Aquatic Assessment - Kalabasfontein Coal Mining Project Extension

Mpumalanga Province, South Africa

November 2018 (Amended July 2019)

CLIENT

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Report Name	**Aquatic Assessment - Kalabasfontein Coal Mining Project Extension**	
Reference	**Kalabasfontein – Aquatics (July 2019 Amendment)**	
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Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Ecological Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.	

EXECUTIVE SUMMARY

GNR 326	Appendix 6 (n): Specialist Opinion
Considering the findings of this assessment, it is the opinion of the specialist that the Kalabasfontein project with the current proposed infrastructure layout areas, may be favourably considered. The Kalabasfontein project area, although predominantly classed as moderately to largely modified, does have sensitivity to further modification and should be preserved throughout all phases of the project lifecycle. Due to the sensitivities of the project environment, and should authorisation be approved for this project, all mitigation measures and recommendations must be strictly adhered to	

Forzando Coal Mines (Pty) Ltd has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) to act as the independent Environmental Assessment Practitioner (EAP) to undertake the Environmental Impact Assessment (EIA) for the proposed Kalabasfontein project. An application for the amendment to the existing Mine Works Programme (MWP) and EMPR, through an MPRDA Section 102 Application, and a full EIA for the proposed new mining area is, therefore, required to support an application for environmental authorisation (EA). A water use licence application (WULA) for the relevant water use triggers associated with the proposed project will also be undertaken. The Biodiversity Company (TBC) was appointed by EIMS to conduct the riverine ecology and impact assessment for the proposed project.

The purpose of the specialist study is to provide relevant input into the EIA process and to provide a report for the proposed activities associated with mining and ancillary activities proposed to take place on site.

The results of the Present Ecological Status assessments indicated that the project area has been altered (historically and currently) predominantly by agricultural land use. The assessed Joubertsvleispruit river reach was classed as moderately modified (class C). Flow and instream habitat modification has resulted in modified biological responses. Instream habitat modification can be attributed to local agricultural activities. The assessed Viskuile River reach was classed as moderately to largely modified (class C/D). Water quality modification in the upper reaches of the watercourse compounded by modified flow in the reach resulted in the observation of modified aquatic ecology during the survey. The modification of the watercourse can be attributed to poor connectivity, agricultural activities and alteration of the river for water storage.

No red listed fish species were expected or sampled within the river reaches in the project area. However, a total of nine fish species, comprising five native, two translocated native and two alien invasive species were captured during this study. The fish community structures are largely intact, despite introductions of additional species. This diversity is indicative of the importance of these systems to collectively provide refugia and corridors for dispersal throughout the project area. Despite modification, the preservation of these systems is of importance for the consideration of the proposed mining project.

Owing to the absence of typical riparian features, no riparian delineation could be completed for the project area. The delineation of the wetland areas which were associated with the watercourse would therefore suffice for this study.

Underground mining requires the placement of new infrastructure (ventilation shaft, powerline and infrastructure associated with new underground area) for the associated mining activities in the project area. These activities will have a significant impact on the local environment and ecological processes. Both of the proposed infrastructure areas (underground area and powerline/ventilation shafts area) at Kalabasfontein are situated in proximity to, underlay or traverse watercourses considered sensitive to further modification.

Careful consideration must be afforded each of the recommendations provided in this report. In the event that environmental authorisation is issued for this project, proven ecological (or environmental) controls and mitigation measures must be entrenched in the management framework. It is recommended that the existing aquatic biomonitoring plan be reassessed to ensure that it is comprehensive and covers all associated project areas prior to the issuing of any environmental authorisation.

The following recommendations were reached based on the results of this assessment:

- The Resource Quality Objectives for the Water Management Area should be complied to, with the aim to meet the default and recommended ecological category (REC) of moderately modified (class C) for the project area watercourses;
- The primary recommended mitigation measure for this project is to ensure that an appropriate, proactive and adaptive Acid Mine Drainage management plan be implemented from the onset of the proposed project; and
- A secondary recommended mitigation measure is to ensure that the powerline be attached to existing river crossing infrastructure before undisturbed areas are considered.

DOCUMENT GUIDE

The table below provides the NEMA (2014) Requirements for Ecological Assessments, and also the relevant sections in the reports where these requirements are addressed:

GNR 982	Description	Section in the Report
Specialist Report		
Appendix 6 (a)	A specialist report prepared in terms of these Regulations must contain— 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 ii
Appendix 6 (b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Page vi
Appendix 6 (c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 4
Appendix 6 (cA)	An indication of the quality and age of base data used for the specialist report;	Section 5
Appendix 6 (cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 12
Appendix 6 (d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 9
Appendix 6 (e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 6
Appendix 6 (f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives;	Section 9
Appendix 6 (g)	An identification of any areas to be avoided, including buffers;	Section 10
Appendix 6 (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;	Section 10
Appendix 6 (i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
Appendix 6 (j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 9
Appendix 6 (k)	Any mitigation measures for inclusion in the EMPr;	Section 12
Appendix 6 (l)	Any conditions for inclusion in the environmental authorisation;	Section 12
Appendix 6 (m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 12
Appendix 6 (n)	A reasoned opinion— i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 13
Appendix 6 (o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	None
Appendix 6 (p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
Appendix 6 (q)	Any other information requested by the competent authority.	None

DECLARATION

I, Dale Kindler, 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 71 and is punishable in terms of Section 24F of the Act.

Dale Kindler

Aquatic Ecologist

The Biodiversity Company

8th July 2019

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1 Introduction and Background

Forzando Coal Mines (Pty) Ltd. applied to the Department of Mineral Resources (DMR) for the conversion of Old Order Mining Rights to New Order Mining Rights for its mining operations at the Forzando North Shaft and Forzando South Shaft. These conversions were granted in November 2011 and executed on the 28th of June 2013.

This application is for the extension of the current mining areas [under Section 102 of MPRDA (Act No. 28 of 2002)] by inclusion of contiguous areas which are held under Prospecting Rights 1035PR & 1170PR. Through an intensive drilling exercise on these areas, economically viable blocks of coal have been defined. The plan is to access these newly defined blocks of coal from the existing Forzando South incline. Underground mining has been selected as the appropriate mining method for the Kalabasfontein project.

Annexation of these Prospecting Rights into the existing Forzando South Mining Right is motivated by subsequent reduction of Reserves at Forzando North Shaft. This diminution is as a result of unexpected poor ground conditions as well as burnt coal (Forzando Coal Mines (Pty) Ltd. 2018).

The Kalabasfontein project area is situated in Mpumalanga, approximately 20 kilometres north of Bethal and approximately 25 kilometres east of Ga-Nala (Kriel). It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality. The project area comprises two prospecting rights, 1035PR and 1170PR, which cover a total area of ~1 547.8296ha over portions 7, 8, Remaining Extent (RE), 11 and 13 of the farm Kalabasfontein 232 IS. An additional ventilation shaft will also be required within the Forzando South mining area on either Portion 7 or Portion 22 of the farm Uitgedacht 229 IS (Figure 1). Initial granting of both Prospecting Rights was in 2006 to Forzando Coal Mines (Pty) Ltd. Subsequent to this, in respect of 1035PR and before the right could lapse on the 2nd of November 2009, a Prospecting Rights renewal was applied for in October 2009. In respect of PR 1170 the renewal was applied for on 12 January 2011 before the right could expire on 9 April 2011. Both renewals were granted on the 31st July 2015 with execution finalised on the 27th October 2015, extending the validity of both Prospecting Rights to the 30th of July 2018. The proposed extension of the current mining area will require minimal new surface infrastructure as the mining method to be employed is underground mining and existing surface infrastructure from the Forzando South mine will be used (Figure 1).

Forzando Coal Mines (Pty) Ltd has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) to act as the independent Environmental Assessment Practitioner (EAP) to undertake the Environmental Impact Assessment (EIA) for the proposed Kalabasfontein project. An application for the amendment to the existing Mine Works Programme (MWP) and EMPR, through an MPRDA Section 102 Application, and a full EIA for the proposed new mining area is, therefore, required to support an application for environmental authorisation (EA). A water use licence application (WULA) for the relevant water use triggers associated with the proposed project will also be undertaken. The Biodiversity Company (TBC) was appointed by EIMS to conduct the aquatic ecology survey and impact assessment for the proposed project.

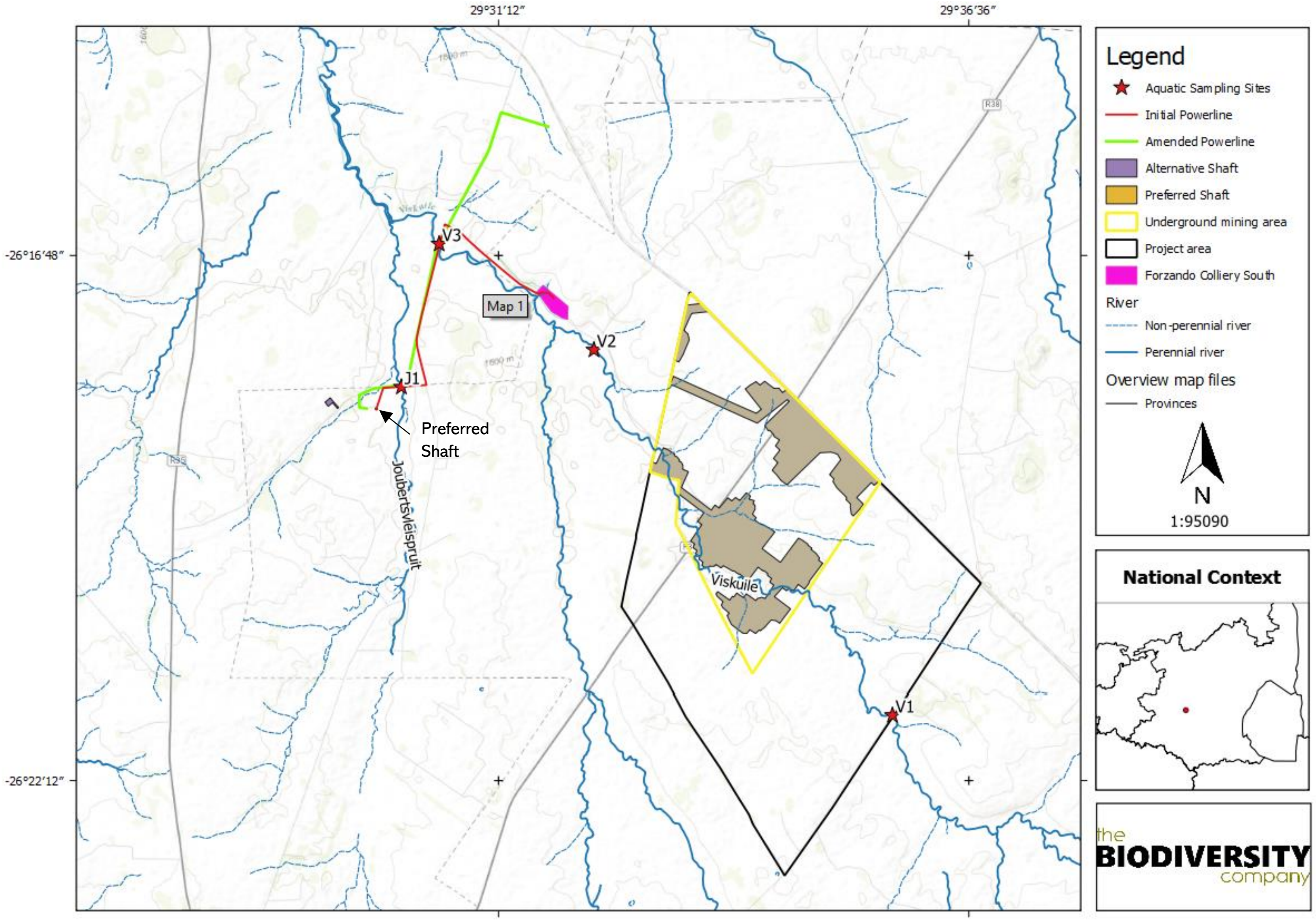


Figure 1: The proposed Kalabasfontein project area

A single aquatic sampling survey was conducted on the 3rd and 4th of October 2018. The sampling during this period is considered a late low flow assessment. The survey focused primarily on those areas which were most likely to be impacted upon by the proposed development at Kalabasfontein and specifically where surface infrastructure was due to be developed. No aquatic baseline information was available for the project area. Therefore, findings reflect those of this baseline assessment.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the EAP and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

1.1 Project Area

As part of the Kalabasfontein project, two alternative sites have been proposed for a new ventilation shaft, and a power line, namely Portion 7 of the farm Uitgedacht 229 IS and Portion 22 of the farm Uitgedacht 229 IS. Land use in the considered catchments consists predominantly of grassland areas, wetlands, farmsteads and irrigated agriculture as well as the urban footprint of the town of Bethal. The project area covers a total area of approximately 1 547.83 hectares in separate blocks on Portions 7, 8, Remaining Extent (RE), 11 and 13 of the farm Kalabasfontein 232 IS.

