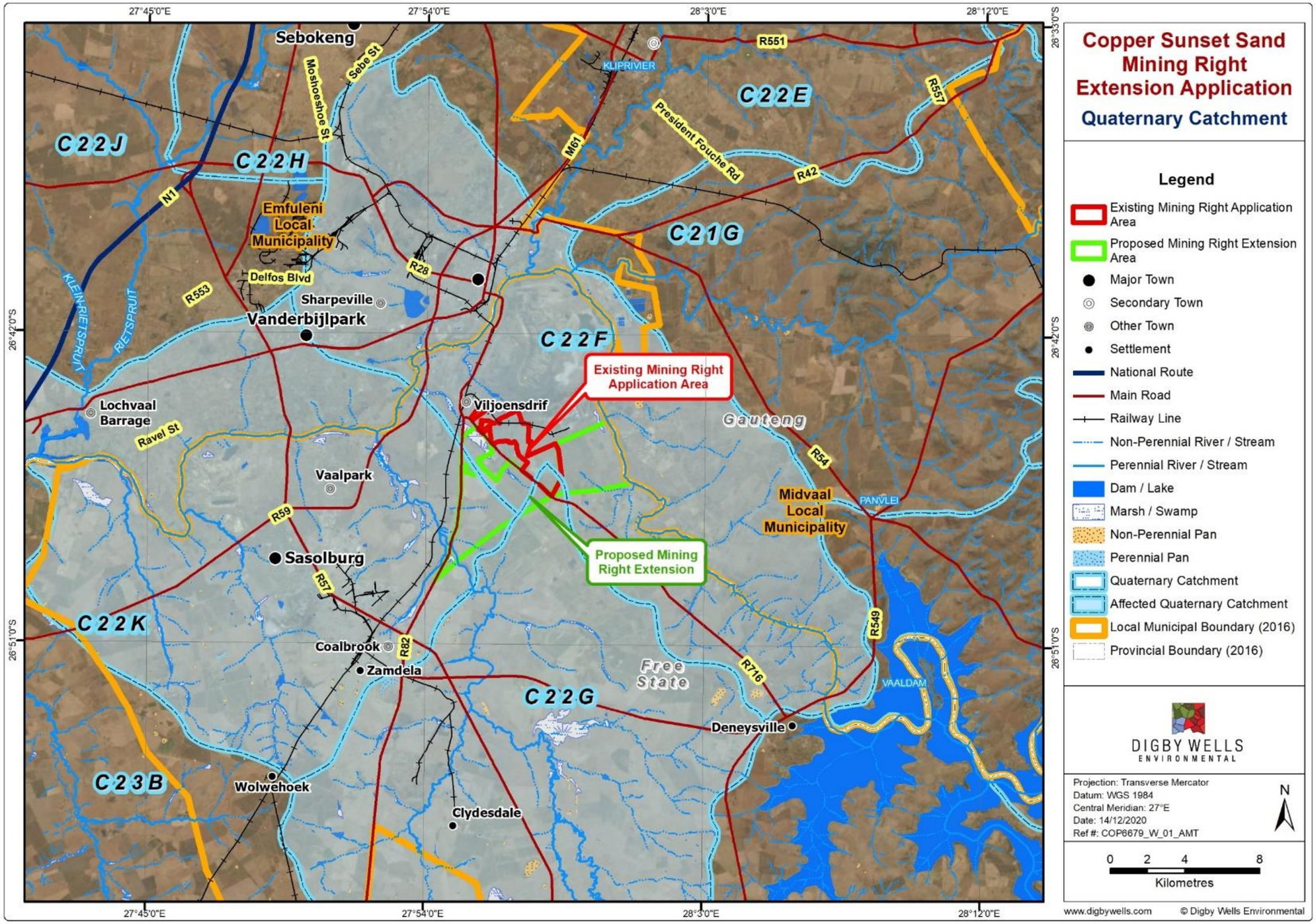

Figure 3-1: Quaternary Catchments associated with the Project Area

3.3. Bioregional Context

The following sub-sections briefly describe the importance of the Project Area and associated watercourses in terms of national, provincial and global contexts, including various strategic guideline planning documents and spatial layers.

3.3.1. Freshwater Ecoregions of the World

The Project Area is located within the **Southern Temperate Highveld** freshwater ecoregion situated in the interior of South Africa, with the western boundary formed by the Magaliesberg, Pilanesberg and Waterberg mountain ranges, the northern boundary formed by the Soutpansberg, and the eastern boundary formed by the Drakensberg Mountains.

This ecoregion combines headwaters of coastal basins that drain to the Indian Ocean with those of the Atlantic-draining Orange basin (Abell *et al*., 2008; Darwall *et al.,* 2009).

3.3.2. National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or (DWS), Department of Environment, Forestry and Fisheries (DEFF), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as ‘FEPAs’) to meet national biodiversity goals for freshwater ecosystems;
    - This aim is to accomplish systematic biodiversity planning to identify priorities for conserving South Africa’s freshwater biodiversity within the context of equitable social and economic development.
- Develop a basis for effective implementation of measures to protect FEPAs, including free-flowing rivers. This aim comprises of two separate components:
    - National component aimed to align DWA (or currently the DWS) and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems, while the Sub-national component is aimed to use three case studies to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes.

The project further aimed to maximize synergies and alignment with other national level initiatives, including the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation (Driver *et al.*, 2012).

Based on the current outputs of the NFEPA project (Nel *et al*., 2011), the associated sub-quaternary catchment is unclassified and not regarded as areas of potential concern in terms of freshwater biodiversity planning (Figure 3-2).

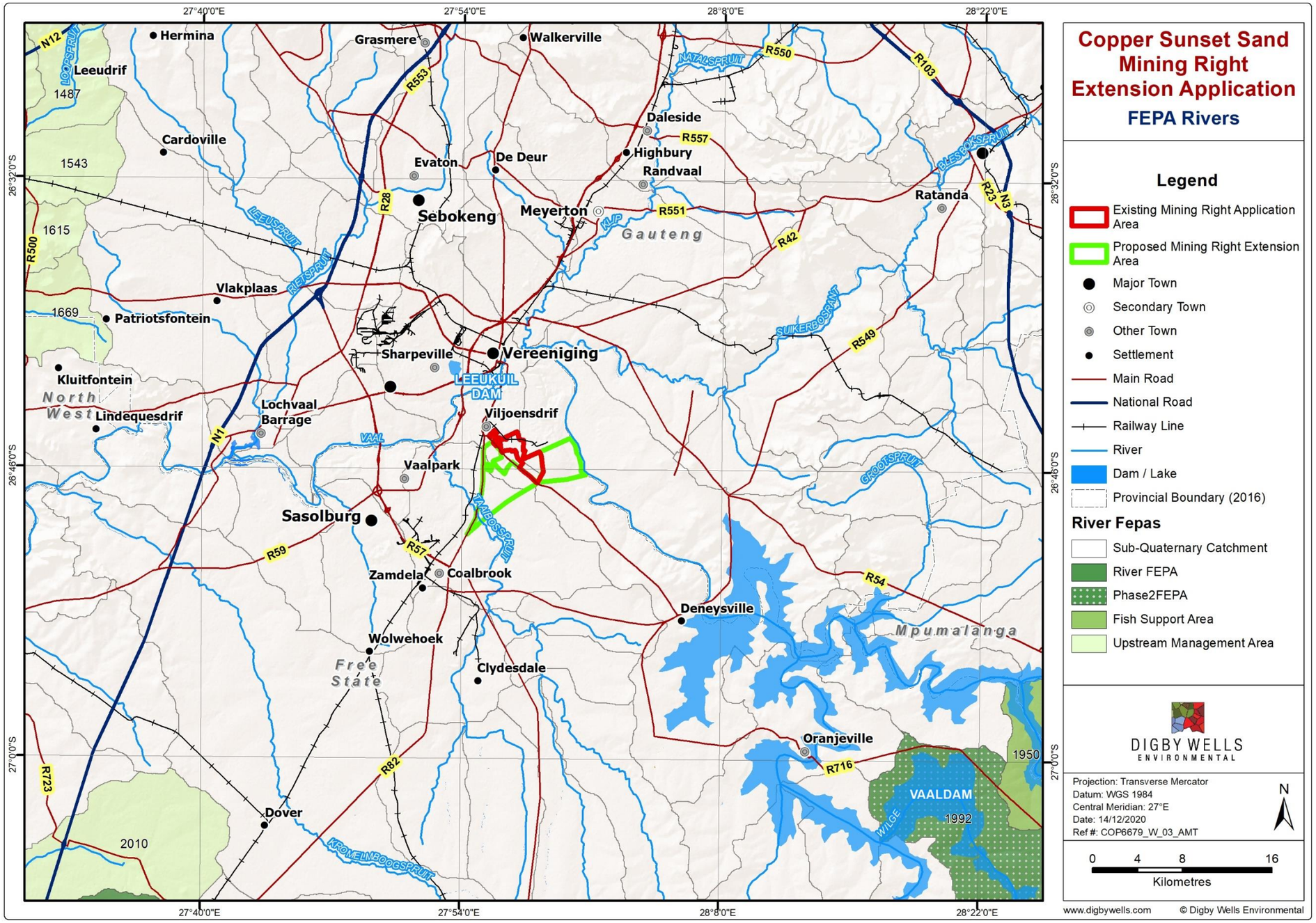

Figure 3-2: NFEPA Rivers Associated with the Project Area

3.3.3. Mining and Biodiversity Guideline

The Mining and Biodiversity Guideline was developed collaboratively by South African National Biodiversity Institute (SANBI), the Department of Environment, Forestry and Fisheries (DEFF), the Department of Mineral Resources (DMR), the Chamber of Mines and the South African Mining and Biodiversity Forum (2013). The purpose of the guideline was to provide the mining sector with a manual to integrate biodiversity into the planning process, thereby encouraging informed decision-making around mining development and environmental authorisations.

The aim of the guideline is to explain the value for mining companies to consider biodiversity management throughout the planning process. The guideline highlights the importance of biodiversity in managing the social, economic, and environmental risk of the proposed MREA. The country has been mapped into biodiversity priority areas, including the four categories each with associated risks and implications (Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, & South African National Biodiversity Institute, 2013) (Table 3-2).

Table 3-2: Mining and Biodiversity Guideline Categories (DEA *et al*., 2013)

Category	Risk and Implications for Mining
Legally Protected	**Mining prohibited**: unless authorised by ministers of both the DEA and DMR.
Highest Biodiversity Importance	**Highest Risk for Mining**: the Environmental Impact Assessment (EIA) process must confirm significance of the biodiversity features that may be a fatal flaw to the proposed Project. Specialists must provide site-specific recommendations for the application of the mitigation hierarchy that informs the decision-making processes of mining licences, water use licences and environmental authorisations. If granted, authorisations should set limits on allowed activities and specify biodiversity-related management outcomes.
High Biodiversity Importance	**High Risk for Mining**: the EIA process must confirm the significance of the biodiversity features for the conservation of biodiversity priority areas. Significance of impacts must be discussed as mining options are possible but must be limited. Authorisations may set limits and specify biodiversity related management outcomes.
Moderate Biodiversity Importance	**Moderate Risk for Mining**: the EIA process must confirm the significance of the biodiversity features and the potential impacts as mining options must be limited but are possible. Authorisations may set limits and specify biodiversity related management outcomes.

Based on these defined spatial priority areas, none of the biodiversity area categories occur within the proposed MREA (Figure 3-3). However, it should be noted that the area to the north-west of the existing operation, toward the Vaal River, is classified as the Highest Biodiversity Importance. This may translate to responsible management practice being enforced within the

mining areas to ensure that no potential impact migrates toward this potential sensitive area, especially along the longitudinal drainage lines.