2 Project Description

This section provides a detailed project description. The aim of the project description is to indicate the activities that are planned to take place at the Forzando South operations as well as the proposed Kalabasfontein project area and amendments that are being applied for in this application. Furthermore, the detailed mine/project description is presented to facilitate the understanding of the project related activities which result in the impacts identified and assessed and for which management measures have been proposed.

2.1 Mining Operations Overview

Although Kalabasfontein annexation is intended to extend the Life of Mine (LOM) of Forzando South Coal Mine, it will come into production a year after the annexation is granted by the DMR. The Kalabasfontein project has an estimated LOM of 17 years with the project schedule and timeframe being based on the Forzando South equipment availabilities, efficiencies and both skilled and unskilled labour force. Mining in the Kalabasfontein project area is based on two Continuous Miner (CM) sections.

The access corridor to Kalabasfontein Reserves was identified during exploration drilling. Reserves will be mined through access from one of Forzando South Reserves block. This will eliminate intense preparation work of developing a new incline, as there will be infrastructure available at the face.

Currently, Forzando South mine is scheduled until 2037. However, the Kalabasfontein portion will be mined as soon as permission is granted, in order to ensure sustained production volumes and quantities from the 5 CM sections that are currently being mined. The mine will maintain its production rate of 2.2 Million tonnes (Mt) per annum. Commissioning of Kalabasfontein will not add to the production of Forzando South but will provide relocation areas for existing Forzando South sections. Since the Kalabasfontein project will be mined concurrently with Forzando South, production decline will be due to depletion of Reserves. In the second quarter of year 17 (2037), the first section will pull out and leave the one section to deplete the remaining Reserves.

2.2 Current Authorisations

The following rights, authorisations and approvals are currently in place and have been considered in the compilation of the report:

- Mining Right (MP380MR) dated 28 June 2013;
- Prospecting Rights (MP 30/5/1/1/2/1035PR) dated 31 July 2015;
- Prospecting Rights (MP 30/5/1/1/2/1170PR) dated 31 July 2015;
- Water Use Licence (04/B11A/A/ACGIJ/521) dated 19 July 2011;
- Amended Water Use Licence (04/B11A/A/ACGIJ/521) dated 15 June 2017; and
- Waste Licence (12/9/11/L180/6) dated 22 February 2010.

2.3 Infrastructure Requirements

As the Kalabasfontein project will use the existing Forzando South and Forzando North infrastructure, additional infrastructure requirements will be minimal. Anticipated demand for water, power and the on-site infrastructure requirements is detailed in the mine works programme (MWP). These requirements are based on staff required over the production period for permanent employees and contractors. Water and electricity requirements for the construction of mine access (ventilation shaft) and surface infrastructure are temporary, lasting for approximately 12 months.

The Forzando North plant is designed to treat ROM of approximately 2.2 Million tons per annum (Mtpa). This will include coal from the proposed Kalabasfontein Project. The plant will be manned for operations on a 24 hour/day, 7 days/week basis, with the exclusion of statutory public holidays.

Below are plant design parameters used:

- A production of 10,000 t per day;
- A production of 3,300 t per shift;
- Feed to ROM bin (peak) of 3,600 t per hour at 50 mm Top Size;
- ROM material top size (mm): 350 mm;
- Primary crusher feed: 1,200 t per hour (peak);
- ROM stockpile surge capacity 10,000 t (max): 4,500 t (live);
- Overland conveyor design maximum and average of 1,125 t/hr and 750 t/hr respectively;
- Conveyor operation: 2 shifts per day for 5 days a week.

2.4 Mining Method to be Employed: Underground Mining

Bord and pillar mining using CM's was selected as the primary extraction method. In bord and pillar mining, parallel roads are developed in the development direction. Perpendicular roads, called splits, are developed at predetermined intervals to the parallel roads. These roads interlink, creating pillars. The roads mined concurrently are determined by the size of the pillars required to support the overburden above the coal seam and the length of the production equipment trailing cables.

Pillar size is determined by the safety factor formula; which is the pillar strength divided by the pillar load (mass of the overburden carried by the pillar). Panel design will be based on either the Probability of Failure (PoF) or the safety factor design criterion. A PoF of 0.1% or SF of 2.0 will be used for main development, whereas a PoF of 1% or SF of 1.6 will be used for production panels depending on the stability and rock engineering characteristics that will be determined by a Rock/Geotechnical Engineer. The dimensions of the roads and the support requirements are determined by a Geotechnical Engineer and documented in a code of practice for the prevention of roof falls.

2.5 Surface Infrastructure

As the Kalabasfontein project will use the existing Forzando South and Forzando North infrastructure, additional infrastructure requirements will be minimal. A ventilation shaft and powerline will be required, which will be located outside the Kalabasfontein project area, either on portion 7 or portion 22 of the farm Uitgedacht 229 IS, approximately 6 km away. Existing access roads will be used.

2.6 Administration Buildings, Engineering Bays, Workshops and Other Buildings

As the Kalabasfontein project will be an extension of the Forzando South operations, the existing infrastructure will be utilized during all phases of the project. The existing surface infrastructure related to Forzando North can be summarised as follows:

- Coal beneficiation plant;
- Coal discard dumps;
- Rail line of about 1,6 km to the Richards Bay Coal Terminal railway line;
- Rail loop of about 400 m diameter;
- Coal product load-out stockpile located to the west of the discard dump;
- ROM coal stockpile;
- Water pollution control dams;
- Metallurgical coal stockpiles; and
- Administration, workshops, change house and related buildings.

At present the existing surface infrastructure related to Forzando South can be summarised as follows:

- Power lines;

- Ventilation shafts (one upcast & one downcast);
- ROM coal stockpile;
- Overland conveyor from boxcut to Forzando North plant;
- Water pollution control dams; and
- Administration, workshops, change house and related buildings.

3 Scope of Work

The Biodiversity Company was commissioned by EIMS to conduct a biodiversity baseline (terrestrial, aquatic and wetland ecosystems) and impact assessment for the proposed Kalabasfontein Coal Mining Project. The Terms of Reference (ToR) for this study included the following:

- Desktop description of the baseline receiving environment specific to the field of expertise (general surrounding as well as site-specific environment);
- Identification and description of any sensitive receptors in terms of relevant specialist disciplines (aquatics, biodiversity, wetlands and soils) that occur in the project area, and the manner in which these sensitive receptors may be affected by the activity;
- Site visit to verify desktop information;
- Screening to identify any critical issues (potential fatal flaws) that may result in project delays or rejection of the application;
- Provide a map identifying sensitive receptors in the project area, based on available maps, database information & site visit verification; and
- Compile summary specialist inputs to feed into the overall report, including the following:
    - Aquatic ecological inputs.

4 Limitations

The following limitations should be noted for the study:

- A single aquatic ecology survey was completed for this assessment. Thus, temporal trends were not investigated.
- No wetlands were considered in this aquatic study
- No baseline biomonitoring data/report(s) was received for the project area. Therefore, information presents the findings of the single aquatic survey
- Due to the rapid nature of the assessment and the survey methods applied, fish diversity and abundance was likely to be under estimated.
- Invertebrates were only considered to the Family level and thus a defined species list for aquatic invertebrates was not completed.

- The river systems were in drought at the time of the survey with low water levels and flow limited to a trickle, limiting habitat diversity. Drought conditions affect aquatic faunal communities.
- Only sites where there will be a proposed activity were selected for this assessment.
- The proposed activities listed in this study are based on the assessment of several existing underground coal mine activities. A number of assumptions have been made through the compilation of the activity list.
- The assessments were conducted on those portions of the project area as originally defined by the client, any changes in the project boundary subsequent to this may negatively impact the robustness of this report;
- The impact assessment was completed for the proposed mining areas and supporting infrastructure for the project area. The impact assessment has considered these layouts to be final, and have not considered the No Go alternative; and
- Despite these limitations, a desktop study was conducted, in conjunction with the detailed results from the surveys, and as such there is a high confidence in the information provided.

5 Desktop Assessment

The project area is located in the Olifants Water Management Area (WMA 4). The project area is located within the quaternary catchment B11A. The two watercourses associated with the project are the B11A-1443 and the B11-1430 Sub Quaternary Reaches (SQR), Joubertsvleispruit and the Viskuile respectively. The Joubertsvleispruit drains into the Viskuile and ultimately drains into the Olifants River. For the purposes of this study, the desktop information on the potentially directly affected river reaches are presented in Table 1 and Table 2.

Table 1: The desktop information pertaining to the B11A-1443 Sub Quaternary Reach (DWS, 2018a)

Component/Catchment	B11A-1443 (Joubertsvleispruit))
Present Ecological Status	Largely modified
Ecological Importance Class	Moderate
Ecological Sensitivity	Very high
Default Ecological Category	Moderately modified

The desktop information for the B11A quaternary catchment indicated that the Joubertsvleispruit river reach was in a largely modified status. The ecological importance class for the river reach was defined as moderate with a very high Ecological Sensitivity. The default ecological category for the river reach was defined as moderately modified.

Table 2: The desktop information pertaining to the B11A-1430 Sub Quaternary Reach (DWS, 2018a)

Component/Catchment	B11A-1430 (Viskuile)
Present Ecological Status	Moderately modified
Ecological Importance Class	High
Ecological Sensitivity	High
Default Ecological Category	Moderately modified

The PES of the B11A-1430 SQR's was defined as moderately modified at a desktop level. Both the ecological importance and the ecological sensitivity of the river reach were high. The default ecological category for the SQR was derived to be moderately modified.

The two river reaches considered in this project are situated in a source zone within the overall Olifants River Basin. In light of the overall longitudinal river profile, as well as the specific gradients of the Olifants River Basin, the portions of river considered in this assessment conforms to the geomorphological river zonation of a lower foothills river (slope class E) (Rowntree *et al.* 2000; Rowntree and Ziervogel, 1999).

Characteristic features of this river system are gentle gradients with associated wetland structures. Considering this, marginal and aquatic vegetation are key components of the river reach. The project area considered in this assessment is located within the Southern Temperate Highveld Freshwater Ecoregion. In comparison to more northern African river systems, the aquatic fauna of the considered ecoregion is "lacking in diversity" (Abel *et al*., 2008). This ecoregion is known to contain approximately 67-101 freshwater fish species of which 1-11 are known to be endemic (Figure 2). The ecoregion is known to have increased flow rates during the spring and summer seasons (September to March) and most of the indigenous fish species breed during this period.