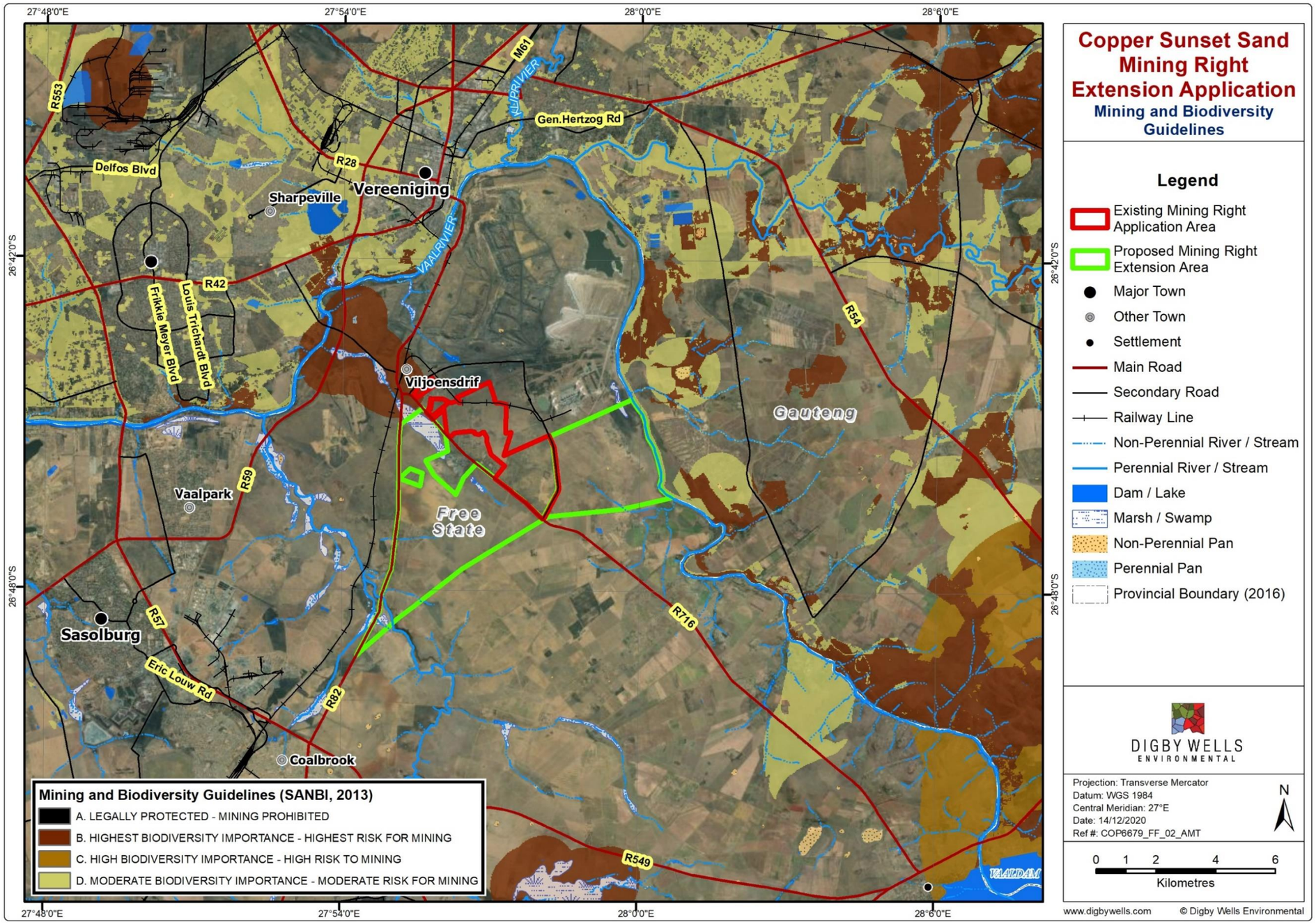

Figure 3-3: Mining and Biodiversity Guideline for Associated Project Area

3.3.4. Free State Biodiversity Plan

The Free State Biodiversity Plan is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy (Collins, 2016). The Free State Biodiversity Plan identifies and maps terrestrial categories with associated land-use and management guidelines. The categories are divided into Protected Area (PA), Critical Biodiversity Area (CBA), Ecological Support Area (ESA), Other Area and Degraded Area (Table 3-3).

The main objective is the sustainable use of resources to unlock meaningful and lasting benefits for both the people of the Free State Province (e.g. enhancing human well-being) and the environment (e.g. enhancing the integrity of the environment). This means that any resource use must, on balance, 'improve the state of the conditions or circumstances prevalent in the area to be affected by the resource use (Collins, 2016).

Table 3-3: Free State Biodiversity Plan Categories

Map Category	Definition	Desired Management Objectives
PA	Those areas that are proclaimed as protected areas under national or provincial legislation, including gazette protected environments.	Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.
CBAs	**CBA Irreplaceable**	Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.
	A site that is irreplaceable or near-irreplaceable for meeting biodiversity targets. There are no or very few other options for meeting biodiversity targets for the features associated with the site. Such sites are therefore critical and they need to be maintained to ensure that features targets are achieved and that such features persist.	
	CBA Optimal	
	A site that has been selected based on its complementarity for meeting biodiversity targets. CBA Optimal sites are therefore important but their maintenance is not critical to ensure that features targets are achieved and that such features persist.	

Map Category	Definition	Desired Management Objectives
ESAs	Area which plays important roles in supporting the ecological functioning of a PA or CBA, or in delivering ecosystem services. In most cases ESAs are currently in at least fair ecological condition and should remain in at least fair functioning condition.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorization process that ensures the underlying biodiversity objectives are not compromised.
	ESA1: sites with minimal degradation.	
	ESA2: sites with degradation, i.e. they can be totally degraded, but not totally transformed.	
Other	Areas of natural habitat not required to meet biodiversity targets for ecosystem types, species or ecological processes, i.e. natural areas not selected as CBA or ESA.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.
Degraded	Areas of degraded or transformed habitat that has not been selected as an ESA, i.e. all remaining areas.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximize ecological functionality and authorization is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilized and restored where possible, especially for soil carbon and water-related functionality.

Portions of the western section of the proposed MREA is classified as **Degraded Land, ESA1 and ESA2**, while the eastern section of the MREA is predominantly classified as **ESA2**, with smaller portions classified as **ESA1** (Figure 3-4). It should be noted that each of the identified ESA areas are largely associated with the defined watercourses within the Project Area and as such, it is likely that a responsible approach toward wetland and riverine management will align with the specified management objectives within these areas.

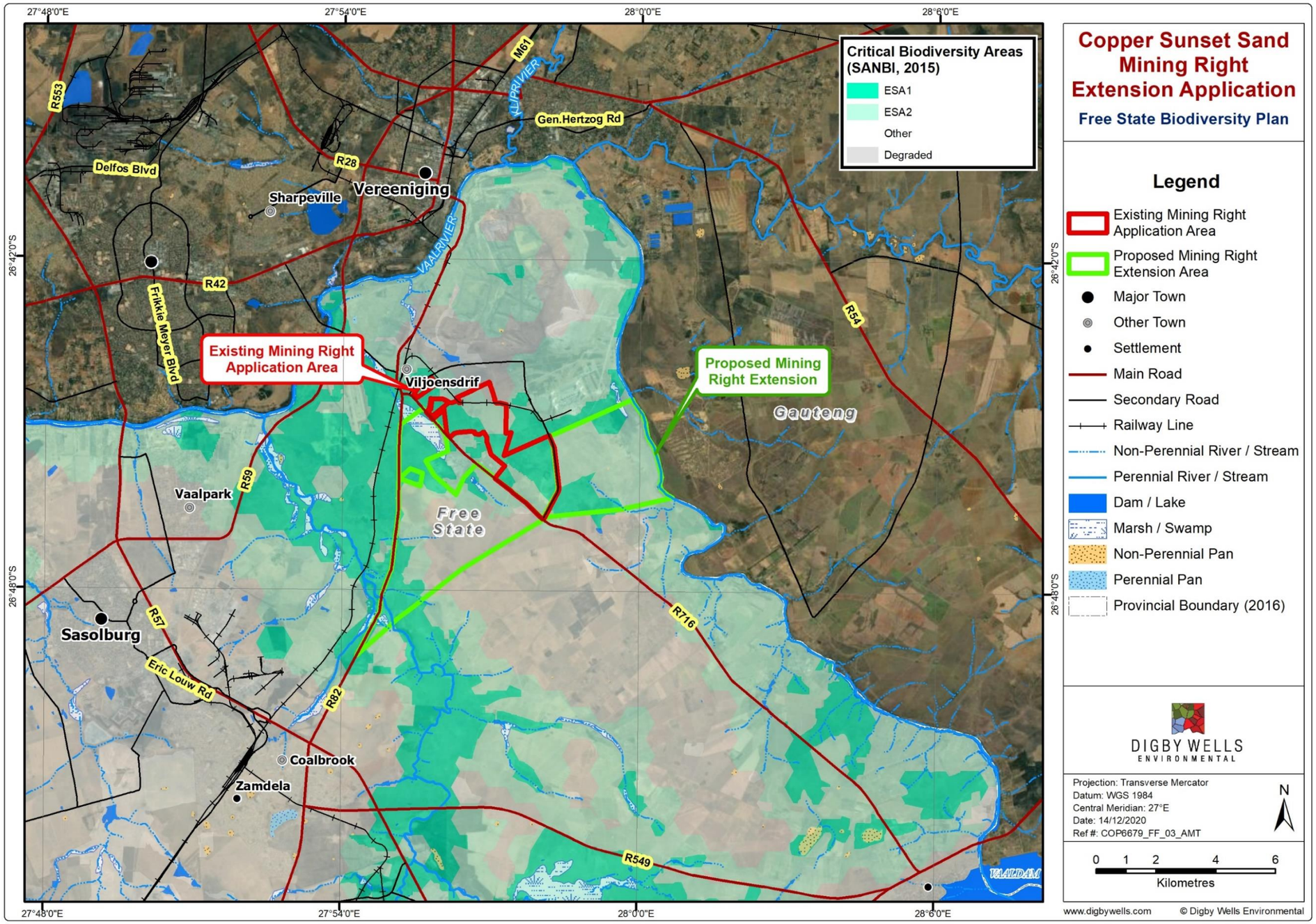

Figure 3-4: Free State Biodiversity Plan for the Proposed Copper Sunset MREA

4. Study Directive

This section provides a brief description of field observations at the time of the field survey, a summary of the approach to the study, including each of the respective bioassessment indices utilised, as well as each of the selected monitoring sites.

4.1. Field Survey

This report presents the current aquatic biodiversity observed within the aquatic ecosystems associated with the Mining Right Expansion Area (MREA). The field survey was conducted on the 23rd of December 2020 and again on the 15th of January 2021 (i.e. wet season survey).

4.2. Approach to Study

To enable an adequate description of the aquatic environment and the determination of the present ecological state, the following stressor, habitat and response indicators were evaluated:

- Stressor indicators:
  - *In situ* water quality assessment (Temperature, pH, Electrical Conductivity, and Dissolved Oxygen), including comparison to applicable guideline values (if any) and identification of parameters of potential concern; and
- Habitat indicator:
  - Instream and riparian habitat conditions, utilising the Index for Habitat Integrity (IHI, version 2); and
  - Aquatic macroinvertebrate biotope evaluation through the Adapted Invertebrate Habitat Assessment System (IHAS, Version 2.2).
- Response indicators:
  - Aquatic macroinvertebrate assessment, including the determination of ecological condition through Version 5 of the South African Scoring System (SASS5) and the Macro-Invertebrate Response Assessment Index (MIRAI);
  - Ichthyological assessment, including the evaluation of reference conditions and determination ecological condition through the Fish Response Assessment Index (FRAI); and
  - Determination of the integrated EcoStatus (EcoStatus 4, Version 1.02).

A detailed description of each index/approach utilised in the baseline determination has been outlined in Appendix A.

4.3. Selected Monitoring Sites

Appropriate monitoring sites were selected based on the location of the proposed MREA and areas suspected to support sensitive aquatic species, including species of potential conservation concern (Table 4-1 and Figure 4-1, refer to Appendix B for Site Photographs).

Table 4-1: Aquatic sampling sites within the Project Area

Site/Point	Coordinates	Description
COP1	26°47'27.85"S 28° 00'49.72"E	Located along the Vaal River upstream of the eastern side of the MREA. Site serves as a reference site for the Vaal River.
COP2	26°40'57.81"S 27°56'18.33"E	Located along the Vaal River at a river crossing north of the MREA. Site serves as a downstream site.
COP3	26°49'22.44"S 27°55'57.68"E	Located along the Taaibosspruit south west of the MREA. Site serves as an upstream reference site.
COP4	26°48'09.15"S 27°54'47.25"E	Lies along the Taaibosspruit at the R82 crossing, downstream of Site COP3.
COP5	26°47'05.43"S 27°55'05.65"E	Located at an unnamed non-perennial tributary of the Taaibosspruit west of the MREA.