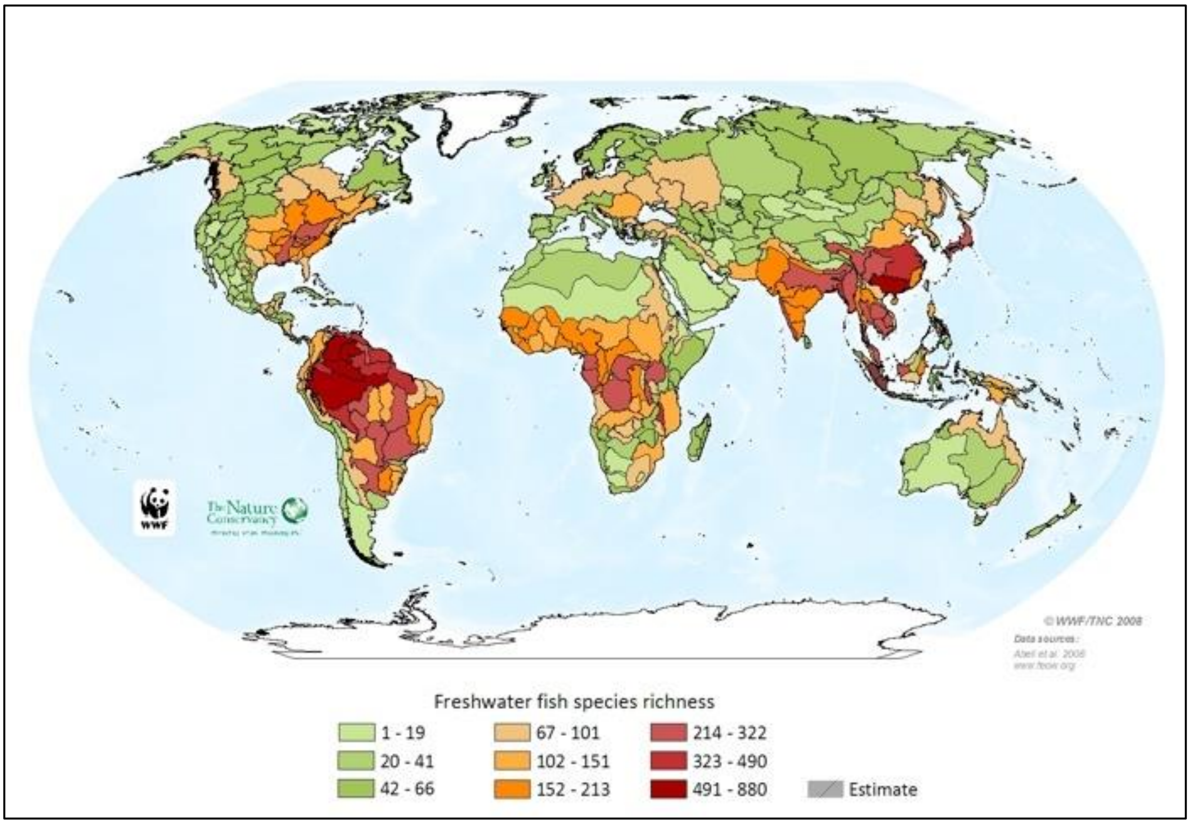


Figure 2: Freshwater Fish Species Richness of the Freshwater Ecoregions of the World (Abel et al., 2008)

According to Nel *et al*., (2011) the watercourses in the project area within the Olifants WMA are not considered National Freshwater Priority Areas (NFEPA) for river systems. Despite their non-FEPA status, these areas need to be managed to maintain water quality for downstream river and wetland FEPA's. The project area location in relation to NFEPA's is presented below.

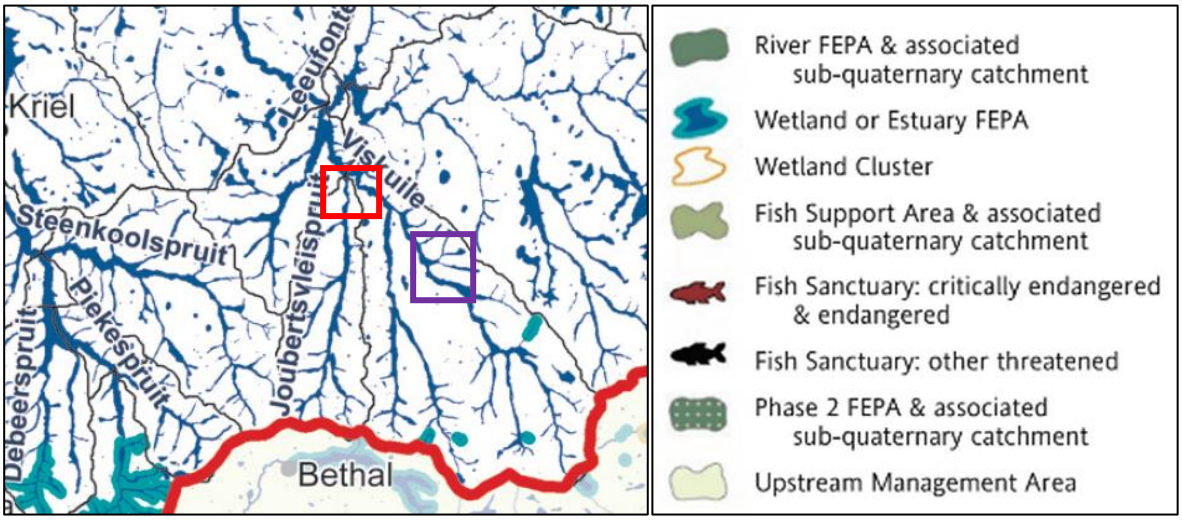


Figure 3: NFEPA map of project area. Red square indicates location of proposed shafts and powerline, while the purple square indicates proposed underground area (Nel et al., 2011)

Aquatic fauna of the Olifants River system, particularly in the source zone, are threatened by extensive agriculture which has resulted in the sedimentation and modification of instream wetland habitats. In addition, the Witbank Coal field is largely located within the source zones of the Olifants River basin which has resulted in several point source contaminants from coal mining and the subsequent modification to aquatic faunal communities.

6 Methodologies

A single aquatic sampling survey was conducted on the 3rd and 4th of October 2018. The sampling during this period would constitute a late low flow assessment.

6.1 Sampling Points

The sampling points selected in this study were completed according to the proposed infrastructure layout. The layout of the sampling points and details of the points are provided in Table 3 and Figure 4.

Table 3: Location of the Aquatic Sampling Points

J1	**Upstream**	**Downstream**
		
GPS	26°18'9.44"S 29°30'5.20"E	
Site description	Site J1 was located east of the proposed ventilation shafts and at the point where both the powerline alternatives cross the Joubertsvleispruit. The Joubertsvleispruit is a tributary of the Viskuile. *In situ* water quality, SASS5, and fish community analyses were conducted at this site. The site presented a uniform deep channel lined by grasses and aquatic vegetation. No flow was present over the sand and mud substrates.	
V1	**Upstream**	**Downstream**
		
GPS	26°21'31.36"S 29°35'43.53"E	

<table>
<tr><td>Site description</td><td colspan="2">Site V1 was located on the Viskuile River, upstream of the proposed underground mining area. This site presents the most upstream monitoring point. The Viskuile River is a tributary of the Olifants River. In situ water quality, SASS5, and fish community analyses were conducted at this site. No flow was present at this site. The site presented standing pools over sand and mud substrates, with limited marginal vegetation and the present of algae.</td></tr>
<tr><td rowspan="2">V2</td><td>Upstream</td><td>Downstream</td></tr>
<tr><td></td><td></td></tr>
<tr><td>GPS</td><td colspan="2">26°17'46.54"S
29°32'17.87"E</td></tr>
<tr><td>Site description</td><td colspan="2">Site V2 was located on the Viskuile River downstream of V1 and the proposed underground mining area. In situ water quality, SASS5, and fish community analyses were conducted at this site. No flow was present at this site. The site presented standing pools over sand and mud substrates, with abundant marginal vegetation present. Old misaligned culvert pipes presented stones habitat.</td></tr>
<tr><td rowspan="2">V3</td><td>Upstream</td><td>Downstream</td></tr>
<tr><td></td><td></td></tr>
<tr><td>GPS</td><td colspan="2">26°16'41.13"S
29°30'31.22"E</td></tr>
<tr><td>Site description</td><td colspan="2">Site V3 was located on the Viskuile River, downstream of V2 and the proposed underground mining area. The site was further located at the tar road bridge where both powerline alternatives will traverse the river. In situ water quality, SASS5, and fish community analyses were conducted at this site. No flow was present in the Viskuile River. The site presented pools and runs over, gravel, sand and mud substrates, with abundant marginal and aquatic vegetation present. This site had a trickle of water flow and present the most downstream monitoring point.</td></tr>
</table>

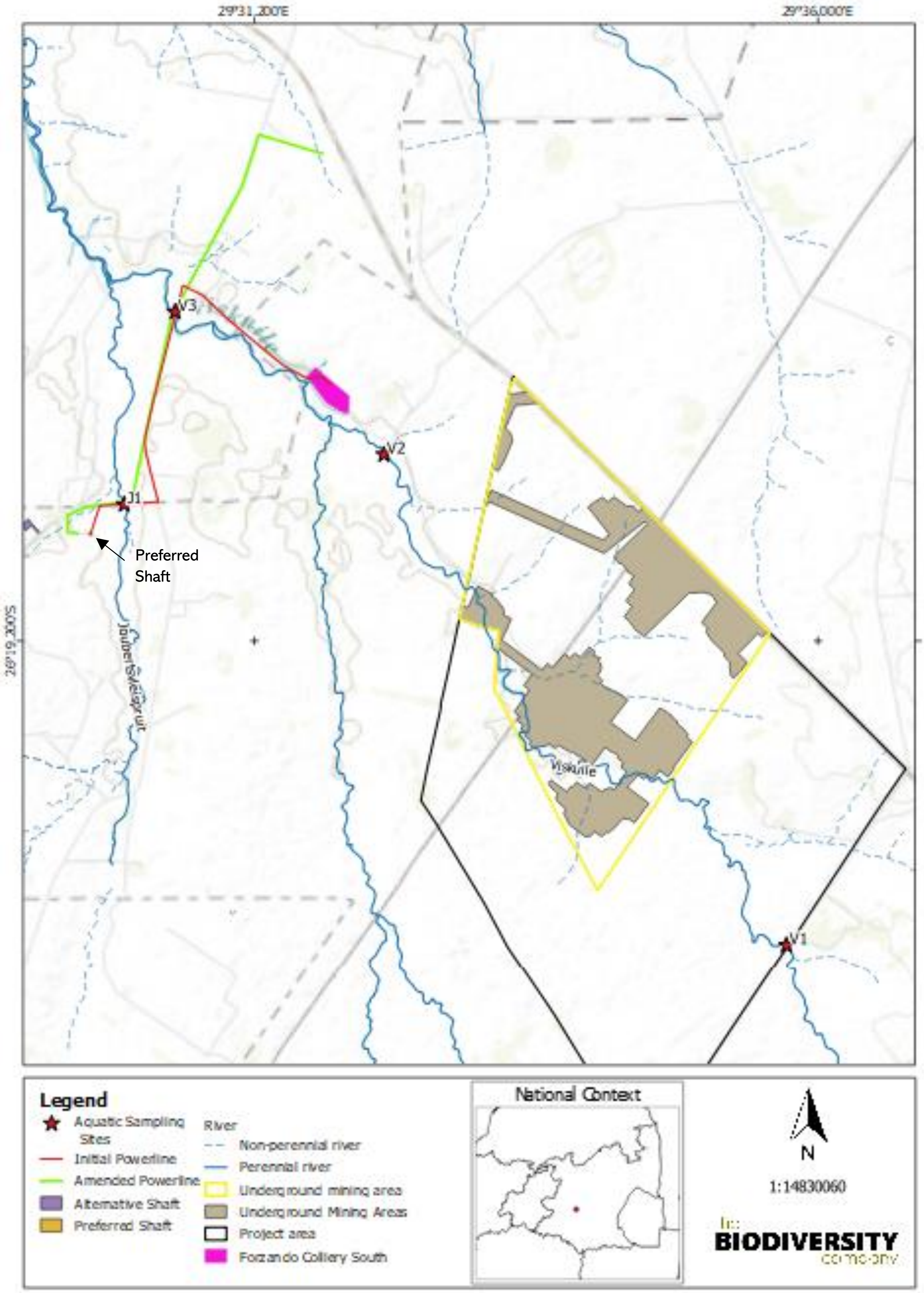


Figure 4: Location of Aquatic Sampling Points in the Kalabasfontein project area

6.2 Water Quality

Water quality was measured *in situ* using a handheld calibrated Extech ExStik II meter. The constituents considered that were measured included: pH, conductivity (µS/cm), temperature (°C) and Dissolved Oxygen (DO) in mg/l.

6.3 Aquatic Habitat Integrity

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), was used to define the ecological status of the river reach. The method is based on Kleynhans (1996).

The area covered in this component of the study is outlined as follows. In the Olifants WMA (WMA 4), the following river reaches were assessed individually according to their location in an SQR:

1. B11A-1443 (Joubertsvleispruit)
2. B11A-1430 (Viskuile)

The IHIA model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 4 and Table 5 respectively.

Table 4: Criteria used in the assessment of habitat integrity (Kleynhans, 1996)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated 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 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 point sources. Measured directly or alternatively 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.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
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.

Criterion	Relevance
Indigenous 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 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 river bank 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.

Table 5: Descriptions used for the ratings of the various habitat criteria

Impact Category	Description	Score
None	No discernible impact or the modification 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 very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are 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
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area 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 influenced detrimentally.	21-25

6.4 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

6.4.1 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g.

Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al.,* 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Highveld Lower macroinvertebrate ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

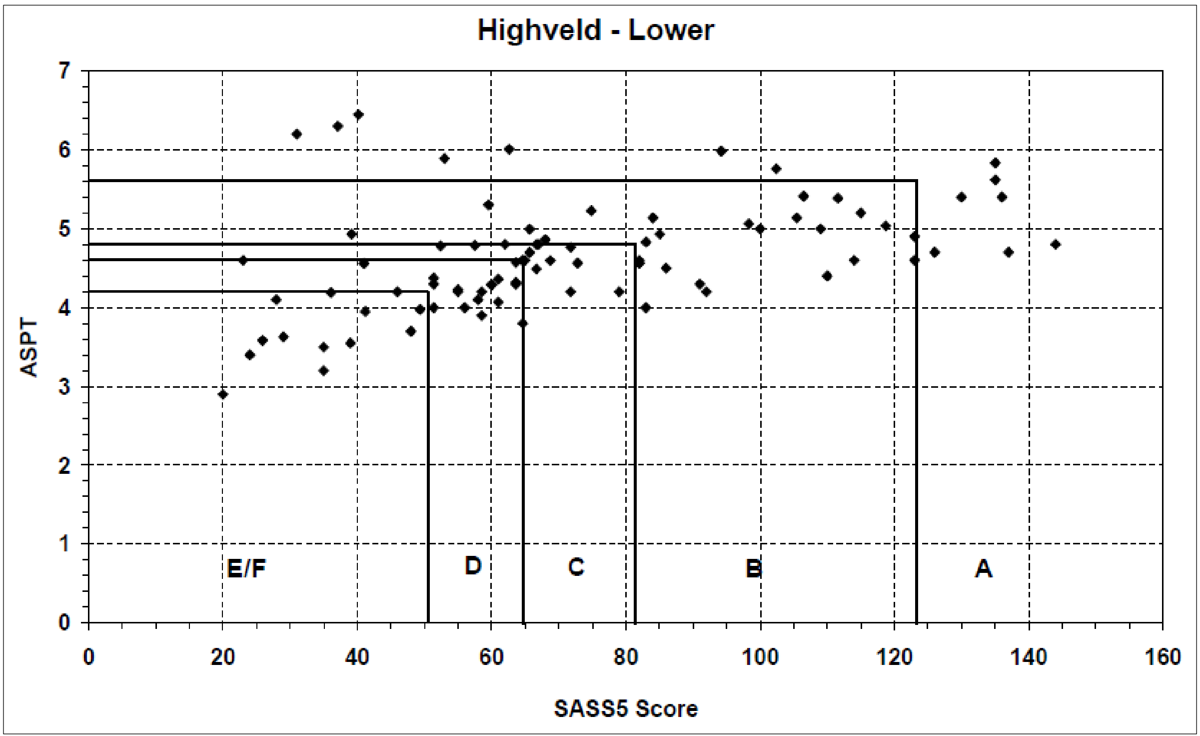


Figure 5: Guidelines used for the interpretation and classification of the SASS5 scores (Dallas, 2007)

6.4.2 Macroinvertebrate Response Assessment Index

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the SQR. This does not preclude the calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;
- Water quality; and
- Energy inputs from the watershed Riparian vegetation assessment.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES.

6.5 Fish Community Assessment

The information gained using the Fish Response Assessment Index (FRAI) gives an indication of the PES of the river based on the fish assemblage structures observed. Fish were captured through electroshocking. All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). The identified fish species were compared to those expected to be present for the quaternary catchment. The expected fish species list was developed from a literature survey and included sources such as (Kleynhans *et al.,* 2007), Skelton (2001) and DWS (2018a). The conservation status of the indigenous fish species was assessed in terms of the IUCN Red List of Threatened Species (IUCN, 2018). It is noted that the FRAI Frequency of Occurrence (FROC) ratings were calculated based on the habitat present at the sites.

6.6 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this study, ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007).

The areas considered in the PES assessment are outlined in the IHIA section above.

7 Key Legislative Requirements

7.1 National Water Act (NWA, 1998)

The Department of Water and Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (Act No. 36 of 1998) (NWA; RSA, 1998a) allows for the protection of water resources, which includes:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means;

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

No activity may take place within a watercourse unless it is authorised by the DWS. Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) and (i).

7.2 National Environmental Management Act (NEMA, 1998)

The National Environmental Management Act (NEMA) (RSA, 1998 b) and the associated Regulations as amended in December 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the EIA process depending on the scale of the impact.

7.3 Expertise of the Specialist

Mr Dale Kindler is an aquatic scientist that joined The Biodiversity Company in October 2015. Prior to that Dale worked at Golder Associates Africa and Prism EMS. Dale studied at the University of Johannesburg and obtained his M.Sc. in Aquatic Health in 2015. He is Pr. Sci. Nat. registered (114743) in the Aquatic Science field of practice. Dale has five years' work experience in the field of aquatic ecology conducting aquatic assessments across southern Africa, Guinea and Mozambique. Considering the wide geographical range of the projects completed, Dale Kindler has a good technical understanding on the variable conditions within Southern African rivers as well as their biological compositions. This has allowed Dale Kindler to gain knowledge of a diversity of freshwater ecoregions within Africa.

His experience includes providing input for studies conducted as per requirements of EIA processes, Baseline Assessments and scoping studies across sectors including mining, energy, and civil engineering. Dale therefore has a knowledge of the potential impacts arising from the proposed project.

8 Study Approach

This EIA report has been compiled in accordance with the accepted Plan of Study and incorporates the findings and recommendations from other specialist studies conducted for the project.

In addition, this EIA is being compiled according to the guidelines provided in GNR 326 of the EIA Regulations (2017).

All specialist studies were initiated on the basis of the conceptual layout plan indicating the proposed mining areas and mine infrastructure associated with the Kalabasfontein Project, as provided by EIMS.

9 Results and Discussion

A single aquatic sampling survey was conducted on the 3rd and 4th of October 2018. The sampling during this period is considered a late low flow assessment. During the survey the instream and riparian habitat and associated aquatic biotic communities in the project area were assessed.

9.1 Water Quality

In situ water quality analysis results from the October 2018 surveys are provided in Table 6.

Table 6: Water Quality Results October 2018

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	**6.5-9.0**	**-**	**>5.00**	**5-30**
J1	8.69	574	7.84	16.9
V1	8.69	703	7.27	17.1
V2	8.55	744	6.33	18.8
V3	8.32	609	6.20	14.2

*TWQR – Target Water Quality Range;

The water quality assessment illustrated acceptable water conditions within the Joubertsvleispruit with pH, electrical conductivity, dissolved oxygen and water temperature all falling within the Target Water Quality Range (TWQR) for aquatic ecosystems according to the Department of Water and Sanitation (DWS, 1996).

The water quality within the Viskuile River was considered modified owing to elevated dissolved solids loads. The pH values increased in a downstream direction from 8.32 at V3 (upstream site) to 8.69 at V1 (most downstream site). It was noted that no surface water flow was present at the time of the survey. Levels of conductivity were found to range from 609 µS/cm at V3 to 744 µS/cm at V2 (Figure 6). Ideally dissolved solids should not exceed 700 µS/cm. The levels of dissolved solids indicated modified water quality from what would be expected in source zones which would typically have freshwater conductivity levels of less than 100 µS/cm. Land-use in the catchments has therefore modified the water quality in the Viskuile River reach.

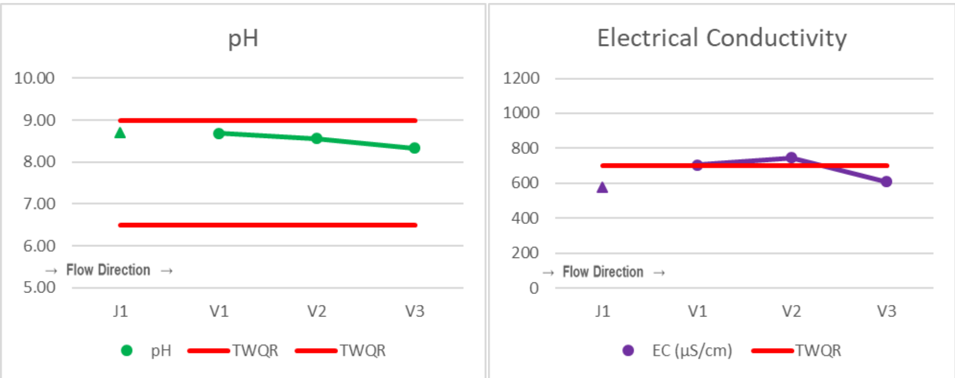


Figure 6: pH and Electrical Conductivity spatial results for the baseline survey

9.2 Intermediate Habitat Integrity Assessment

The IHIA was completed on a reach basis as described in the IHIA methodology component of this study. The results of the IHIA for the Viskuile are presented in Table 7, while the Joubertsvleispruit River system is presented in Table 8.

Table 7: Instream Intermediate Habitat Integrity Assessment for the Viskuile River

Criterion	Impact Score	Weighted Score
Instream		
Water abstraction	8	4.48
Flow modification	13	6.76
Bed modification	12	6.24
Channel modification	12	6.24
Water quality	9	5.04
Inundation	7	2.8
Exotic macrophytes	0	0
Exotic fauna	6	1.92
Solid waste disposal	5	1.2
Total Instream Score	**65.32**	
Instream Category	**class C**	
Riparian		
Indigenous vegetation removal	8	4.16
Exotic vegetation encroachment	7	3.36
Bank erosion	15	8.4
Channel modification	12	5.76
Water abstraction	7	3.64
Inundation	9	3.96
Flow modification	12	5.76
Water quality	11	5.72
Total Riparian Score	**59.24**	
Riparian Category	**class D**	

The results of the habitat assessment in the Viskuile River indicates that the instream habitat is moderately modified (class C). The modification can be largely attributed to the modification of the overall river system as a result of numerous river crossing structures (formal and informal), livestock influence (trampling and defecation), agricultural land use and direct river channel modification for water storage. It was further noted that there is possible water-abstraction by Forzando Colliery located approximately 2 km upstream of site V3. These factors have resulted in the modification of river flow, river bed and banks, which ultimately alter the aquatic ecosystem functioning and ability to maintain a diversity of aquatic biota.

Table 8: Instream Intermediate Habitat Integrity Assessment for the Joubertsvleispruit River

Criterion	Impact Score	Weighted Score
Instream		
Water abstraction	4	2.24
Flow modification	7	3.64
Bed modification	9	4.68
Channel modification	7	3.64
Water quality	8	4.48
Inundation	2	0.8
Exotic macrophytes	0	0
Exotic fauna	11	3.52
Solid waste disposal	4	0.96
Total Instream Score	**76.04**	
Instream Category	**class C**	
Riparian		
Indigenous vegetation removal	7	3.64
Exotic vegetation encroachment	10	4.8
Bank erosion	8	4.48
Channel modification	6	2.88
Water abstraction	7	3.64
Inundation	6	2.64
Flow modification	8	3.84
Water quality	6	3.12
Total Riparian Score	**70.96**	
Riparian Category	**class C**	

The results of the instream and riparian integrity assessment derived a class C (moderately modified) status for the considered river reach in this assessment. The river system was largely intact, however minor impacts stemming from river crossing structures and dryland agriculture have influenced the functioning of system. Exotic fish were sampled during this assessment and these are known habitat and macroinvertebrate community modifiers.

9.3 Aquatic Macroinvertebrate Assessment

9.3.1 Macroinvertebrate Habitat

Biological assessments were completed at representative sites in the considered river reaches. The invertebrate habitat at each site was assessed using the South African Scoring System version 5 (SASS5) biotope rating assessment as applied in Tate and Husted (2015). The results of the biotope assessment are provided below (Table 9). A rating system of 0 to 5 was applied, 0 being not available. The weightings for lower foothills rivers (slope class E) were used to categorize biotope ratings (Rowntree *et al.* 2000; Rowntree and Ziervogel, 1999).