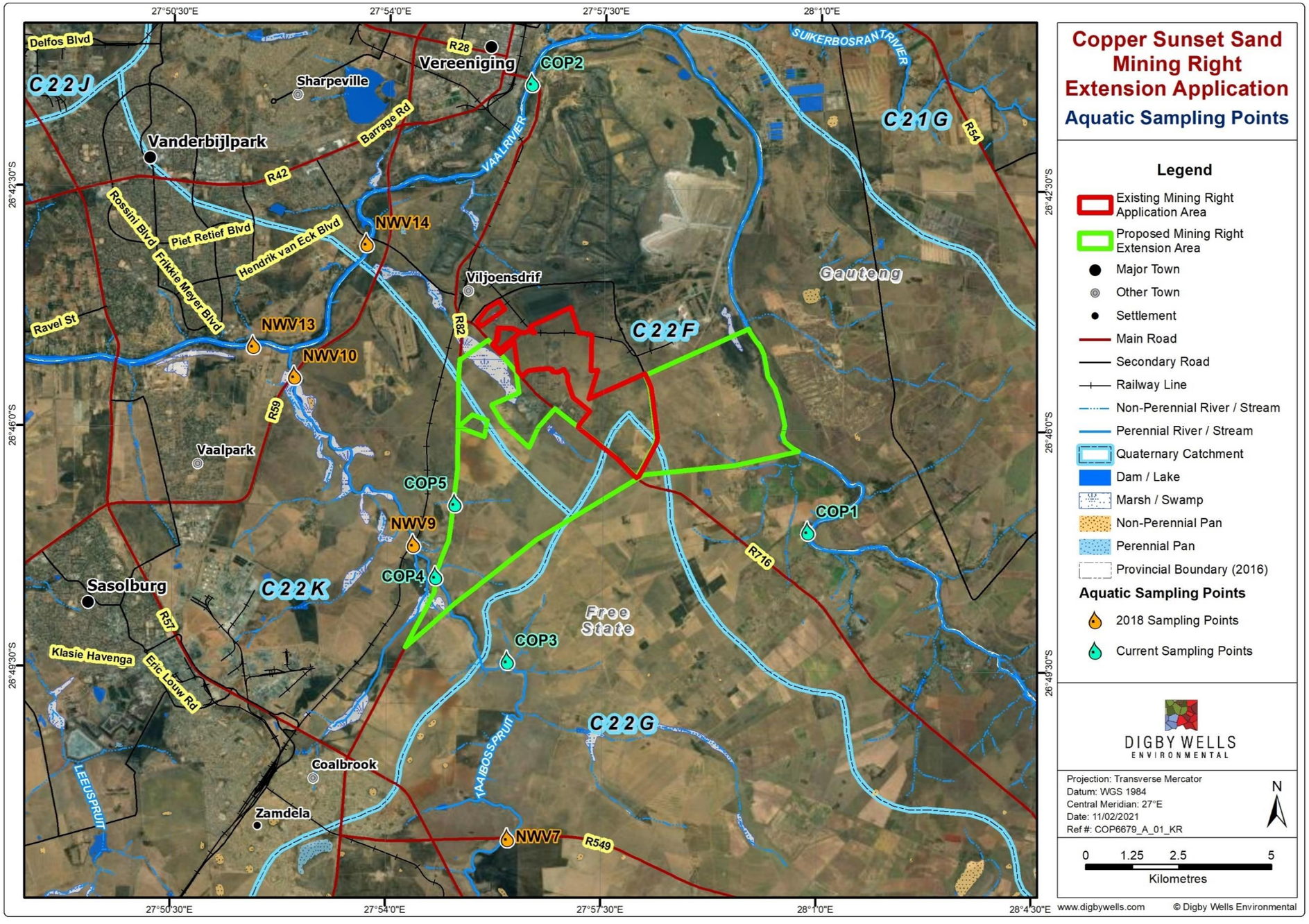

Figure 4-1: Selected aquatic sampling sites in relation to the proposed MREA

5. Desktop Information

The Present Ecological State, Ecological Importance and Sensitivity (PES & EIS) information available for the considered aquatic ecosystems in the Department of Water and Sanitation 1:500 000 river layer (DWS, 2014) are discussed below.

5.1. Present Ecological State, Ecological Importance and Sensitivity

Of the four Sub-Quaternary Reaches (SQRs) associated with the MREA, only the Vaal River SQR C22F-01737 and the Taaibosspruit SQR C22K-01795 are expected to be potentially impacted by the proposed mining activities. The other associated reaches along the Vaal River, namely SQRs C22F-01725 and C22F-01654, occur approximately 8 km downstream of the proposed MREA along an existing mine, as such, these were excluded from the assessment.

Desktop aquatic-related data for the considered river reaches is shown in Table 5-1 below.

Table 5-1: Desktop Aquatic Data Pertaining to the Reaches Associated with the Proposed MREA

River	Vaal	Taaibosspruit
SQR Code	C22F-01737	C22K-01795
Ecological Category	**C**	**D**
Category Description	Moderately Modified	Largely Modified
Ecological Importance (EI)	High	High
Ecological Sensitivity (ES)	High	High

According to the desktop data obtained for the Vaal River SQR C22F-01737 (DWS, 2014), the reach has been categorised as Moderately Modified (i.e. Ecological Category C). Activities impacting this reach are associated with agriculture, a power station, mining and the upstream Methabo weir. The Taaibosspruit SQR C22K-01795 has been categorised as Largely Modified (i.e. Ecological Category D) and is impacted by activities, including residential and industrial effluent discharge, agriculture and back-water from the Vaal Barrage in the lower reach.

Both EI and ES has been considered High for both river reaches (DWS, 2014). A total of 50 and 35 macroinvertebrate taxa are expected to occur at the Vaal River reach and the Taaibosspruit reach, respectively. Eleven indigenous fish species are expected to occur at both river reaches.

5.2. Expected Aquatic Macroinvertebrates Taxa

The expected macroinvertebrate taxa for the river reaches associated with the MREA are presented in Table 5-2.

Table 5-2: Expected Aquatic Macroinvertebrates within the MREA

Family names		
Turbellaria	Libellulidae	Hydrophilidae
Oligochaeta	Belostomatidae	Athericidae
Hirudinea	Corixidae	Ceratopogonidae
Potamonautidae	Gerridae	Chironomidae
Atyidae	Hydrometridae	Culicidae
Hydracarina	Naucoridae	Dixidae
Perlidae	Nepidae	Muscidae
Baetidae > 2 sp	Notonectidae	Simuliidae
Caenidae	Pleidae	Tabanidae
Heptageniidae	Veliidae/Mesoveliidae	Tipulidae
Leptophlebiidae	Ecnomidae	Ancylidae
Polymitarcyidae	Hydropsychidae > 2 sp	Planorbinae
Prosopistomatidae	Philopotamidae	Lymnaeidae
Tricorythidae	Hydroptilidae	Physidae
Chlorocyphidae	Leptoceridae	Planorbinae
Coenagrionidae	Dytiscidae	Corbiculidae
Aeshnidae	Elmidae	Sphaeriidae
Gomphidae	Gyrinidae	

Green shading = high requirement for moderate to high water quality; **Blue** shading = high requirement for fast-flowing water; **Yellow** = high requirement for both high water quality and flow velocity

The expected aquatic macroinvertebrate assemblage is largely composed of taxa with preference for slow flowing to moderately flowing water and low water quality dependence. Of the expected 53 taxa, only nine taxa have preference for *moderate to high* water quality and five taxa are dependent on fast-flowing water, whilst four taxa are dependent on both *moderate to high* water quality and fast-flowing water (DWS, 2014).

5.3. Expected Fish Species

The fish species expected in the reaches associated with the MREA have been provided for in Table 5-3 (DWS, 2014). Additionally, each species sensitivity ratings towards physio-

chemical and no-flow conditions have been provided for, together with their conservation status according to the IUCN Red List of Threatened Species (2018).

Following a review of available collection records of fish species occurring within the watercourses associated with the Project Area (including records from FBIS), a total of 12 fish species (excluding alien species) are expected to occur within the C22F, C22G and C22K catchments. Ten of the species are regarded as tolerant to modified water quality and eight are regarded as tolerant to no-flow conditions (DWS, 2014). According to Skelton (2001), all the species are indigenous to South Africa and their conservation status is regarded as Least Concern.

Table 5-3: Expected Fish Species in the reaches associated with the MREA

Species Name	Common Name	Modified Water Quality	No-Flow	Status
Austroglanis sclateri	Rock Catfish	2.6	3.2	LC
Labeobarbus aeneus	Smallmouth Yellowfish	2.5	3.3	LC
Enteromius anoplus	Chubbyhead Barb	2.6	2.3	LC
Enteromius pallidus	Goldie Barb	3.3	2.8	LC
Enteromius paludinosus	Straightfin Barb	1.8	2.3	LC
Enteromius trimaculatus	Threespot Barb	1.8	2.7	LC
Clarias gariepinus	Sharptooth Catfish	1.0	1.7	LC
Labeo capensis	Orange River Labeo	2.8	3.5	LC
Labeo umbratus	Moggel	1.6	2.7	LC
Labeobarbus kimberleyensis	Imberi	3.6	3.8	LC
Pseudocrenilabrus philander	Southern Mouthbrooder	1.4	1.0	LC
Tilapia sparrmanii	Banded Tilapia	1.4	0.9	LC
Tolerance: 1-2 = tolerant, 3-4 moderately tolerant; 4-5 = Intolerant; Red Shading = intolerant, Green shading = tolerant, Conservation Status: LC=Least Concern				

6. Results and Discussion

Each of the assessment indicators applied at the time of the present survey are discussed below and where possible, compared against data collected during a previous survey undertaken in 2018 by Golder Associates Africa . During the 2018 survey (Golder Associates Africa, 2019), the Vaal River and the Taaibosspruit reaches were assessed at points indicated in Figure 4-1.

6.1. *In situ* Water Quality

The *in-situ* water quality results of the wet season survey for the watercourses associated with the MREA are presented in Table 6-1 and further discussed in the sub-sections below.

Table 6-1: In situ Water Quality Results for Watercourses Associated with the MREA

Monitoring Site	COP1	COP2	COP3	COP4	COP5	Guideline
Temperature (°C)	23.5	23.6	24.8	24.5	DRY	5-30
pH	**8.08**	7.36	7.62	7.23		6-8
Conductivity (µS/cm)	162.3	**578.0**	166.5	131.5		≤500
Dissolved oxygen (mg/l)	7.61	**4.20**	7.03	**3.82**		>5
Dissolved oxygen (Saturation %)	97.1	**48.9**	83.5	**43.4**		80-120
Target Water Quality Range (TWQR), as described in **red** (DWAF, 1996; Nebeker, *et al.*, 1996; USEPA, 2010)						

For the purposes of the assessment, each of the values recorded during the survey were compared against various water quality guidelines originating each respective source:

- pH and saturation percentage guidelines obtained from Department of Water Affairs and Forestry (1996a);
- Conductivity guideline value of 500 µS/cm stipulated in U.S. Environmental Protection Agency (2010); and
- Dissolved oxygen concentration guideline for macroinvertebrates from Nebeker *et al*. (1996). And dissolved oxygen saturation for aquatic biota from Department of Water Affairs and Forestry (1996).

6.1.1. Temperature

Water temperature is an important abiotic factor in aquatic ecosystems, it influences organisms' growth, feeding and metabolic rates, emergence, fecundity and behaviour. Thus, all organisms have an optimum temperature range within which they survive. The temperatures of inland waters in South Africa generally range from 5-30 ^{o}C, which is the range within which most aquatic macroinvertebrates in southern Africa thrive (DWAF, 1996). Human-induced changes in temperature include (amongst others), water abstraction, heated return-flows of irrigation water; and discharge of water from impoundments (Department Of Water Affairs And Forestry, 1996).

Temperature values recorded at the assessed sites ranged from 23.5 ^{o}C to 24.8 ^{o}C, typical of the summer season temperatures in South Africa. Therefore, all recordings were within the expected temperature ranges of inland waters in the country, thus none of the assessed sites were expected to deter colonising aquatic biota.

6.1.2. pH

The pH value is a measure of hydrogen (H^+), hydroxyl (OH^-), bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) ions in water (Dallas & Day, 2004). The pH of natural water is determined by geological and atmospheric influences and may also vary both diurnally and seasonally. Diurnal fluctuations occur in productive systems, where the relative rates of photosynthesis and respiration vary over a 24-hour period.

The pH values recorded exhibited close to neutral to slightly alkaline conditions, ranging from 7.23 pH units to 8.08 pH units during the present study. The DWAF (1996) guideline upper limit of 8 pH units was slightly exceeded at Site COP1 only. While photosynthesis can alter the carbonate/bicarbonate equilibrium by removing CO_2 from the water, marginally elevated pH levels can be a characteristic of eutrophic systems nutrient levels are increased (DWAF, 1996). Consequently, this may be an indication of potential influx of excessive nutrient enrichment originating from fertiliser application on nearby farms. Nonetheless, this exceedance can be considered insignificant and not likely to deter existing aquatic biota, however this site must be closely monitored to prevent further increases in pH levels.

6.1.3. Electrical Conductivity

Electrical conductivity (conductivity) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence of total dissolved salts or dissolved compounds that carry an electrical charge. Conductivity in natural waters varies in part on the characteristics of geological formations which the water has been in contact with and the dissolution of minerals in soils and plant matter. Anthropogenic sources of increased dissolved salts include domestic and industrial effluent discharges and surface runoff from urban, industrial and cultivated areas (DWAF, 1996).

Conductivity values recorded during the present study were predominantly low and recorded within the recommended guideline of 500 µS/cm (USEPA, 2010) at all the sites ,except at Site COP2. Site COP2 lies along the Vaal River at a river crossing flanked by residential, industrial and mining areas in close proximity and as such, the water quality at this site is likely influenced by cumulative impacts. During the current survey, there was a pungent odour and solid waste disposal (i.e litter) was evident (Figure 6-1).

Figure 6-1: Solid waste observed at Site COP2 during the current survey

6.1.4. Dissolved Oxygen

Gaseous oxygen (O_2) from the atmosphere dissolves in water and is also produced in water by aquatic plants and phytoplankton. The maintenance of adequate dissolved oxygen (DO) concentrations is critical for the survival and functioning of the aquatic biota because it is required for the respiration of all aerobic organisms. Therefore, the DO concentration provides a useful measure of the health of an aquatic ecosystem.

Dissolved oxygen levels were predominantly low throughout the sampled sites, however only recorded below the recommended guidelines of 5 mg/l and 80% saturation (Nebeker *et al*., 1996; DWAF, 1996) at sites COP2 and COP4. A high abundance of marginal vegetation and some aquatic vegetation were observed at both sites COP2 and COP4 during the survey. Thus, dissolved oxygen at these sites was not expected to be below the recommended limit. This may therefore be attributed to a myriad of sources including anthropogenic activities stemming from the nearby residential, industrial and mining areas.

6.2. Aquatic and Riparian Habitat

Assessment of aquatic habitat within the Project Area was based largely on the application of recognised assessment indices at each of the selected sampling points, as well as associated reach within the assessed watercourses, namely the Index for Habitat Integrity (IHI). The IHI is a rapid, field-based, visual assessment of modifications to a number of pre-selected biophysical drivers (i.e. semi-quantitative) used to determine the PES or Ecological Category of associated instream and riparian habitats.

6.2.1. Index for Habitat Integrity

The IHI was completed on a desktop-level for each aquatic ecosystem considered in the present survey and populated with observations recorded during the field survey (Table 6-2).

Table 6-2: IHI Findings for the Watercourses Associated with the Proposed MREA

River system	Site	Habitat Component	IHI Score	Ecological Category	Major Impacts
Vaal River	COP1	Instream	56.5	**D**	Water quality deterioration due to nutrient enrichment stemming from the surrounding land use activities including farms and sewage treatment plants
		Riparian	56.7	**D**	Exotic vegetation encroachment following land disturbances/manipulation for mining and farming activities
	COP2	Instream	51.3	**D**	Water quality deterioration resulting from the surrounding land use activities including industrial, residential and mining areas
		Riparian	55.7	**D**	Exotic vegetation encroachment due to land disturbances/manipulation along the river banks
Taaibosspruit	COP3	Instream	61.8	**C**	Water quality deterioration stemming from the upstream farms. Erosion resulting in channel modification and increase in sedimentation
		Riparian	65.4	**C**	Exotic vegetation encroachment and bank erosion resulting in flow modification and water quality impacts
	COP4	Instream	61.8	**C**	Presence of exotic fauna. Erosion resulting in channel modification and increase in sedimentation.
		Riparian	66.4	**C**	Exotic vegetation encroachment and bank erosion resulting in flow modification and water quality impacts
	COP5	Instream	-	**N/A**	No instream habitat assessment could be undertaken at the time of the survey, as this stream was observed to be **dry**

River system	Site	Habitat Component	IHI Score	Ecological Category	Major Impacts
		Riparian	65.6	**C**	This site lies on an unnamed non-perennial tributary of the Taaibosspruit. Exotic vegetation encroachment resulting in channel and flow modifications
N/A = Not suitable for assessment					

The findings from the IHI assessments conducted during the current survey indicate that the habitat integrity along the assessed Vaal River reaches were *Largely Modified* (Ecological Category D) for both instream and riparian components. Major impacts of the instream habitat were water quality deterioration due to potential nutrient enrichment stemming from the surrounding land use activities including farms, mines, industries and residential areas. For the riparian habitat, major impacts include exotic vegetation encroachment as a result of land disturbances/manipulation.

Along the Taaibosspruit systems, the IHI assessments indicate that the habitat integrity were *Moderately Modified* (Ecological Category C) for both instream and riparian components. Major impacts of the instream habitat were exotic fauna and water quality deterioration stemming from anthropogenic activities at the surrounding farms. The alien fish species *Gambusia affinis* (mosquito fish) was sampled in high abundances along the Taaibosspruit reach. The riparian component was found to be impacted by exotic alien vegetation encroachment.

6.3. Aquatic Macroinvertebrate Assessment

The following sections provides insights into the available habitat that was sampled at each respective monitoring sites at the time of the current survey, as well as the South African Scoring System (SASS, Version 5) metrics obtained and the subsequent determination of the ecological condition of the observed assemblages in relation to reference conditions.

6.3.1. Invertebrate Habitat Assessment System

The IHAS (Version 2.2), developed by McMillan (1998), has routinely been used in conjunction with the SASS approach as a measure of variability in the quantity and quality of representative aquatic macroinvertebrate biotopes available during sampling. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores at assessed sampling sites, as its performance appears to vary between geomorphologic zones and biotope groups (Ollis *et al*., 2006). While no conclusion can be made regarding the accuracy of the index until further testing has been conducted, these potential limitations and/or shortfalls should be noted. Nevertheless, due to the value of basic instream habitat assessment data and its suitability for comparison of

available macroinvertebrate habitats between various sampling sites, an adapted IHAS approach was maintained during the interim period, excluding assessment of the '*surrounding physical stream condition*.'

Table 6-3 shows the adapted IHAS scores at the sites assessed during the current survey.

Table 6-3: IHAS values and Interpretation for the Sampled Sites

Site	IHAS Score (%)	Interpretation
COP1	47.3	**Poor**
COP2	23.6	**Poor**
COP3	41.8	**Poor**
COP4	50.9	**Poor**
COP5	DRY	

During the survey, the sampled sites were dominated by deep, still and/or slow-flowing water with marginal vegetation, sand and mud being the most prevalent biotopes along the Vaal River. Similarly, along the Taaibosspruit, the sampled sites were dominated by shallow to deep and slow-flowing water with marginal vegetation, sand and mud being the most prevalent biotopes. A lack of flow and depth variety, aquatic vegetation and the stones biotope was a common feature throughout the selected sampling sites, which may have attributed to their condition representing largely *Poor* habitat availability for aquatic macroinvertebrates.

Figure 6-2 shows the typical habitat and biotope availability at the assessed river systems.

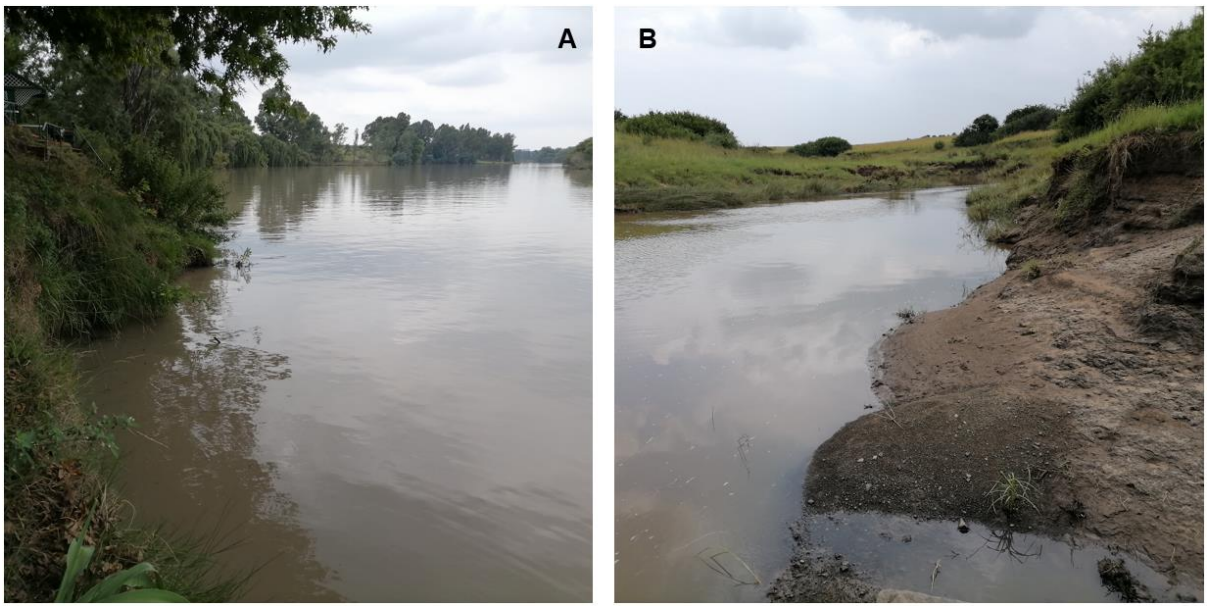

Figure 6-2: Photos Showing Typical Aquatic Habitat and Biotope Availability at the Assessed Systems. A – Vaal River and B – Taaibosspruit

Findings of the aquatic macroinvertebrate habitat availability at the Vaal River and the Taaibosspruit are consistent with those obtained in a 2018 survey (Golder Associates Africa, 2019), each of which also observed a *Poor* habitat availability.

6.3.2. Benthic Communities and Composition

Due to the differential sensitivities of aquatic macroinvertebrates, the composition of the aquatic macroinvertebrate community can provide an indication of changes in water quality and other ecological conditions within a watercourse. The use of the SASS has undergone numerous advances, culminating in Version 5 presently being utilised in river health studies along with the application of the MIRAI. Table 6-4 presents the SASS5 results for the assessed monitoring sites within the proposed MREA.

Table 6-4: SASS5 Data for the Sites Assessed during the Current Survey

Site	SASS5 Score	Number of Taxa	ASPT
Vaal River			
COP1	48	9	5.3
COP2	22	7	3.1
Taaibosspruit			
COP3	46	9	5.1
COP4	36	10	3.6
COP5	DRY		
ASPT = Average Score Per Taxon			

The SASS5 scores recorded for all assessed sites was regarded as low, especially in comparison to typical riverine ecosystems. The low macroinvertebrate diversity can be linked to the poor availability of macroinvertebrate habitat. A total of 20 macroinvertebrate taxa (out of the expected 53) were collected throughout the assessed sites, ranging from seven at the Vaal River downstream site (Site COP2) to 10 at the Taaibosspruit downstream site (Site COP4).

Table 6-5: SASS5 Data for the Sites Assessed during the 2018 Survey (Golder Associates Africa, 2019)

River	Site	No. of Taxa	SASS5 Score	ASPT
Kromellenboogspruit (KBS)	NWV1	*Dry*		
Taaibosspruit	NWV1a	15	53	3.5
	NWV7	10	34	3.4
	NWV9	17	72	4.2
Robspruit	NWV3	5	22	4.4
Vaal	NWV13	12	51	4.3
	NWV14	7	27	3.9

The aquatic macroinvertebrate community assemblages were predominantly composed of taxa that have *"low"* water quality requirements. Of the collected taxa, a single taxon with a "*high*" water quality requirement (Heptageniidae, - sensitivity score of 13) was collected at the Vaal River upstream site (Site COP1) and three taxa with a "*Moderate"* water quality requirement (Atyidae, Aeshnidae and Elmidae - sensitivity score of 8) were all collected at the Taaibosspruit upstream site (Site COP3).

In comparison to the 2018 survey (Golder Associates Africa, 2019), the sampled macroinvertebrate assemblages collected are variable. Table 6-5 presents the SASS5 data obtained in 2018, which generally correlates quite closely for each of the assessed site. These differences could be due to the timing of the surveys. The 2018 survey was undertaken in October.

6.3.3. Ecological Condition of the Aquatic Macroinvertebrate Assemblages

Although Chutter (1998) originally developed the SASS protocol as an indicator of water quality, it has since become clear that the SASS approach gives an indication of more than mere water quality, but also a general indication of the current state of the macroinvertebrate community. While SASS does not have a particularly strong cause-effect basis for interpretation, as it was developed for application in the broad synoptic assessment required for the old River Health Programme (RHP), the aim of the MIRAI is to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic macroinvertebrate community (assemblage) from the reference condition (Thirion, 2008). This does not preclude the calculation of SASS scores, but encourages the application of MIRAI assessment, even for River Health Programme purposes, as the preferred approach.

Accordingly, the SASS5 data obtained was used in the MIRAI (Thirion, 2008) to determine the Present Ecological State (PES, or Ecological Category) of the associated macroinvertebrate

assemblage. Results for the MIRAI at the assessed sites are shown in Table 6-6 and discussed below.