Table 9: Biotope Scores in the Olifants Water Management Area during the October 2018 Survey

Biotope	Weighting	J1	V1	V2	V3
Stones in current	18	0	0	0	0
Stones out of current	12	0	0	1	1.5
Bedrock	3	0	1	1	0
Aquatic Vegetation	1	3	3	3	3.5
Marginal Vegetation In Current	2	0	0	0	0
Marginal Vegetation Out Of Current	2	3	2	3	3
Gravel	4	0	0.5	0.5	2
Sand	2	2	3	2.5	3
Mud	1	3	3	2.5	3
Biotope Score		7	9	15	20
Weighted Biotope Score (%)		11	12.5	13.5	16
Biotope Category (Tate and Husted, 2015)		**F**	**F**	**F**	**F**

Habitat availability within the assessed watercourses were rated as poor (category F). The low biotope scores can be attributed to low diversity/abundance of the stones in current, stones out of current, bedrock, and marginal vegetation biotopes. This is an anticipated result for the considered river reaches due to the zonation of the respective river systems. Typical instream habitat largely consisted of marginal and aquatic vegetation with sand and mud substrates (Figure 7).

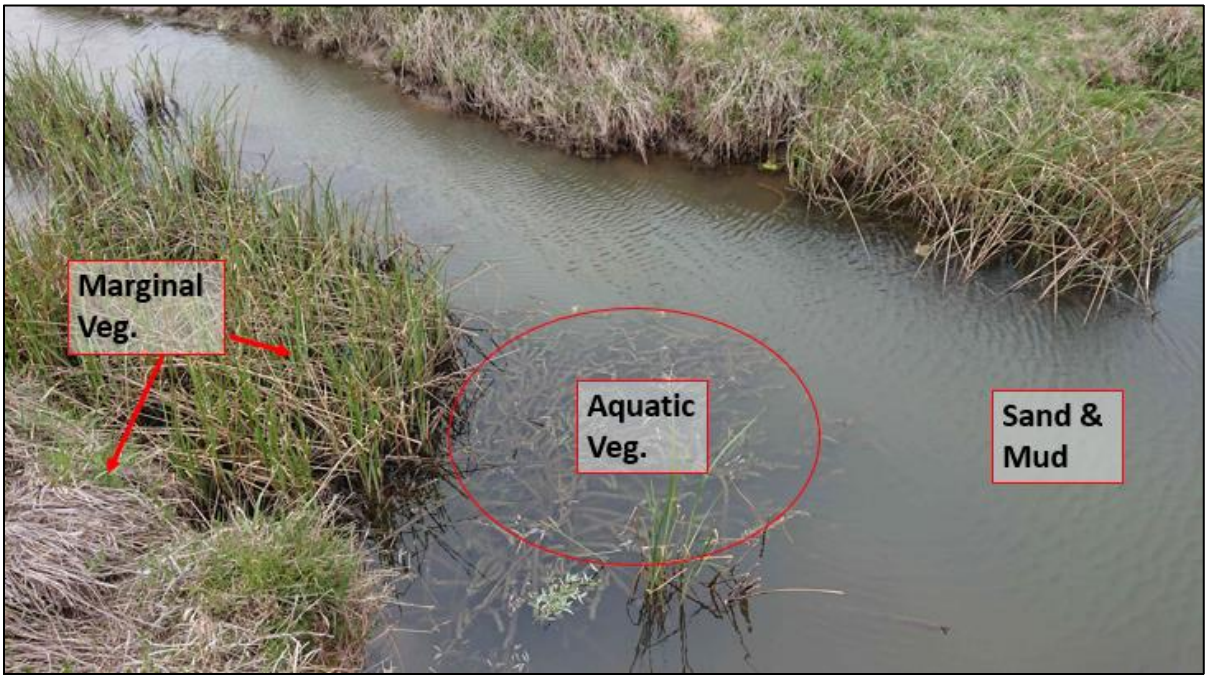


Figure 7: Typical aquatic Habitat rich in the sampled river reaches (J1, October 2018)

9.3.2 Macroinvertebrate Community Assessment

9.3.2.1 South African Scoring System

The results of the SASS5 results for the sites located in the Olifants WMA are presented in

Table 10: Macroinvertebrate Assessment Results Recorded in the Olifants Water Management Area (October 2018)

Site	SASS5	Taxa	ASPT	*Class (Dallas, 2007)
J1	79	19	4.2	**C**
V1	127	26	4.9	**A**
V2	79	18	4.4	**C**
V3	96	20	4.8	**B**

*Highveld Lower Ecoregion

The results of the SASS5 assessment in the Joubertsvleispruit derived a SASS5 score of 79 at J, with 19 invertebrate taxa and an ASPT of 4.2. The assessment derived a C invertebrate class or moderately modified. The Joubertsvleispruit housed very few sensitive taxa, with the assemblage dominated by tolerant taxa. Notable families observed in the macroinvertebrate assemblage include Hydracarina (Freshwater mites) and Hydraenidae (Minute moss beetles).

The Viskuile River SASS5 assessment derived SASS5 scores that ranged from 79 at V2 to 127 at V1. The number of taxa obtained per site ranged from 18 at V2 to 26 at V1. The ASPT was found to range from 4.4 at V2 to 4.9 at V1. Ecological classes based on the interpretation guidelines were derived to move from class A at V1 upstream of the proposed underground mining area to class C at V3 further downstream of the underground area. Similarly, the Viskuile River had very few sensitive taxa, with the assemblage dominated by tolerant taxa. Notable families observed included Atyidae (shrimp), Hydracarina, Lestidae (Spreadwing), Ecnomidae and Hydraenidae. Although Lestidae are widespread, they are sensitive to water quality modification and have a requirement for aquatic macrophytes or dense marginal vegetation. The presence of this species provides an indication of fair water quality and suitable habitat.

9.3.2.2 Macroinvertebrate Response Assessment Index

The MIRAI model, a more robust model of assessment, was conducted using a modified reference list. The results of the MIRAI for the Joubertsvleispruit and Viskuile River are provided in Table 11 and Table 12, respectively.

Table 11: Macroinvertebrate Response Assessment Index for the Joubertsvleispruit based on results obtained in October 2018

Invertebrate Metric Group	Score Calculated
Flow Modification	31.9
Habitat	33.8
Water Quality	49.8
Ecological Score	**38.6**
Invertebrate Category	**class D/E**

The results of the MIRAI assessment indicates that a largely to seriously modified invertebrate community was present in the considered Joubertsvleispruit reach based on the survey results. The modified condition of the macroinvertebrate assemblage was attributed to cumulative factors of flow, habitat and water quality modification resulting in the largely to seriously modified (class D/E) ecological category.

Table 12: Macroinvertebrate Response Assessment Index for the Viskuile River based on results obtained in October 2018

Invertebrate Metric Group	Score Calculated
Flow Modification	55.4
Habitat	61.6
Water Quality	48.2
Ecological Score	**55.3**
Invertebrate Category	**class D**

The results of the MIRAI show that the macroinvertebrate community within the whole Viskuile River reach was largely modified (class D). This can be primarily attributed to modified water quality compounded by modified flow in the reach. Flow was largely absent from the entire reach with a trickle present at the most downstream site V3. The absence of flow is related to poor rainfall in the project area during the late low flow season, limiting the presence of flow dependent taxa (Figure 8). The absence of cobbled substrate in this watercourse based on survey observations resulted in the absence of key taxa such as Hydropsychidae. The vegetation component was intact with majority of the macroinvertebrate community showing a preference for vegetation. Habitat availability was deemed acceptable in this reach and contributed least to the modified conditions.

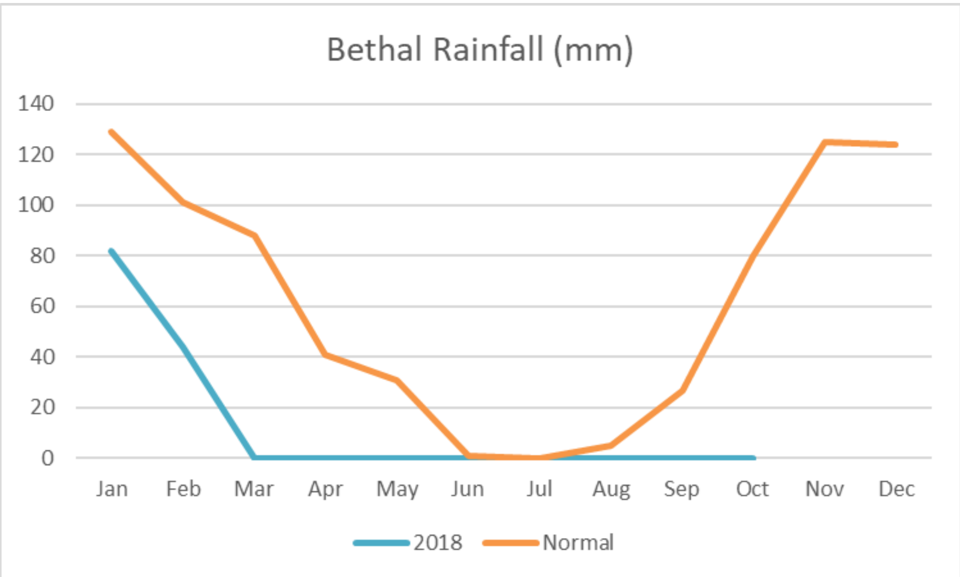


Figure 8: Monthly rainfall for the project area (Accuweather, 2018)

The current macroinvertebrate communities assessed in both river reaches during the study were found to be composed of predominantly tolerant invertebrate taxa. Despite modification, a portion of each community comprised sensitive invertebrates, highlighting the importance of preserving the current invertebrate classes from further deterioration.

9.4 Fish Community

The anticipated fish community and the results of the qualitative fish assessment in the project area are presented in Table 13.

Table 13: Fish Community Assessment for the Watercourses in the Olifants Water Management Area (IUCN, 2018)

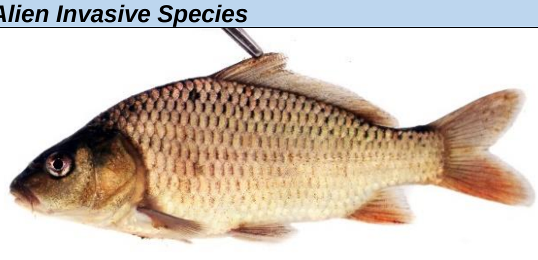
Species/Site	IUCN Status	Jouberts-vleispruit	Viskuile		
		J1	V1	V2	V3
Clarias gariepinus	LC	1	0	0	0
Enteromius anoplus	LC	1	1	1	1
Enteromius neefi	LC	0	0	0	0
Enteromius paludinosus	LC	1	1	1	1
Labeobarbus polylepis	LC	0	0	0	0
Pseudocrenilabrus philander	LC	1	0	1	1
Tilapia sparrmanii	LC	0	0	0	1
**Labeo capensis*	LC	0	0	0	1
**Labeo umbratus*	LC	0	1	0	0
***Cyprinus carpio*	Invasive	1	0	0	0
***Gambusia affinis*	Invasive	1	0	0	1
Total Native Species		4	2	3	5
Total Expected Native Species (per site)		6	7	7	7
Total Species Sampled		6	3	3	6
% Fish Community Sampled		67	29	43	71

*Introduced Species; **Alien Species; LC: Least Concern; 1 = Observed; 0 = Absent

A total of five of the seven expected native fish species were captured during this study (Table 14). Two additional indigenous fish species were collected in the project area namely, *Labeo capensis* (Orange River Mudfish) and *Labeo umbratus* (Moggel). Both *L. capensis* and *L. umbratus* are not native to the Olifants catchment and have been translocated through inter basin water transfer schemes from the Vaal River catchment. Furthermore, two alien invasive fish species *Cyprinus carpio* (Carp) and *Gambusia affinis* (Mosquitofish) were recorded during the survey. This brings the total fish species count to nine in the project area. Images of fish species collected are presented in Table 14.