Table 6-6: MIRAI Data for the Assessed Sites

Site	MIRAI Value	Ecological Category	Description
Vaal River			
COP1	22.7	**E**	Seriously Modified
COP2	18.6	**E/F**	Seriously to Critically Modified
Taaibosspruit			
COP3	25.1	**E**	Seriously Modified
COP4	18.7	**E/F**	Seriously to Critically Modified
COP5	DRY		

The macroinvertebrate assemblage at the upstream sites of the assessed river systems, Site COP1 at the Vaal River and Site COP3 at the Taaibosspruit exhibited *Seriously Modified* conditions (Ecological Category E), whilst the downstream sites (Site COP2 and Site COP4) at the respective river systems exhibited *Seriously to Critically Modified* conditions (Ecological Category E/F).

Along the Vaal River, collected aquatic macroinvertebrate assemblages indicated that major changes from the reference assemblage were largely attributed to habitat dependence of the reference assemblage. Along the Taaibosspruit, collected macroinvertebrate assemblages indicated that major changes from the reference assemblage were largely due to flow dependence of the reference assemblage.

6.4. Ichthyofaunal Assessment

The use of fish as a means to determine ecological disturbance has many advantages (Zhou *et al.,* 2008). Fish are long living, respond to environmental modification, continuously exposed to aquatic conditions, often migratory and fulfil higher niches in the aquatic food web. Therefore, fish can effectively give an indication into the degree of modification of the aquatic environment. The electro-narcosis technique was applied to sample the available fish species within the Vaal River and Taaibosspruit reaches associated with the proposed MREA.

Eleven indigenous fish species were expected to occur within the Project Area, (see section 5.3; Table 5-3). The fish species collected during the present study are presented in Table 6-7 and discussed in the below sub-sections. It should be noted that sampling within the Vaal River sites and the Taaibosspruit downstream site was restricted to the marginal areas due to the non-wadeable depth presenting instream inaccessibility issues.

Table 6-7: Fish Collected (or Observed) within the Project Area

Fish Species	COP1	COP2	COP3	COP4	COP5
Austroglanis sclateri	-	-	-	-	DRY
Clarias gariepinus	-	-	-	1	
Enteromius anoplus	9	2	3	-	
Enteromius cf. pallidus	-	-	-	-	
Enteromius paludinosus	-	-	-	-	
Enteromius trimaculatus	-	-	-	-	
*Gambusia affinis**	6	-	15	70	
Labeo capensis	9	-	-	1	
Labeo umbratus	-	-	-	-	
Labeobarbus aeneus	3	-	-	-	
Labeobarbus kimberleyensis	-	-	-	-	
Pseudocrenilabrus philander	-	-	2	6	
Tilapia sparrmanii	-	-	-	3	
Number of Species	**4**	**1**	**3**	**5**	
Total Catch	**27**	**2**	**20**	**81**	

* Alien species. Values in parenthesis indicated observed specimens.

A total of seven fish species were collected (or observed), of which one was regarded as alien invasive species (*Gambussia affinis,* or Mosquitofish). Along the Vaal River sites, four species were collected at the upstream Site COP1, whilst a single species was observed at the downstream Site COP2. At the Taaibosspruit sites, three species were collected at the upstream Site COP3 and five species were collected at the downstream Site COP4. Two species (*E. anoplus* and *G. affinis*) dominated the assessed watercourses and were each collected at three of the four sites. The Mosquitofish was also the most abundant with a total catch of 91 specimens, most of which were collected at the Taaibosspruit downstream Site COP4.

The alien Mosquitofish (Figure 6-3) was introduced in South Africa as a mosquito control agent and forage for bass but has proved to be an aggressive invader species capable of restricting other fish populations by preying on fish larvae (Skelton, 2001). Its occurrence and dominance at Site COP4 can be attributed to its habitat requirements, which were suited at the time of the survey (i.e. standing or slow-flowing water with plant cover).

Figure 6-3: *Gambusia affinis* (Mosquitofish) collected within the assessed watercourses

Similarly to the 2018 survey (Golder Associates Africa, 2019), a total of seven fish species were collected, two of which were collected during the current survey and not during the previous survey (*Labeo capensis* and *Labeobarbus aeneus*).

6.4.1. Ecological Condition of the Fish Assemblages

The REMP uses the FRAI, which is based on the preferences of various fish species, as well as the frequency of occurrence. FRAI results for the sampled river reaches are shown in Table 6-8 and discussed below.

Table 6-8: FRAI Results for the Assessed Vaal River and Taaibosspruit Sites

Site	FRAI Score (%)	Ecological Category	Description
Vaal River			
COP1	48.9	**D**	Largely Modified
COP2	28.1	**E**	Seriously Modified
Taaibosspruit system			
COP3	36.4	**E**	Seriously Modified
COP4	51.8	**D**	Largely Modified
COP5	DRY		

A dominant feature among the current fish assemblage is the tolerance to modified water quality. The absence of the species *Enteromius pallidus* and *Labeobarbus kimberleyensis,* which are moderately intolerant to modified water quality suggests the impacted state of the

water quality associated with the sampled reaches within the Project Area. However, it should be noted that some sites lacked potential habitat for fish and sampling was restricted to the margins within the Vaal River sites and the Taaibosspruit downstream site.

FRAI results indicate *Largely Modified* conditions (Ecological Category D) at the Vaal River upstream Site COP1 and *Seriously Modified* conditions (Ecological Category E) at the downstream Site COP2. For the Taaibosspruit sites, FRAI results indicate *Seriously Modified* conditions (Ecological Category E) at the upstream Site COP3 and *Largely Modified* conditions (Ecological Category D) at the downstream Site COP4.

The biotic integrity for the previous assessment (Golder Associates Africa, 2019) ranged from *Moderately Modified* to *Seriously Modified* conditions (Ecological Category C to E) along the assessed Taaibosspruit sites and ranged from *Seriously Modified* to *Critically Modified* (Ecological Category E to F) conditions along the Vaal assessed sites.

6.5. Integrated EcoStatus Determination

The EcoStatus is defined as: "*The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services*" (Iversen *et al*., 2000). In essence, the EcoStatus represents an integrated ecological state representing the drivers (hydrology, geomorphology, physico-chemical) and responses (fish, aquatic invertebrates and riparian vegetation; Kleynhans & Louw, 2008). The Instream Biological Integrity, as well as the integrated EcoStatus, for the sampled river reaches within the Project Area were determined below.

Following integration of the defined ecological conditions obtained for the instream biological integrity (i.e. MIRAI from aquatic invertebrates) and the riparian component (i.e. IHI from riparian vegetation assessment), it was determined that the sampled river reaches along the Vaal River and the Taaibosspruit systems represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

In relation to the Recommended Ecological Category (REC), the assessed sections of the Vaal River and the Taaibosspruit systems were observed to be below the stipulated Ecological Category of a B/C, as gazetted in April 2016 (*Classes and Resource Quality Objectives of Water Resources for Catchments of the Upper Vaal in Terms of Section 13(1)(A) and (B) of the National Water Act, 1998 (Act No.36 of 1998)*, 2016). It should be noted that the Integrated Unit of Analysis (IUA) referred to for the RECs was that of the Vaal River reach from Vaal Dam to C23L. The assessed Vaal River and the Taaibosspruit systems fall within the specified IUA.

Table 6-9: The PES of the reaches under study through the use of the ECOSTATUS4 (Version 1.02; Kleynhans & Louw, 2008)

Site	Response Indices				EcoStatus	
	MIRAI EC	FRAI EC	Instream EC	Riparian Vegetation EC (IHI)	Score	Category
Vaal River						
COP1	24.1	44.4	33.76	56.7	49.1	D
COP2	19.4	28.1	23.5	55.7	45	D
Taaibosspruit system						
COP3	25.1	36.4	30.7	65.4	53.8	D
COP4	19.2	47.3	33	61.8	52.2	D
COP5	-	-	-	65.6	N/A	

EC = Ecological Category; N/A = EcoStatus could not be determined due to missing instream data

7. Impact Assessment

Any development in a natural (or modified) system will impact on the surrounding environment, potentially in a negative way. The purpose of this section of the report is to identify and assess the significance of the impacts likely to arise during the proposed activity and provide a short description of the mitigation required to limit the magnitude of the potential impact of the proposed activity on the natural environment.

Focus of the impact assessment has been solely on the proposed MREA to include adjacent properties to extend the LoM (i.e. to continue mining general sand). The identified potential impacts that will negatively affect aquatic ecosystems are discussed below for the various phases of the Project (i.e. Establishment Phase, Operational Phase, as well as Closure and Decommissioning Phase).

For a detailed description of the Impact Assessment Criteria and Calculations used during the assessment below, the reader is referred to Appendix B.

7.1. Proposed Activities

Table 7-1 below provides the project activities to be considered as part of the impact assessment.

Table 7-1: Project Phases and Associated Activities

Activity No.	Activity
Establishment Phase	• Site clearance, soil disturbance and vegetation removal; • Placement of infrastructure (i.e. mobile offices, bunded 14,000 L hydrocarbon storage tank, waste storage and parking area); • Establishment of a haul road / tracks; and • Stockpiling of topsoil.
Operational Phase	• Mining of sand resources including screening (if required); • Transportation of sand; • Refuelling of machinery within the mining area; and • Handling of general and hazardous waste.
Closure and Rehabilitation Phase	• Backfilling of the mined excavations with topsoil and waste from the screening plants; • Dismantling and removal of infrastructure; and • Rehabilitation (topsoil cover, ripping and vegetation establishment).

7.2. Establishment Phase

Land manipulation and vegetation clearing associated with the proposed MREA is the main foreseeable aquatic-related impact associated with the Establishment Phase of the Project. There is also a risk of contaminants associated with construction activities and machinery entering the aquatic systems from the Project workings and storage sites.

7.2.1. Impact Description: Water and Habitat Quality Deterioration Associated with Soil Disturbance and Vegetation Clearing

Soil disturbance and vegetation clearance during removal of the topsoil and construction of a haul road will most likely increase surface runoff, erosion and subsequently the amount of suspended and dissolved solids, as well as pollutants (i.e. hazardous substances from the actual construction areas such as hydrocarbons, organic waste from lack of ablutions and domestic litter) entering the associated watercourses. This has the potential to negatively affect the water and habitat quality within the associated watercourses.

Erosion of land in association with natural aquatic ecosystems will not only modify the morphology of the systems (e.g. channel and bank modifications), but also has the potential to impact on aquatic-related habitat which, in turn, has the potential to alter biological community structure. Erosion and runoff into the associated aquatic ecosystems can result in the sedimentation of habitat and overall increase in suspended solids content. This can directly alter aquatic habitats after deposition (Wood & Armitage, 1997), which in turn will negatively impact biotic community structure by displacing biota that favour the affected habitat.

Suspended solids can also directly impact aquatic biota through the accumulation of silt on respiratory organs (i.e. gills) and by decreasing visibility (i.e. increasing turbidity) which will affect feeding habits of specific taxa.

Erosion and runoff from cleared land can also alter water quality by increasing turbidity, as aforementioned, and by increasing the number of contaminants entering the watercourses from the surrounding landscapes, such as fertilisers/nutrients and unearthed metals. This is expected to alter the physio-chemistry of water and deter water quality sensitive biota.

7.2.1.1. *Management Objectives*

The main objective for mitigation would be to limit the areas proposed for disturbance/vegetation clearance combined with keeping as far as possible from the banks of associated watercourses.

7.2.1.2. *Management Actions*

General mitigation actions provided in the wetlands and surface water studies conducted by Digby Wells should be used to guide the effective management of aquatic resources potentially affected by the MREA. However, more specific management actions for the Establishment Phase are listed below:

- Limit vegetation removal to the infrastructure and mining footprint area only. Where removed or damaged, vegetation areas (riparian or aquatic related) should be revegetated as soon as possible;
- Bare land surfaces downstream of construction activities must be vegetated to limit erosion from the expected increase in surface runoff from infrastructure;
- Environmentally friendly barrier systems, such as silt nets or, in severe cases, use trenches downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses;
- Construction chemicals, such as hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions;
- All vehicles must be frequently inspected for leaks;
- No material may be dumped or stockpiled within any rivers, drainage lines in the vicinity of the proposed project;
- All waste must be removed and transported to appropriate waste facilities; and
- High rainfall periods (usually November to March) should be avoided during the Establishment of infrastructure to possibly avoid increased surface runoff in attempt to

limit erosion and the entering of external material (i.e. contaminants and/or dissolved solids) into associated aquatic systems.

7.2.1.3. *Impact Ratings*

Table 7-2 presents the impact ratings associated with land and vegetation clearing impacts predicted for the Establishment Phase of the MREA. It must be noted that the ratings have been determined based on the observations during the survey.

Table 7-2: Impact assessment ratings for the Establishment Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Site clearance and establishment of proposed infrastructure in proximity to the watercourses.			
Impact Description: Sedimentation and water quality deterioration			
Prior to Mitigation/Management			
Duration	Project life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until project closure.	Minor (negative) – 60
Extent	Local (3)	Based on the proximity of the proposed MREA to the Vaal River and Taaibosspruit, the extent of runoff is expected to extend to the respective catchment.	
Intensity x type of impact	Moderately high - Negative (-4)	Effects to biological or physical resources is expected to occur within immediate proximity and potentially impact on downstream reaches.	
Probability	Probable (5)	Due to the gentle slope between the MREA and the Vaal River and Taaibosspruit, the impact is likely to be significant during high-flow season only.	
Nature	Negative		
Post-Mitigation			
Duration	Project Life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until the closure phase of the Project or removal of the infrastructure.	Negligible (negative) – 24

Dimension	Rating	Motivation	Significance
Extent	Limited (2)	Following mitigation actions and if high rainfall periods are avoided for construction, impacts will be limited to immediate surroundings.	
Intensity x type of impact	Minor - Negative (-2)	If mitigation measures are all incorporated for the Establishment Phase, the intensity of the impact should be low.	
Probability	Unlikely (3)	The likelihood of the impact occurring at the surrounding watercourses is reduced by the mitigation actions and should only result in extreme cases or unexpected rainfall events.	
Nature	Negative		

7.3. Operational Phase

A major foreseeable impact associated with the Operational Phase of the Project is increased runoff, seepage and chemical leaks possibly resulting in erosion, sedimentation and water quality deterioration because of bare surfaces.

7.3.1. Impact Description: Water Quality and Habitat Deterioration Associated with Runoff, Seepage and Leaks from the Operational Areas of the Project

Like the impacts described for the Establishment Phase, runoff from the mining areas and seepage/leaks has the potential to increase flow rates, sediment input, erosion and contaminants in the associated watercourses. These influences will directly impact on water quality and aquatic habitat which in turn will negatively affect the aquatic biota.

Stormwater and water used on site has the potential to directly alter habitat and the morphology of the receiving aquatic ecosystems if allowed to flow freely from the MRA (e.g. through sedimentation). Uncontrolled runoff also has the potential to alter water chemistry and degrade water quality of the affected systems by collecting contaminants as it drains across the associated landscapes. This will consequently affect the aquatic ecology and water quality.

7.3.1.1. *Management Objectives*

Water should not be allowed to flow freely from the operational areas. As proposed, dirty water or water runoff from mine related infrastructure should be controlled and utilised as intended.

7.3.1.2. *Management Actions*

The following management actions are recommended to guide the effective management of stormwater and water generated on site:

- Runoff should not be allowed to flow into the nearby watercourses, unless DWS discharge authorisation and compliance with relevant discharge standards, as stipulated in the NWA is obtained;
- Bare surfaces downstream from the developments where silt traps are not an option should be vegetated in order to attempt to limit erosion and runoff that might be carrying contaminants;
- Careful monitoring of the areas where dust suppression is proposed should be undertaken regularly. Areas concentrating water runoff should be addressed and not allowed to flow freely into associated watercourses; and
- Biannual biomonitoring of the associated water courses should be done by an aquatic specialist to determine potential impacts, where after new mitigation actions should be implemented, as per the specialist's recommendations.

7.3.1.3. *Impact Ratings*

Table 7-3 presents the impact ratings determined for the potential runoff, seepage and leaks from the proposed infrastructure and associated activities.

Table 7-3: Impact Assessment Ratings for the Operational Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Uncontrolled runoff of stormwater from or through the surface infrastructure and mining area			
Impact Description: Water quality and habitat deterioration of watercourses receiving unnatural/contaminated runoff			
Prior to Mitigation/Management			
Duration	Project Life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until the closure phase of the Project or removal of the infrastructure.	Minor (negative) – 70
Extent	Catchment (4)	Based on the proximity of the proposed MREA to the Vaal River and Taaibosspruit, the extent of runoff is expected to extend to the respective catchment.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	High - Negative (-5)	Runoff, seepage and or leakage into watercourses is expected to impact functioning of the aquatic ecosystems.	
Probability	Likely (5)	The impact is likely to occur throughout the life of the Project but limited due to periodic rainfall events.	
Nature	Negative		
Post-Mitigation			
Duration	Short term (2)	Implementation of a concurrent rehabilitation during the mining process will significantly reduce impacts onto associated watercourses.	Negligible (negative) – 12
Extent	Very limited (1)	Runoff will most likely be largely restricted and captured after mitigation.	
Intensity x type of impact	Minimal to no loss - Negative (-1)	If mitigation measures are all incorporated for the Project, the intensity of the impact should decrease. However, contaminants are more difficult to manage compared to solid particles and may enter associated aquatic systems resulting in water quality deterioration.	
Probability	Unlikely (3)	The likelihood of the impact occurring is reduced by the mitigation actions and should only result in extreme rainfall events or if mitigation structures aren't maintained.	
Nature	Negative		

7.4. Closure, Decommissioning and Rehabilitation Phase

This phase entails removal of mine related infrastructure, as well as rehabilitation of potentially affected areas and aquatic ecosystems, including some level of landscaping to avoid pooling and changes to catchment drainage patterns.

7.4.1. Impact Description: Removal of Infrastructure in Proximity to Watercourses

Disturbance of aquatic ecosystems, using heavy machinery, will most likely result in erosion and increased runoff in the areas near or in the associated watercourses. Water runoff during these activities may also be of poor quality which will also result in the deterioration of the quality of the affected ecosystems. Dirty water entering natural aquatic ecosystems from the Decommissioning activities and associated areas have the potential to alter water chemistry and degrade water quality of the affected systems. This will consequently affect the aquatic ecology and aquatic biota.

7.4.1.1. *Management Objectives*

The main management objective should be to restore any affected areas to natural/reference conditions without resulting in additional downstream impacts throughout the process.

7.4.1.2. *Management Actions*

The goal of mitigation should be to limit erosion and runoff from the footprint of the areas/infrastructure during Decommissioning as well as during rehabilitation. The following measures may be utilised in attempt to reduce the Decommissioning impacts:

- Removed or damaged vegetation areas should be revegetated;
- Storm water must be diverted from Decommissioning activities;
- Water used during Decommissioning should be kept onsite and not be allowed to freely flow into nearby watercourses; and
- Ensure the revegetation activities use appropriate indigenous plant species.

7.4.1.3. *Impact Ratings*

The impact rating associated with activities related to the removal of surface infrastructure and rehabilitation of potentially affected areas have been predicted in Table 7-4 below.

Table 7-4: Impact assessment ratings for the Decommissioning/Rehabilitation Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Physical removal of surface infrastructure and rehabilitation activities near and within drainage lines			
Impact Description: Water quality and habitat deterioration of watercourses in contact with heavy machinery and receiving runoff from surface workings			
Prior to Mitigation/Management			
Duration	Short term (2)	The impact will only occur during Decommissioning and until rehabilitation is complete.	Minor (negative) – 55

Dimension	Rating	Motivation	Significance
Extent	Catchment (4)	Based on the proximity of the proposed MREA to the Vaal River and Taaibosspruit, the extent of runoff is expected to extend to the respective catchment.	
Intensity x type of impact	High - Negative (-5)	Runoff into watercourses is expected to result in erosion, increased sedimentation and contamination impacting functioning of the aquatic ecosystems.	
Probability	Likely (5)	The impact is likely to occur throughout the Decommissioning Phase but limited due to periodic rainfall events.	
Nature	Negative		
Post-Mitigation			
Duration	Short Term (2)	Concurrent rehabilitation will ensure Impacts only persist for a short term.	Negligible (negative) – 12
Extent	Very limited (1)	If mitigation measures are adhered to, especially working in the dry season, runoff is expected to be restricted to the mitigation structures.	
Intensity x type of impact	Minimal to no loss - Negative (-1)	If mitigation measures are all incorporated for the Project, the intensity of the impact should decrease notably especially after rehabilitation.	
Probability	Unlikely (3)	The likelihood of the impact occurring is reduced by the mitigation actions and should only result in extreme rainfall events or if mitigation structures are not maintained.	
Nature	Negative		

7.5. Cumulative Impacts

The MREA lies downstream of the Vaal Dam within a watershed draining the Vaal River and Taaibosspruit catchments flanked by agriculture fields, mining/Industrial zones, and residential

areas, such as Vereeniging, Vanderbijlpark and Sasolburg. Consequently, current activities already appear to potentially impact on the identified aquatic ecosystems.

It is suspected that additional impacts associated with the proposed expansion areas will significantly contribute towards any notable changes to the ecological integrity of the Vaal River and Taaibosspruit systems, especially following the implementation of proposed mitigation measures.

7.6. Unplanned and Low Risk Events

There is a risk that watercourses associated with the MREA operations and infrastructure throughout the Project Life might be affected by the entry of hazardous substances, such as hydrocarbons. Spillage and/or accidents, or deterioration of structures along the roadways, might affect the habitat and water quality of associated aquatic ecosystems.

Therefore, Table 7-5 outlines mitigation measures that must be adopted in the event of unplanned impacts throughout the life of the Project.

Table 7-5: Unplanned events and Associated Mitigation Measures

Unplanned Risk	Mitigation Measures
Chemical and (or) contaminant spills from machinery and associated activities.	• Ensure correct storage of all chemicals at operations as per each chemical's specific storage requirements (e.g. Material Safety Data Sheets); • Ensure staff involved at the proposed developments have been trained to correctly work with chemicals at the sites; and • Ensure spill kits (e.g. Drizit) are readily available at areas where chemicals are known to be used. Staff must also receive appropriate training in the event of a spill, especially near watercourses/drainage lines.

8. Environmental Management Plan

This section provides a summary of the proposed project activities, environmental aspects and impacts on the receiving surface waterbodies. The frequency of mitigation, timing of implementation, the roles and responsibilities of persons implementing the EMP are summarized (Table 8-1).

Table 8-1: Environmental Management Plan

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
• Site clearing; • Access and haul road construction; • Topsoil stockpiling; and • Loading, transport, tipping and spreading of materials	• Siltation of water resources due to increased turbidity from dust and soil erosion; and • Water contamination due to leaks or spills of hazardous and hydrocarbon containing material	Water Quality	Establishment	• Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones; • If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments, dust generation and hazardous substances from construction vehicles used during site clearing; • Bare land surfaces downstream of construction activities must be vegetated to limit erosion from the expected increase in surface runoff from infrastructure; • Environmentally friendly barrier systems, such as silt nets or, in severe cases, use trenches downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction; • No material may be dumped or stockpiled within any rivers, drainage lines in the vicinity of the proposed project; • All waste must be removed and transported to appropriate waste facilities; Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills; • All vehicles must be frequently inspected for leaks; • Vehicles should regularly be maintained as per the developed maintenance program. These should also be inspected daily before use to ensure there are no leakages underneath; • Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses; • Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors; and • Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow.	Storm water management: Control contamination of receiving waterbodies by consideration of potential contamination sources and strategic Decommissioning to minimize on potential environmental impacts	During the Establishment and Operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
• Stockpiling; • Diesel storage; • Movement of vehicles and mine machinery; and • Storage, handling and treatment of hazardous products (including fuel and oil) and waste	• Siltation of water resources due to increased turbidity from dust and soil erosion; and • Water contamination due to leaks or spills of hazardous and hydrocarbon containing material.	Surface Water Quality and Quantity	Operational	• The water quality monitoring program provided in this report should be adhered to for monitoring water resources within and in close proximity to the Project Area to allow detection of any contamination arising from operational activities; • Runoff should not be allowed to flow into the nearby watercourses, unless DWS discharge authorisation and compliance with relevant discharge standards, as stipulated in the NWA is obtained; • Channelled water should not be dispersed in a concentrated manner. Baffles should be incorporated into artificial drainage lines/channels around the surface infrastructure to decrease the kinetic energy of water, as it flows into the natural environment; • Bare surfaces downstream from the developments where silt traps are not an option should be vegetated in order to attempt to limit erosion and runoff that might be carrying contaminants; • Careful monitoring of the areas where dust suppression is proposed should be undertaken regularly. Areas concentrating water runoff should be addressed and not allowed to flow freely into associated watercourses; • The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites; • The overall housekeeping and storm water system management (including the maintenance of berms and clean-up of leaks) must be maintained throughout the LoM; • The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances; • Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended; and • Vehicles must only be serviced within designated service bays.	Implementation of the proposed stormwater management plan will control the impacts by mitigating the impacts	During the Establishment and Operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
• Removal of infrastructure; and • Rehabilitation and closure.	• Siltation of water resources due to increased turbidity from soil erosion; and • Restoration of the pre-mining streamflow regime	Water Quality and Water quantity	Decommissioning	• Restore the topography to pre-mining conditions as much as is practically possible by backfilling, removing stockpiles and restore the slope gradient and angle of the site; • Clearing of vegetation should be limited to the Decommissioning footprint area and immediate revegetation of cleared areas is recommended; • Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas; • Movement of machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance; • Water used during Decommissioning should be kept onsite and not be allowed to freely flow into nearby watercourses; • Ensure the revegetation activities use appropriate indigenous plant species; and • Use of accredited contractors for removal of infrastructure during Decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages.	Storm water management: Control contamination of receiving waterbodies by consideration of potential contamination sources and strategic Decommissioning to minimize on potential environmental impacts	During the Decommissioning phase

9. Monitoring Programme

An aquatic biomonitoring programme has been developed for the monitoring and preservation of the aquatic ecosystems assessed for the Project. This programme is aimed at better determining the ecological health of the ecosystems, as well as to act as an early detection tool for impacts that might severely affect the expected aquatic biota in the associated riverine systems.