Enteromius neefi (Sidespot Barb) and *Labeobarbus polylepis* (Smallscale Yellowfish) were on the expected fish species list but were not collected during the survey. *Enteromius neefi* is not a common or abundant species, however may be present within the project area. *Labeobarbus polylepis* is a common and abundant species usually associated with larger perennial river systems. They do occur downstream of the project area in the Olifants River. Due to the lack of flow in the sampled reaches during the survey, *L. polylepis* were not expected, however likely do occur in the project area in times of higher flow.

Table 14: Fish Species Observed during the October 2018 Survey

Native Species	
 *Clarias gariepinus*	 *Enteromius anoplus*
 *Enteromius paludinosus*	 *Pseudocrenilabrus philander*
 *Tilapia sparrmanii*	
Translocated Species	
 *Labeo capensis*	 *Labeo umbratus*
Alien Invasive Species	
 *Cyprinus carpio*	 *Gambusia affinis*

9.4.1 Presence of Species of Conservation Importance

No red listed species are expected directly within the river reaches in the project area (IUCN, 2018). However, during the assessment two alien species of conservation concern were sampled in the Olifants River system. A brief description of each species is provided below.

Cyprinus carpio is currently listed as Vulnerable (VU) in its native range but it remains an exotic species in South African waters. All collected *C. carpio* should be destroyed when collected and not returned to the river or translocated to other water bodies. *Cyprinus carpio* is known to be a habitat modifier through its feeding methods that involve stirring up the sediment in search of plant roots and other sources of protein, often increasing the turbidity of the water body (IUCN, 2018).

Gambusia affinis is a species of freshwater fish native to the USA and is currently listed as one of the world's worst invasive species. The common name 'mosquitofish' stems from the diet which predominantly consists of mosquito larvae (and other invertebrate larvae). An adult female *G. affinis* can consume hundreds of mosquito larvae in a day. According to NEMBA, *G affinis* falls under Category 1b in national parks, provincial reserves, mountain catchment areas and forestry reserves declared in terms of the Protected Areas Act. NEMBA Category 2 for breeding for the purpose of feeding stock for zoos and animal breeders and NEMBA Category 3 for all other discrete catchment systems in which it occurs (ISSS, 2016). Adults are known to be extremely aggressive, attacking other fish, shredding their fins or killing them. *Gambusia affinis* are known to prey on eggs, larvae and juveniles of various fishes, including largemouth bass and common carp. They are also known to prey on adults of smaller species (ISSS, 2016, Skelton, 2001).

9.4.2 Fish Response Assessment Index

Fish data collected during the low flow survey was applied to FRAI. The FRAI results for the Joubertsvleispruit and Viskuile river reaches are provided in Table 15 and Table 16, respectively.

Table 15: Fish Response Assessment Index for the Joubertsvleispruit

FRAI% (Automated)	82.6
EC FRAI	class B

The results of the FRAI derived a largely natural (class B) fish community in the Joubertsvleispruit at site J1. The presence of key species surveyed in this river reach resulted in the largely intact fish community. Absent fish species included *Tilapia sparrmanii,* a common hardy species and *Enteromius neefi*, an uncommon species.

Table 16: Fish Response Assessment Index for the Viskuile

FRAI% (Automated)	60.2
EC FRAI	class C/D

The results of the FRAI derived a moderately to largely modified (class C/D) in the Viskuile River reach for the three sampled sites V1, V2, and V3. The modified status was largely related to the absence of water flow and widely distributed species indicating modification of habitat and connectivity in the watercourse.

9.5 Overall Aquatic Ecology Present Ecological Status

The results of the PES assessment for the Joubertsvleispruit and Viskuile River are provided in Table 17 and Table 18, respectively.

Table 17: Present Ecological Status of the Joubertsvleispruit assessed in the October 2018 survey

Aspect Assessed	Ecological Category
Instream Ecological Category	76.0
Riparian Ecological Category	71.0
Aquatic Invertebrate Ecological Category	38.6
Fish Ecological Category	82.6
Ecostatus	**class C**

The results of the PES assessment derived moderately modified (class C) conditions in the Joubertsvleispruit river reach considered in this assessment. Flow and instream habitat modification has resulted in modified biological responses. Instream habitat modification can be attributed to local agricultural activities compounded by poor rainfall.

Table 18: Present Ecological Status of the Viskuile River reach assessed in the October 2018 survey

Aspect Assessed	Ecological Category
Instream Ecological Category	65.3
Riparian Ecological Category	59.2
Aquatic Invertebrate Ecological Category	55.3
Fish Ecological Category	60.2
Ecostatus	**class C/D**

The PES assessment derived moderately to largely modified (class C/D) conditions in the Viskuile River reach considered in this assessment. Water quality modification in the upper reaches of the watercourse compounded by modified flow in the reach has resulted in modified aquatic ecology. The modification of the watercourse can be attributed to poor connectivity due to poor rainfall, agricultural activities and alteration of the river for water storage.

9.6 Riparian Assessment

The water resources associated with the Kalabasfontein project are characterised as lower foothill river systems within the highveld ecoregion. Typical habitat features are presented in Figure 10 and Figure 11. As the project area falls within the grasslands biome, standard riparian delineation methodologies are not possible due to the absence of typical riparian features as illustrated in Figure 9. Therefore, the water resource delineation follows the wetland delineation as provided in Figure 12.

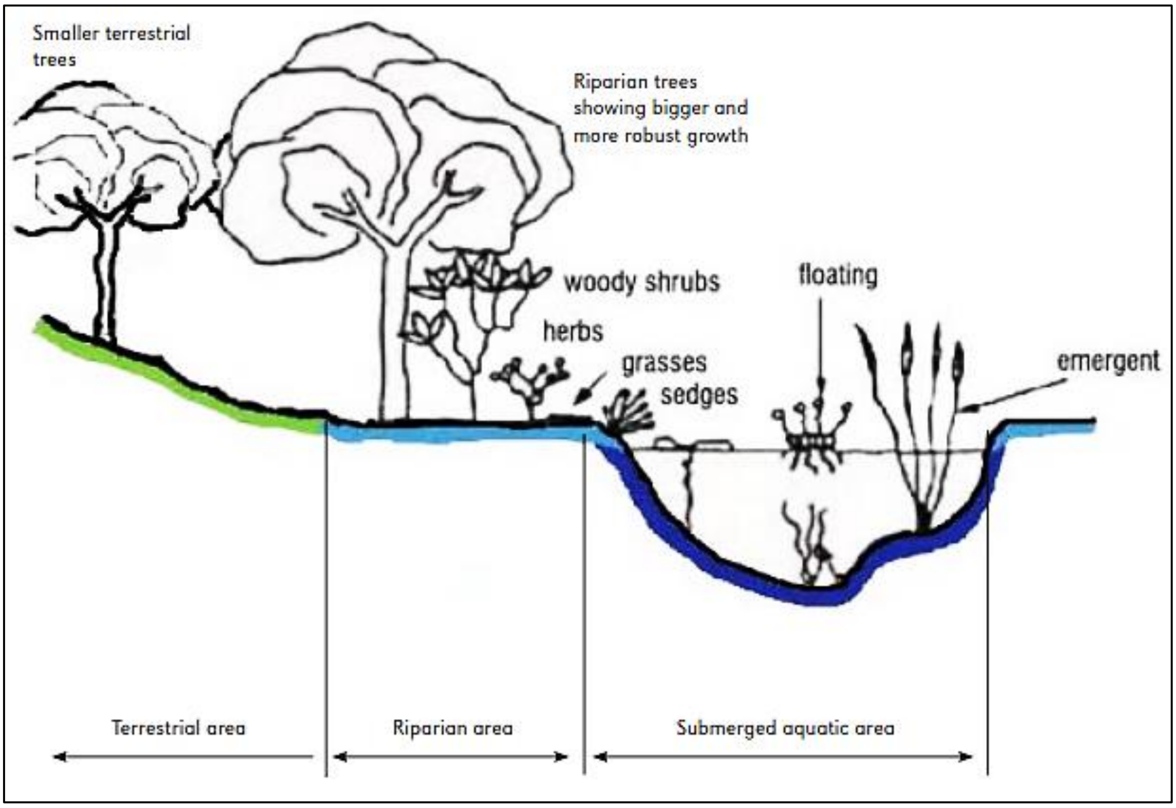


Figure 9: Riparian Habitat Delineations (DWAF, 2005a)

Figure 10: Illustration of typical riverine features downstream of the project area (Site V3, October 2018)

Figure 11: Illustration of typical riverine features associated within the project area (Site V1, October 2018)

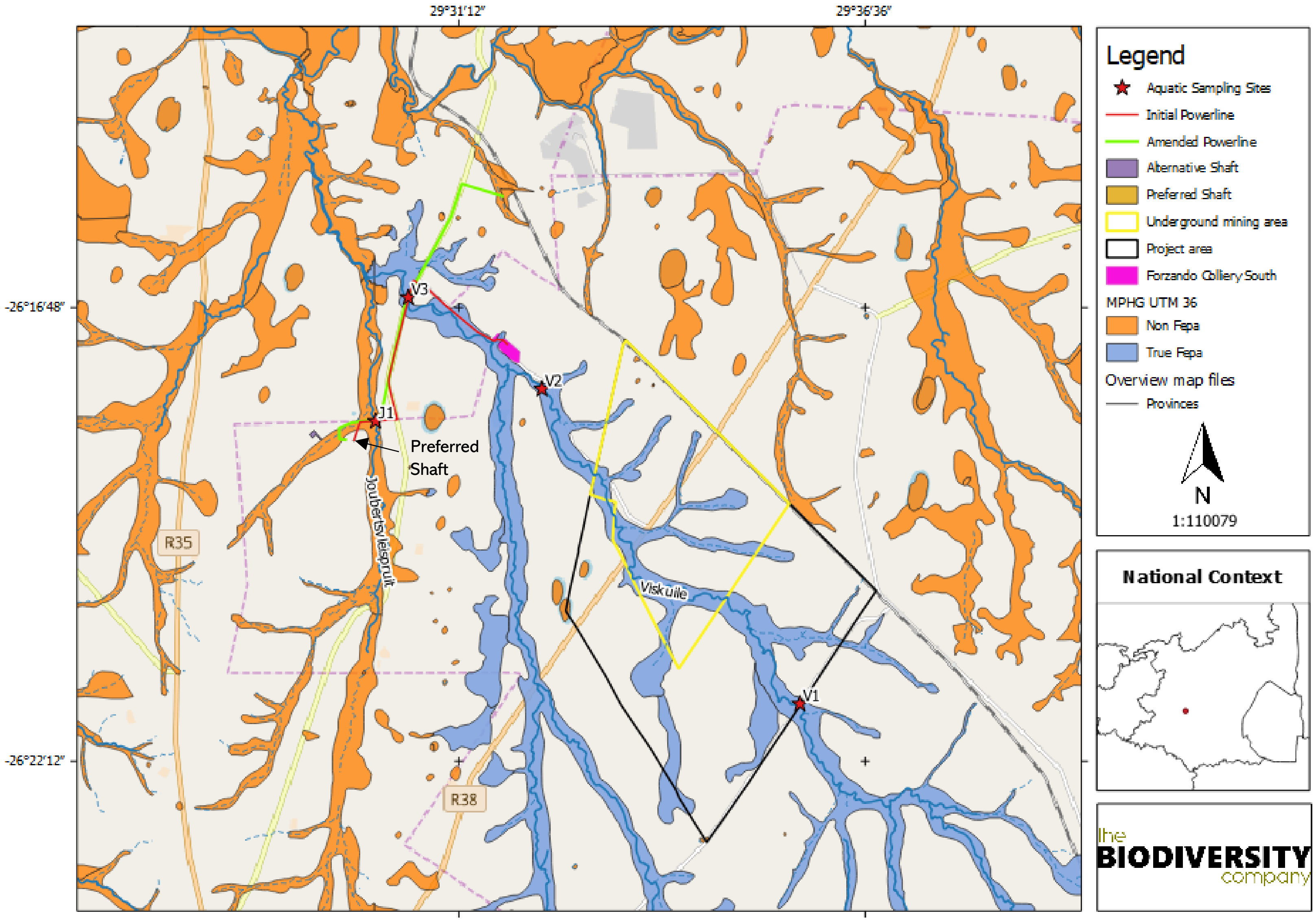


Figure 12: Map illustrating water resources associated with the Kalabasfontein project area

10 Aquatic Ecological Importance and Sensitivity (No-Go Area's)

10.1 Ecological Importance and Sensitivity

The overall Ecological Importance and Sensitivity (EIS) of the river reaches in this study were assessed according to Kleynhans (1996). The results of the EIS assessment are provided in the table below (Table 19).