Table 9-1 outlines the aquatic monitoring methods to be undertaken at the monitoring points set out above (see section 4.3) on a biannual basis by a suitably qualified aquatic ecologist. It is recommended that an additional site immediately below the MRA along the Vaal River is monitored to determine potential impacts stemming from the Project. The annual programme comprises of a single survey during the dry season (or low flow season) for the Project Area and a single survey during the wet season (or high flow) at the monitoring points indicated. This will determine the PES for the assessed aquatic ecosystems which will further determine whether the proposed Project is impacting the associated aquatic ecology and to what extent.

Table 9-1: Biomonitoring Programme

Method and Aquatic Component of Focus	Details	Goal/Target	REC
Water Quality: In situ water testing focusing on temperature, pH, conductivity and oxygen content.	Water quality should be tested on a biannual basis at each monitoring site to determine the extent of change from baseline results.	No noticeable change from determined baseline* water quality for each respective season	Salt concentrations must be at levels that do not threaten the ecosystem and are suitable for users. Dissolved organic carbon concentrations must not cause the ecosystem to become unsustainable. The river water must not be toxic to aquatic organisms or be a threat to human health. Pathogens must be at levels safe for human use (excluding for direct consumption).

Method and Aquatic Component of Focus	Details	Goal/Target	REC
Habitat Quality: Instream and riparian habitat integrity; and Availability/suitability of macroinvertebrate habitat at each monitoring site.	The application of the IHI should be done for the Vaal River and the Taaibosspruit systems; The IHAS must be applied at each monitoring site prior to sampling.	The Ecological Category determined for each assessed site must be improved for the watercourses under study); and The baseline IHAS scores should improve.	Must be in a Moderately Modified or better condition ≥ C (≥ 62)
Aquatic Macroinvertebrates: Aquatic Macroinvertebrate assemblages must be assessed biannually.	This must be done through the application of the latest SASS5, incorporated with the application of the MIRAI as outlined in this Aquatic Study.	The baseline SASS5 scores should not noticeably deteriorate; and Baseline Ecological Categories should not be allowed to drop in category for each assessed site.	Must be in a Moderately Modified or better condition ≥ C (≥ 62)
Fish: Fish assemblages must be assessed biannually	Sampling of fish must be undertaken by utilising various methods such as cast nets in addition to the standard electro-narcosis techniques for the inaccessible deeper sites.	Baseline Ecological Categories should not be allowed to drop in category for each assessed site. The main goal for the Project must be to conserve the expected sensitive and conservation important species.	Must be in a Moderately Modified or better condition ≥ C (≥ 62)
***REC = Recommended Ecological Category**			

The Project should not commence without inclusion of the above Aquatic Biomonitoring Programme into the EA.

10. Stakeholder Engagement Comments Received

The consultation process affords Interested and Affected Parties (I&APs) opportunities to engage in the EIA process. The objectives of the Stakeholder Engagement Process (SEP) include the following:

- To ensure that I&APs are informed about the Project;
- To provide I&APs with an opportunity to engage and provide comment on the Project;
- To draw on local knowledge by identifying environmental and social concerns associated with the Project;
- To involve I&APs in identifying methods in which concerns can be addressed;
- To verify that stakeholder comments have been accurately recorded; and
- To comply with the legal requirements.

The Public Participation Process (PPP) has been completed in part, as a process separate to the EIA. No formal consultation was undertaken as part of this assessment. Should any I&AP comments be submitted in relevance to the watercourses associated with the proposed Project during the SEP, these will be considered in the final EIA report.

11. Conclusion and Way Forward

Amongst the water quality results, the pH values recorded exhibited close to neutral to slightly alkaline conditions, with a single site exceeding the recommended guideline, Site COP1 which is located along the Vaal River upstream of the proposed MREA. The recorded alkaline pH was likely attributed to the use of chemicals/fertilizers at the surrounding farms. Conductivity values were predominantly low, only Site COP2 recorded above the recommended guideline. This site lies along the Vaal River at a river crossing flanked by residential, industrial and mining areas in close proximity, as such, the water quality at this site is likely influenced by cumulative impacts. Dissolved oxygen levels were predominantly low throughout the sampled sites, however, only recorded below the recommended guidelines at sites COP2 and COP4 (downstream site at the Taaibosspruit). A high abundance of marginal vegetation and some aquatic vegetation were observed at both sites COP2 and COP4 during the survey, therefore the low dissolved oxygen at these sites may have been attributed to a myriad of sources including anthropogenic activities stemming from the nearby residential, industrial and mining areas.

The findings from the Index for Habitat Integrity assessments conducted during the current survey indicate that the habitat integrity along the assessed Vaal River reaches was *Moderately Modified* (Ecological Category C) and *Largely Modified* (Ecological Category D) at the assessed Taaibosspruit reaches. Major impacts of the instream habitat were water quality

deterioration and exotic fauna. Residential areas including the surrounding mining and farming activities observed at the time of the survey, are potential sources for these impacts.

The availability of aquatic macroinvertebrate biotopes was predominantly *Poor* across the sampled river reaches. The sites were dominated by deep, still and/or slow-flowing water with marginal vegetation, sand and mud being the most prevalent biotopes along the Vaal River. Similarly, along the Taaibosspruit, the sampled sites were dominated by shallow to deep and slow-flowing water with marginal vegetation, sand and mud being the most dominant biotopes. Similarly, the results of the South African Scoring System version 5 (SASS5) and Macroinvertebrate Response Assessment Index (MIRAI) indicate that conditions at the sampled reaches ranged between *Seriously Modified* (Ecological Category E) and *Seriously to Critically Modified* (Ecological Category E/F) with macroinvertebrate community assemblages largely composed of taxa that have "*Low"* water quality requirements.

Results of the fish community assessment indicated that the sampled River Reaches ranged from *Largely Modified* (Ecological Category D) conditions at the upstream sites to *Seriously Modified* condition (Ecological Category E) conditions at the downstream sites. Five fish species were collected (or observed), of which one was regarded as alien invasive species (*Gambussia affinis* or Mosquitofish). Along the Vaal River, three species were recorded whilst six species were recorded at the Taaibosspruit. A dominant feature among the sampled fish assemblage is the tolerance to modified water quality. The absence of the species *Enteromius pallidus* and *Labeobarbus kimberleyensis,* which are moderately intolerant to modified water quality suggests the impacted state of the water quality associated with the sampled reaches within the Project Area.

Following integration of the defined ecological conditions obtained for the instream biological integrity and the riparian component, it was determined that all assessed sites represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

11.1. Reasoned Opinion Whether Project Should Proceed

In light of the distances and gentle slope between the proposed MREA boundary and the Vaal River and Taaibosspruit, potential negative impacts are likely to occur following heavy rainfall events. Furthermore, impacts of the proposed MREA onto the associated water courses are predicted to be *Negligible* upon implementation of mitigation measures.

No notable fatal flaws were identified during the current study, thus the proposed MREA may proceed with an immediate implementation of the mitigation measures and the aquatic biomonitoring programme must be adhered to throughout the Operation and Decommissioning phases to ensure no deterioration of the associated watercourses occur.

11.2. Recommendations

Based on the results of the current study, the following actions have been recommended to allow for commencement of the proposed Project:

- The depth of the Vaal River presents challenges in sampling the instream habitat, therefore, diatom assemblage assessments should be undertaken to provide a better indication of the PES and determine the potential drivers of change; and
- The developed Aquatic Biomonitoring Programme must be adopted on an annual basis after commencement of the Establishment Phase of the Project. This programme should continue for the life of the Project and for at least three years post the Decommissioning Phase.

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Appendix A: Site Photographs

COP1

COP2

COP3

COP4

COP5

Appendix B: Methodology

13. Baseline Methodology

Descriptions of the various approaches for the determination of the aquatic ecology baseline are detailed in the respective sections below.

13.1. Water Quality

Selected *in-situ* water quality variables were measured at each of the sampling sites using water quality meters manufactured by Extech Instruments, namely an ExStik EC500 Combination Meter and an ExStik DO600 Dissolved Oxygen Meter. Temperature, pH, electrical conductivity and dissolved oxygen were recorded prior to sampling, while the time of day at which the measurements were assessed was also noted for interpretation purposes.

13.2. Habitat Quality

The availability and diversity of aquatic habitat is important to consider in assessments due to the reliance and adaptations of aquatic biota to specific habitats types (Barbour *et. al*., 1996). Habitat quality and availability assessments are usually conducted alongside biological assessments that utilise fish and macroinvertebrates. Aquatic habitat will be assessed through visual observations on each river system considered.

13.3. Index for Habitat Integrity

The IHI (Version 2, Kleynhans, C.J., pers. comm., 2015) aims to assess the number and severity of anthropogenic perturbations along a river/stream/wetland and the potential inflictions of damage toward the habitat integrity of the system (Dallas, 2005). Various abiotic (e.g. water abstraction, weirs, dams, pollution, dumping of rubble, etc.) and biotic (e.g. presence of alien plants and animals, etc.) factors are assessed, which represent some of the most important and easily quantifiable, anthropogenic impacts upon the system (Table 13-1).

As per the original IHI approach (Kleynhans, 1996), the instream and riparian components were each analysed separately to yield two separate ecological conditions (i.e. Instream and Riparian components). However, it should be noted that the data for the riparian area is primarily interpreted in terms of the potential impact upon the instream component and as a result, may be skewed by a potentially deteriorated instream condition.

While the recently upgraded index (i.e. IHI-96-2; Dr. C. J. Kleynhans, pers. comm., 2015) replaces the aforementioned comprehensive and expensive IHI assessment model developed by Kleynhans (1996), it is important to note that the IHI-96-2 does not replace the IHI model developed by Kleynhans *et al.* (2008a) which is recommended in instances where an abundance of data is available (e.g. intermediate and comprehensive Reserve Determinations). Accordingly, the IHI-96-2 model is typically applied in cases where a relatively few numbers of river reaches need to be assessed, the budget and time provisions are limited, and/or any detailed available information is lacking (i.e. rapid Reserve Determinations and for REMP/RHP purposes).

Table 13-1: Descriptions of criteria used to assess habitat integrity (Kleynhans, 1996; cited in Dallas, 2005)

Factors	Relevance
Water abstraction	Direct impact upon habitat type, abundance and size. Also impacted in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in the temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included
Water quality modification	Originates from point and diffuse sources. Measured directly, or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Alien/Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Alien/Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous

Factors	Relevance
	organic matter input will also be changed. Riparian zone habitat diversity is also reduced
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the riverbank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

In accordance with the magnitude of the impact created by the abovementioned criterion, the assessment of the severity of the modifications was based on six descriptive categories ranging between a rating of 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact; Table 13-2). Based on available knowledge of the site and/or adjacent catchment, a confidence level (high, medium, low) was assigned to each of the scored metrics.

Given the subjective nature of the scoring procedure utilised within the general approach to habitat integrity assessment (including IHI-96-2; see Appendix A), the most recent version of the IHI application (Kleynhans *et al.,* 2008) and the Model Photo Guides (Graham & Louw, 2008) were used to calibrate the severity of the scoring system. It should be noted that the assessment was limited to observed and/or suspected impacts present within the immediate vicinity of the delineated assessment units, as determined through the use of aerial photography (e.g. Google Earth) and observations made at each of the assessed sampling points during the field survey. However, in cases where major upstream impacts (e.g. construction of a dam, major water abstraction, etc.) were confirmed, potential impacts within relevant sections were considered and accounted for within the application of the method.

Table 13-2: Descriptive of scoring guidelines for the assessment of modifications to habitat integrity

Impact Category	Description	Score
None	No discernible impact or the factor is located in such a way that it has no impact on habitat quality diversity, size and variability.	0
Small	The modification is limited to a very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1 - 5
Moderate	The modification is present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6 - 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced	11 - 15

Impact Category	Description	Score
Serious	The modification is frequently present and the habitat quality, diversity, size and variability of almost the whole of the defined section are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity; the habitat quality, diversity, size and variability in almost the whole of the defined section are detrimentally influenced.	21 - 25

Each of the allocated scores was then moderated by a weighting system (Table 13-3), which is based on the relative threat of the impact to the habitat integrity of the riverine system. The total score for each impact is equal to the assigned score multiplied by the weight of that impact. The estimated impacts (assigned score / maximum score [25] X allocated weighting) of all criteria are then summed together, expressed as a percentage and then subtracted from 100 to determine the Present Ecological State score (PES; or Ecological Category) for the instream and riparian components, respectively.

Table 13-3: Criteria and weightings used to assess habitat integrity

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality modification	14	Water abstraction	13
Inundation	10	Inundation	11
Alien/Exotic macrophytes	9	Flow modification	12
Alien/Exotic aquatic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	100	TOTAL	100

However, in cases where selected instream component criteria (i.e. water abstraction, flow, bed and channel modification, water quality and inundation) and/or any of the riparian component criteria exceeded ratings of large, serious or critical, an additional negative weight was applied. The aim of this is to accommodate the possible cumulative effect (and integrated) negative effects of such impacts (Kemper, 1999). The following rules were applied in this respect:

- Impact = Large, lower the integrity status by 33% of the weight for each criterion with such a rating.
- Impact = Serious, lower the integrity status by 67% of the weight for each criterion with such a rating.
- Impact = Critical, lower the integrity status by 100% of the weight for each criterion with such a rating.

Subsequently, the negative weights were added for both facets of the assessment and the total additional negative weight subtracted from the provisionally determined integrity to arrive at a final habitat integrity estimate (Kemper, 1999). The eventual total scores for the instream and riparian zone components are then used to place the habitat integrity in a specific habitat integrity ecological category (Table 13-4).

Table 13-4: Ecological Categories for the habitat integrity scores

Ecological Category	Description	Score (% of Total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. A 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	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and there has been 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

13.4. Aquatic Invertebrate Assessment

13.4.1. Integrated Habitat Assessment System

Assessment of the available habitat for aquatic macroinvertebrate colonization at each of the sampling sites is vital for the correct interpretation of results obtained following biological assessments. It should be noted that the available methods for determining habitat quality are

not specific to rapid biomonitoring assessments and are inherently too variable in their approach to achieve consistency amongst users.

Nevertheless, the Invertebrate Habitat Assessment System (IHAS) has routinely been used in conjunction with the South African Scoring System, Version 5 (SASS5) as a measure of the variability of aquatic macroinvertebrate biotopes available at the time of the survey (McMillan, 1998). The scoring system was traditionally split into two sections, namely the sampling habitat (comprising 55% of the total score) and the general stream characteristics (comprising 45% of the total score), which were summed together to provide a percentage and then categorized according to the values in Table 13-5.

Table 13-5: Adapted IHAS Scores and associated description of available aquatic macroinvertebrate habitat

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

According to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores at assessed sampling sites, as its performance appears to vary between biotopes. However, the lack of reliability and evidence of notable variability within the application of the IHAS method has prompted further field validation and testing, which implies a cautious interpretation of results obtained until these studies have been conducted (Ollis *et al.,* 2006). In the interim and for the purpose of this assessment, the IHAS method was adapted by excluding the assessment of the aforementioned '*general stream characteristics*,' which resulted in the calculation of a percentage score out of 55 that was then categorised by the aforementioned Table 13-5. Consequently, the assessment index describes the quantity, quality and diversity of available macroinvertebrate habitat relative to an "ideal" diversity of available habitat.

13.4.2. South African Scoring System Version 5 (SASS5)

While there are a number of indicator organisms that are used within these assessment indices, there is a general consensus that benthic macroinvertebrates are amongst the most sensitive components of the aquatic ecosystem. This was further supported by their largely non-mobile (or limited mobility) within reaches of associated watercourses, which also allows for the spatial analysis of disturbances potentially present within the adjacent catchment area. However, it should also be noted that their heterogeneous distribution within the water resource is a major limitation, as this results in spatial and temporal variability within the collected macroinvertebrate assemblages (Dallas & Day, 2004).

SASS5 is essentially a biological assessment index which determines the health of a river based on the aquatic macroinvertebrates collected on-site, whereby each taxon is allocated a score based on its perceived sensitivity/tolerance to environmental perturbations (Dallas, 1997). However, the method relies on a standardised sampling technique using a handheld net (300 mm x 300 mm, 1000 micron mesh size) within each of the various habitats available for standardised sampling times and/or areas. Niche habitats (or biotopes) sampled during SASS5 application include:

- Stones (both in-current and out-of-current);
- Vegetation (both aquatic and marginal); and
- Gravel, sand and mud.

Once collection is complete, aquatic macroinvertebrates are identified to family level and a number of assemblage-specific parameters are calculated including the total SASS5 score, the number of taxa collected, and the Average Score per Taxa i.e. SASS5 score divided by the total number of taxa identified (Thirion *et al*., 1995); Davies and Day, 1998; (Dickens and Graham, 2002; Gerber and Gabriel, 2002). The SASS5 bio-assessment index has been proven to be an effective and efficient means to assess water quality impairment and general river health (Chutter, 1998; Dallas, 1997).

13.4.3. Macroinvertebrate Response Assessment Index (MIRAI)

In order to determine the Present Ecological State (PES; or Ecological Category) of the aquatic macroinvertebrates collected/observed, the SASS5 data was used as a basic input (i.e. prevalence and abundance) into the recently improved MIRAI (Version 2, Thirion. C., *pers. comm.*, 2015). This biological index integrates the ecological requirements of the macroinvertebrate taxa in a community (or assemblage) and their respective responses to flow modification, habitat change, water quality impairment and/or seasonality (C. Thirion, 2008). The presence and abundance of the aquatic macroinvertebrates collected are compared to a derived reference list of families/taxa that are expected to be present under natural, un-impacted conditions (i.e. prior to the effect of anthropogenic activities). Consequently, the three (or four) aforementioned metric groups utilised during the application were combined within the model to derive the ecological condition of the site in terms of aquatic macroinvertebrates (Table 13-6).

Table 13-6: Allocation protocol for the determination of the Present Ecological State for aquatic macroinvertebrates following application of the MIRAI

MIRAI (%)	Ecological Category	Description
90-100	**A**	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	**B**	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	**C**	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	**D**	Largely modified. Fewer species present then expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	**E**	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	**F**	Critically modified. Few species present. Only tolerant species present, if any.

13.5. Ichthyofaunal Assessment

Fish were collected by means of electro-narcosis (or electro-fishing), whereby an anode and a cathode are immersed in the water to temporarily stun fish in the near vicinity. Each of the collected fish specimens were identified in the field – using the "Complete Guide to the Freshwater Fishes of Southern Africa" (Skelton, 2001) – and released back into the river.

13.5.1. Fish Response Assessment Index

Assessment of the Present Ecological State (PES; or Ecological Category) of the fish assemblage of the watercourses associated with the Project Area was conducted by means of the FRAI (Kleynhans, 2008). This procedure is an integration of ecological requirements of fish species in an assemblage and their derived (or observed) responses to modified habitat conditions. In the case of the present assessment, the observed response was determined by means of fish sampling, as well as a consideration of species requirements and driver changes (Kleynhans, 2008). The expected fish species assemblage within the Project Area was derived from (Kleynhans *et al*., 2008) and aquatic habitat sampled.

Although the FRAI uses essentially the same information as the Fish Assemblage Integrity Index (FAII), it does not follow the same procedure. The FAII was developed for application in

the broad synoptic assessment required for the River Health Programme, and subsequently does not offer a particularly strong cause-and-effect basis. The purpose of the FRAI, on the other hand, is to provide a habitat-based cause-and-effect underpinning to interpret the deviation of the fish assemblage from the perceived reference condition (Kleynhans, 2008).

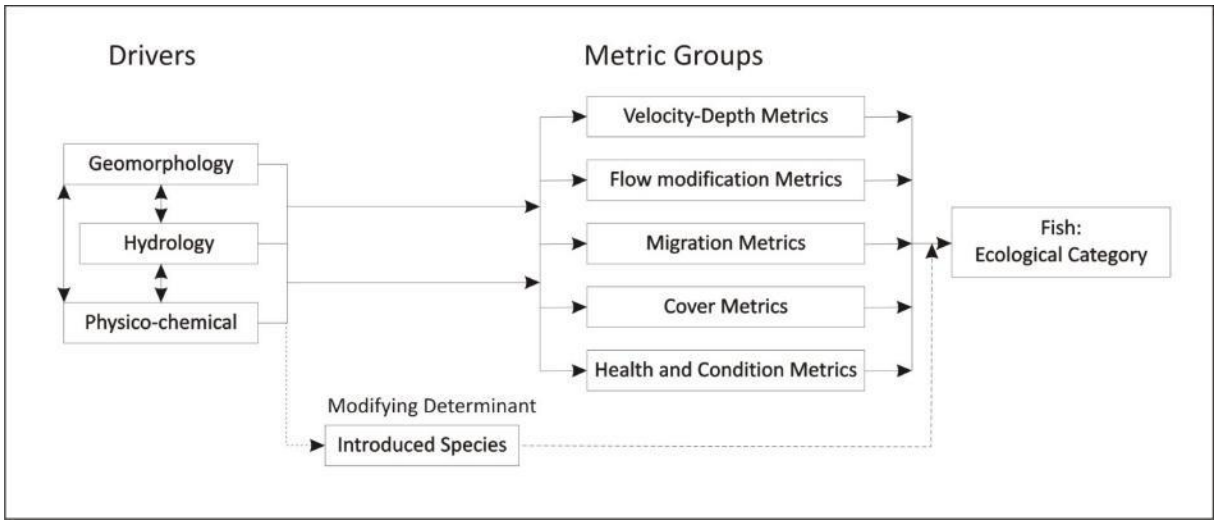

Figure 13-1: Relationship between drivers and fish metric groups

The FRAI is based on the assessment of selected metrics within metric groups, which are assessed in terms of:

- Habitat changes that are observed or derived;
- The impact of such habitat changes on species with particular preferences and tolerances; and
- The relationship between the drivers used in the FRAI and the various fish response metric groups, as are indicated in Figure 13-1. Table 13-7 provides the steps and procedures required for the calculation of the FRAI.

Table 13-7: Main steps and procedures followed in calculating the Fish Response Assessment Index

STEP	PROCEDURE
River section earmarked for assessment	As for study requirements and design
Determine reference fish assemblage: species and frequency of occurrence	• Use historical data & expert knowledge • Model: use ecoregional and other environmental information • Use expert fish reference frequency of occurrence database if available

STEP	PROCEDURE
Determine present state for drivers	• Hydrology • Physico-chemical • Geomorphology; or • Index of habitat integrity
Select representative sampling sites	Field survey in combination with other survey activities
Determine fish habitat condition at site	• Assess fish habitat potential Assess fish habitat condition
Representative fish sampling at site or in river section	• Sample all velocity depth classes per site if feasible • Sample at least three stream sections per site
Collate and analyse fish sampling data per site	Transform fish sampling data to frequency of occurrence ratings
Execute FRAI model	• Rate the FRAI metrics in each metric group • Enter species reference frequency of occurrence data • Enter species observed frequency of occurrence data • Determine weights for the metric groups • Obtain FRAI value and category • Present both modelled FRAI & adjusted FRAI.

Interpretation of the FRAI score follows a descriptive procedure in which the FRAI score is classified into a particular PES (or Ecological Category) based on the aforementioned integrity classes (Kleynhans, 1999). Each category describes the generally expected conditions for a specific range of FRAI scores (Table 13-8).

Table 13-8: Allocation protocol for the determination of the Present Ecological State (or Ecological Category) of the sampled/observed fish assemblage following application of the FRAI

FRAI (%)	Ecological Category	Description
90-100	**A**	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	**B**	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	**C**	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	**D**	Largely modified. Fewer species present then expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	**E**	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	**F**	Critically modified. Few species present. Only tolerant species present, if any.

13.6. EcoStatus4 1.02 Model

For the purpose of the present assessment, the latest ECOSTATUS4 1.02 model was used, which is an upgraded and refined version of the original ECOSTATUS4 model (Kleynhans & Louw,2008). The results obtained from the fish and aquatic macroinvertebrate response indices (i.e. FRAI and MIRAI) are to be integrated within the model to determine an Instream Ecological Category, whereas the riparian elements from the IHI-96-2 model can be used as a surrogate for the Riparian Ecological Category in the following manner (Dr. C.J. Kleynhans, *pers. comm.*, 2015):

Riparian Vegetation EC = 100-(((IHI 'Natural vegetation removal')+(IHI 'Exotic Vegetation Encroachment'))/50*100).

13.7. Impact Assessment Methodology

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 13-11. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 13-10, which is extracted from Table 13-9. The description of the significance ratings is discussed in Table 13-11.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 13-9: Impact Assessment Parameter Ratings

Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.

Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 13-10: Probability/Consequence Matrix

Probability	Significance																																				
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Consequence

Table 13-11: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)