Table 19: Ecological Importance and Sensitivity Ratings for the Watercourses in the Project area

Biological Determinants		
Determinant	**Rating**	**Comment**
Rare and endangered biota	0	No rare or endangered species/taxon at any scale
Unique biota	0	No population (or taxon) judged to be unique at any scale
Intolerant biota	2	A small proportion of the biota is expected to be dependent on permanently flowing water during some phases of their life cycle.
Species richness	2	On a local scale the species richness is moderate
Habitat Determinants		
Diversity of aquatic habitat	2	Upper reach river system with moderately diverse habitat typical of upper reach
Refuge value of habitat types	2.5	The rivers are largely uniform offering moderate refuge areas. Although in the current drought conditions, large pools serve as adequate refuge
Sensitivity of habitat to flow modification	2	Moderate river system with low sensitivity to flow modification
Sensitivity to flow related water quality changes	2	Large river system with moderate dilution capacity to water quality modification
Migration route corridor for instream and riparian biota	2.5	The watercourses are in the upper reaches of the river systems with several weirs or dams present
National parks and wilderness areas	1.5	No NFEPA listing or nature reserve associated with the watercourses. However, does serve as ecologically sound systems requiring management to protect water quality for downstream areas
Mean	**1.65**	
EIS class	**Moderate**	

The results of the EIS assessment derived a moderate EIS for the Joubertsvleispruit and Viskuile River reaches.

10.2 Spatial Sensitivity Assessment

The layout of sensitive environments in respect to aquatic ecology is presented in Figure 13. It is noted that a 40 m buffer for ventilation shafts and powerlines has been presented in these figures based on the delineated watercourses in the project area. It was noted that the proposed powerline alternatives (initial and amended) are in direct proximity to both the Joubertsvleispruit and the Viskuile rivers (Figure 13). The two powerline alternatives traverse both rivers and falls within the proposed buffer zone. It is further noted that the northern section of the amended powerline traverses a non-perennial drainage line. The underground mining activities are proposed to undermine the Viskuile River at an unknown depth. These activities therefore pose a direct threat to sensitive aquatic ecological habitats.

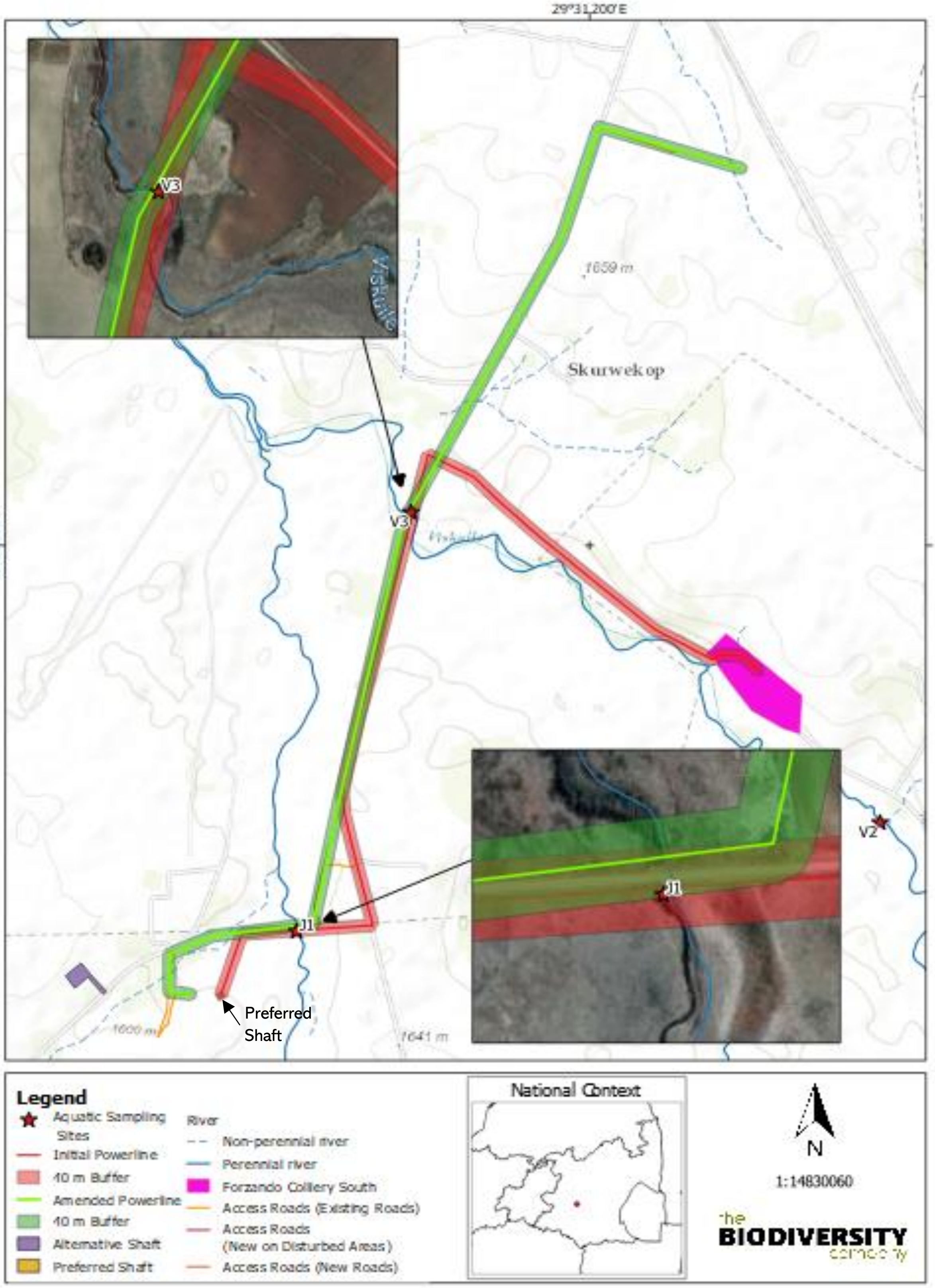


Figure 13: Sensitive Aquatic Habitats associated with the powerline river crossings

11 Impact Assessment

A detailed list of proposed project activities and associated methodologies has not been provided for the compilation of this report. However, based on previous assessments and the study of active underground coal mining activities, as well as the proposed infrastructure layout of this project, the following potential activities and potential impacts are expected.

The aquatic ecology impact assessment includes the following:

- Assess impacts of ongoing and proposed activities on aquatic ecosystems within the project area;
- Assess whether proposed activities are likely to have significant impacts on aquatic ecosystems;
- Identify practically implementable mitigation measures to reduce the significance of proposed activities on the aquatic environment; and
- Assess residual and cumulative impacts after implementation of mitigation measures.

11.1 Methodology

The impact assessment methodology was provided by EIMS and is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (pre-and post-mitigation) by considering the consequence of each impact (nature of impact, extent, duration, magnitude, reversibility and probability). This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor which is applied to the environmental risk to determine the overall significance.

11.2 Current Impacts

The current impacts observed during the survey are listed below. Photographic evidence of a selection of these impacts is shown in Figure 14.

- Agriculture;
- Mining;
- Trampling of marginal vegetation by livestock;
- Artificial impoundments;
- River crossings;
- Flow modification (impoundments);
- Erosion;
- Incised banks;
- Alien and/or Invasive aquatic fauna; and
- Water quality impairment.

Figure 14: Some of the identified impacts within the project area: A) Coal mining, B) Livestock, C) Low water levels and no flow, and D) Erosion and incised banks

11.3 Anticipated Impact Framework

An anticipated impact framework was considered for the impact assessment. The following list provides a framework for the anticipated major impacts associated with the project.

1. Loss / degradation of aquatic habitat and biota
    a. Project activities that can cause loss of habitat (especially with regards to the two proposed infrastructure areas):
        i. Physical removal of vegetation
        ii. Access roads and servitudes
        iii. Alteration of flow volumes in river reaches
        iv. Construction of culverts/bridges for vehicle access
        v. Construction camps & laydown areas
        vi. Earth moving (removal and storage of topsoil and overburden)
        vii. Blasting and excavation
        viii. Pollution of water resources due to dust effects, chemical spills, acid mine drainage, etc.
        ix. Intentional killing of fauna for food (fishing)
        x. Infrastructure development (buildings)
        xi. Linear trench excavation and berm creation
        xii. Soil dust precipitation
        xiii. Coal dust precipitation
        xiv. Stochastic events such as fire (cooking fires or cigarettes from staff)
    b. Secondary impacts anticipated
        i. Erosion and sedimentation
        ii. Loss of instream and riparian habitat
        iii. Displacement/loss of aquatic fauna
        iv. Increased potential for soil erosion (in conjunction with alterations in hydrological regimes)

v. Impaired water quality
vi. Increased potential for establishment of alien & invasive vegetation
vii. Loss of stored carbon & carbon sequestration potential
viii. Loss of ecosystem services

2. Impaired water quality in watercourses

    a. Project activities that can cause impaired water quality in watercourses
        i. Chemical (organic/inorganic) spills
        ii. Erosion and sedimentation
        iii. Untreated runoff or effluent
        iv. Soil dust depression (spraying of roads & exposed areas)
        v. Attachment of powerline to existing watercourse crossing structures
        vi. Produce stockpiles and storage
        vii. Discharge of contaminated groundwater from shafts & voids
        viii. Elevated water temperatures from discharged water
        ix. Runoff from RoM and stockpiles
        x. Seepage from mine infrastructure, waste and stockpile areas
        xi. Leaks, breaches, overtopping and subsurface leaking of PCD's
        xii. Transport of coal
        xiii. Sewage from ablutions
        xiv. Mismanagement of dirty water systems
        xv. Acid mine drainage (decanting)

    b. Secondary impacts associated with pollution in watercourses
        i. Metal leaching and mobilisation of salts during operation
        ii. Contamination of surface water runoff (rain water)
        iii. Contamination of groundwater through infiltration
        iv. Acid Mine Drainage altering physico-chemical conditions of watercourses post closure
        v. Change in aquatic fauna communities
        vi. Change/deterioration of the ecological status of rivers/streams

3. Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography

    a. Project activities that can cause alterations in hydrological regime:
        i. Vegetation removal
        ii. Excavations and infrastructure development
        iii. Trenches for powerline burial
        iv. Road network creation
        v. River crossing infrastructure development
        vi. Alterations to surface topography (due to voids and surface structures)
        vii. Underground mining
        viii. Dewatering of working areas
        ix. Abstraction of water for use in mine operational phase
        x. Decant of water
    b. Secondary impacts associated with alterations in hydrological regime:
        i. Increased or reduced runoff dependent on system manipulation
        ii. Scouring and erosion of river bed and banks
        iii. Change in aquatic fauna communities
        iv. Degradation of the ecological status of rivers/streams

v. Change in water availability in rivers following abstraction for use by mine
vi. Subsidence resulting from void collapse

12 Impact Assessment Results (Significance)

12.1 Planning Phase

The planning phase activities are considered a low risk as they typically involve desktop assessments and initial site inspections. This would include compiling of mine and waste management plans, obtaining of necessary permits, environmental and social impact assessments, characterisation of baseline site conditions, design of mine layouts and facilities and consultation with various contractors involved with a diversity of proposed project related activities going forward.

All project aspects scored the same low level of risk as the planning phase is considered largely desktop with minimal impacts to the aquatic ecosystem (Table 20).

Table 20: Impact significance during the planning phase pre- and post-mitigation

Impact Name	**1. Loss / degradation of aquatic habitat and biota** **2. Impaired water quality in watercourses** **3. Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both shafts, Powerline, Underground Mining & Associated infrastructure**				
Phase	**Planning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	1	1	Magnitude of Impact	1	1
Extent of Impact	1	1	Reversibility of Impact	1	1
Duration of Impact	1	1	Probability	1	1
Environmental Risk (Pre-mitigation)					1
Environmental Risk (Post-mitigation)					1
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.00
Final Significance					1,00

12.2 Construction Phase

The tables below (Table 21 to Table 29) show the significance of potential construction phase impacts on floral and faunal communities before and after implementation of mitigation measures.

The construction phase activities have the potential to degrade water and habitat quality within the considered river systems. Water quality impacts may include increased dissolved/suspended solids, as well as potential persistent pollutants within the water column and sediments of the associated watercourses. Considering this, general water chemistry modification may occur as a result of changed salt balances stemming from the influx of runoff from a modified catchment. Habitat quality impacts are likely to include reduced water volumes, sedimentation, bed, channel and flow modification, as well as the specific loss of aquatic habitat through direct modification during the construction of watercourse crossings (where needed), associated infrastructure (construction camps, ablutions, laydown yards and site office), ventilation shafts and a powerline.

Although the PES (baseline) of the river reaches assessed were derived to range from moderately to largely modified from reference conditions, further deterioration is possible and thus a potential decline in the PES could be observed. Thus, impacts described above will result in reduced aquatic biodiversity on a catchment scale.

Owing to the nature of construction phase activities and the initial disturbance of ground, the significance was rated as low to moderate prior to mitigation. Following mitigation implementation these activities will move to a lower risk.

Table 21: Powerline Impact 1 significance during the construction phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Powerline Alternatives**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	5	6
Environmental Risk (Pre-mitigation)					-10.00
Environmental Risk (Post-mitigation)					-5.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17

Final Significance	-6.13

Table 22: Powerline Impact 2 significance during the construction phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Powerline Alternatives**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	5	3
Environmental Risk (Pre-mitigation)					-12.5
Environmental Risk (Post-mitigation)					-6
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-7.00

Table 23: Powerline Impact 3 significance during the construction phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Powerline Alternatives**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	3	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-10.00
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					

Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.17
Final Significance	-4.08

Table 24: Both Shafts Impact 1 significance during the construction phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Shafts**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	3	1
Environmental Risk (Pre-mitigation)					-6.75
Environmental Risk (Post-mitigation)					-2
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-2.00

Table 25: Both Shafts Impact 2 significance during the construction phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Shafts**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-6.75
Environmental Risk (Post-mitigation)					-3.5
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					

Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-3.50

Table 26: Both Shafts Impact 3 significance during the construction phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Shafts**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-6.75
Environmental Risk (Post-mitigation)					-3.5
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.50

Table 27: Associated Infrastructure Impact 1 significance during the construction phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Associated Infrastructure**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-6.75
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					High

Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-3.50

Table 28: Associated Infrastructure Impact 2 significance during the construction phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Associated Infrastructure**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	3	2	Reversibility of Impact	3	2
Duration of Impact	2	1	Probability	3	3
Environmental Risk (Pre-mitigation)					-8.25
Environmental Risk (Post-mitigation)					-5.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-6.13

Table 29: Associated Infrastructure Impact 3 significance during the construction phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Associated Infrastructure**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	3	2	Reversibility of Impact	3	2
Duration of Impact	2	1	Probability	3	3

Environmental Risk (Pre-mitigation)	-8.25
Environmental Risk (Post-mitigation)	-5.25
Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.17
Final Significance	-6.13

12.3 Operational Phase

The tables below (Table 30 to Table 38) show the significance of potential operational phase impacts on the aquatic ecosystem, water quality and hydrological regime and surface topography before and after implementation of mitigation measures.

As discussed in the construction phase, the activities and interactions listed above have the potential to degrade water and habitat quality within the associated river systems. The storage, transport and processing of carboniferous material presents a risk to contaminate the downstream river reaches. During rainfall events runoff which has been in contact with this material may enter local aquatic ecosystems. Once rainwater is in contact with the carboniferous material, dissolved substances will alter downstream water chemistry resulting in the loss of sensitive aquatic biota. Due to the intricacies related to groundwater and pumping of water from active underground shafts, the decant is likely to have the greatest risk to the three assessed impacts. The significance ranged from low to moderate prior to mitigation. Following mitigation implementation these activities will move to a lower risk.

Table 30: Underground Mining Impact 1 significance during the operational phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Underground Mining**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	3
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	5	4	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.75
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					

Cumulative Impacts	3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.50
Final Significance	-8.25

Table 31: Underground Mining Impact 2 significance during the operational phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Underground Mining**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	2
Extent of Impact	4	2	Reversibility of Impact	2	2
Duration of Impact	5	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-11.25
Environmental Risk (Post-mitigation)					-4.5
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-6.75

Table 32: Underground Mining Impact 3 significance during the operational phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Underground Mining**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	4	1	Reversibility of Impact	3	2
Duration of Impact	5	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-15
Environmental Risk (Post-mitigation)					-3.5
Degree of confidence in impact prediction:					High

Impact Prioritisation	
Public Response	2
Issue has received a meaningful and justifiable public response	
Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.50
Final Significance	-4.67

Table 33: Powerline Impact 1 significance during the operational phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Powerline Alternatives**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	1	1	Reversibility of Impact	1	1
Duration of Impact	1	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-2.00
Environmental Risk (Post-mitigation)					-2.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-2.00

Table 34: Powerline Impact 2 significance during the operational phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Powerline Alternatives**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	1	1	Reversibility of Impact	1	1
Duration of Impact	1	1	Probability	2	1

Environmental Risk (Pre-mitigation)	-2.00
Environmental Risk (Post-mitigation)	-1.00
Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-1.00

Table 35: Powerline Impact 3 significance during the operational phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Powerline Alternatives**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	1	1	Reversibility of Impact	1	1
Duration of Impact	3	2	Probability	1	1
Environmental Risk (Pre-mitigation)					-1.50
Environmental Risk (Post-mitigation)					-1.25
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-1.46

Table 36: Both Shafts Impact 1 significance during the operational phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Shafts**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2

Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.5
Environmental Risk (Post-mitigation)					-1.75
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-1.75

Table 37: Both Shafts Impact 2 significance during the operational phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Shafts**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	1	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-3.5
Environmental Risk (Post-mitigation)					-1.5
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-1.50

Table 38: Both Shafts Impact 3 significance during the operational phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**
Alternative	**Both Shafts**
Phase	**Operation**

Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.5
Environmental Risk (Post-mitigation)					-2
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-2.00

12.4 Decommissioning Phase

The tables below (Table 39 to Table 47) show the significance of potential decommissioning phase impacts on the aquatic ecosystem, water quality and hydrological regime & surface topography before and after implementation of mitigation measures.

The removal of infrastructure and rehabilitation activities will be a large scale operation and thus has the potential to contaminate surface water. The significance ranged from low to moderate prior to mitigation. Following mitigation implementation these activities will move to a lower risk. Particular areas which will require attention includes the RoM stockpiles, screening areas and pollution control facilities. The rehabilitation of these areas will require special attention to avoid contamination of the surrounding aquatic ecosystems.

Table 39: Underground Mining Impact 1 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Underground Mining**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	3
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	5	4	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.75
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2

Issue has received a meaningful and justifiable public response	
Cumulative Impacts	3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.50
Final Significance	-8.25

Table 40: Underground Mining Impact 2 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Underground Mining**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	3
Extent of Impact	4	4	Reversibility of Impact	4	3
Duration of Impact	5	4	Probability	3	3
Environmental Risk (Pre-mitigation)					-12.75
Environmental Risk (Post-mitigation)					-10.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-15.75

Table 41: Underground Mining Impact 3 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Underground Mining**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	4	2	Reversibility of Impact	3	2
Duration of Impact	5	3	Probability	4	2
Environmental Risk (Pre-mitigation)					-15.00
Environmental Risk (Post-mitigation)					-4.5

Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	2
Issue has received a meaningful and justifiable public response	
Cumulative Impacts	3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.50
Final Significance	-6.75

Table 42: Powerline Impact 1 significance during the decommissioning phase pre-and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Powerline Alternatives**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-8.00
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.50

Table 43: Powerline Impact 2 significance during the decommissioning phase pre-and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Powerline Alternatives**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	3	2	Reversibility of Impact	2	2

Duration of Impact	2	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-10.00
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-4.67

Table 44: Powerline Impact 3 significance during the decommissioning phase pre-and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Powerline Alternatives**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	3	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-9.00
Environmental Risk (Post-mitigation)					-3.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-3.50

Table 45: Both Shafts Impact 1 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**
Alternative	**Both Shafts**
Phase	**Decommissioning**
Environmental Risk	

Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	1	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.0
Environmental Risk (Post-mitigation)					-1.5
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-1.50

Table 46: Both Shafts Impact 2 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Shafts**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	1	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-5.25
Environmental Risk (Post-mitigation)					-3.0
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.00

Table 47: Both Shafts Impact 3 significance during the decommissioning phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**

Alternative	Both Shafts				
Phase	Decommissioning				
Environmental Risk					
Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	1	1	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.0
Environmental Risk (Post-mitigation)					-3.0
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.00

12.5 Rehabilitation and Closure Phase

The tables below (Table 48 to Table 56) show the significance of potential rehabilitation and closure phase impacts on the aquatic ecosystem, water quality and hydrological regime & surface topography before and after implementation of mitigation measures.

Typically, following the cessation of underground mining activities groundwater returns to the voids created by the mining process. This process results in the contamination of the groundwater resource. Following this influx of groundwater, seepage and decant at specific locations can result in the ingress of contaminated water in downstream river systems, thus severely degrading the local PES. In addition, in line with the precautionary principle, it is anticipated that the undermining of wetlands and river systems within the project area will result in the subsidence of the surface. The resultant potential impacts include serious changes to surface hydrology resulting in the significant alteration of catchment areas and subsequent habitat levels impacts. The significance ranged from low to high prior to mitigation. Following mitigation implementation these activities will move to a lower risk, with the exception of underground mining related impacts that remained moderate to high. Active water treatment has been provided for, lowering water quality impacts.

Table 48: Underground Mining Impact 1 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	Loss / degradation of aquatic habitat and biota				
Alternative	Underground Mining				
Phase	Rehab and closure				
Environmental Risk					
Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation

Nature of Impact	-1	-1	Magnitude of Impact	3	3
Extent of Impact	3	2	Reversibility of Impact	2	2
Duration of Impact	4	4	Probability	4	3
Environmental Risk (Pre-mitigation)					-12.00
Environmental Risk (Post-mitigation)					-8.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-12.38

Table 49: Underground Mining Impact 2 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Underground Mining**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	3
Extent of Impact	4	3	Reversibility of Impact	4	3
Duration of Impact	5	4	Probability	4	3
Environmental Risk (Pre-mitigation)					-17.00
Environmental Risk (Post-mitigation)					-9.75
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-14.63

Table 50: Underground Mining Impact 3 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**
Alternative	**Underground Mining**

Phase	Rehab and closure				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	3
Extent of Impact	4	4	Reversibility of Impact	3	3
Duration of Impact	5	4	Probability	4	4
Environmental Risk (Pre-mitigation)					-15.00
Environmental Risk (Post-mitigation)					-14.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-21.00

Table 51: Powerline Impact 1 significance during the rehabilitation and closure phase pre-and post-mitigation

Impact Name	Loss / degradation of aquatic habitat and biota				
Alternative	**Both Powerline Alternatives**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	2	1	Reversibility of Impact	2	1
Duration of Impact	2	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.0
Environmental Risk (Post-mitigation)					-1.0
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-1.17

Table 52: Powerline Impact 2 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Powerline Alternatives**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	3	2	Reversibility of Impact	2	1
Duration of Impact	2	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.50
Environmental Risk (Post-mitigation)					-1.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-1.46

Table 53: Powerline Impact 3 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Powerline Alternatives**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	2	1	Reversibility of Impact	2	1
Duration of Impact	3	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.50
Environmental Risk (Post-mitigation)					-1.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1

The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.17
Final Significance	-1.17

Table 54: Both Shafts Impact 1 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Loss / degradation of aquatic habitat and biota**				
Alternative	**Both Shafts**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	3	2	Reversibility of Impact	2	1
Duration of Impact	1	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.0
Environmental Risk (Post-mitigation)					-1.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-1.25

Table 55: Both Shafts Impact 2 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Impaired water quality in watercourses**				
Alternative	**Both Shafts**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	3	2	Reversibility of Impact	2	1
Duration of Impact	2	1	Probability	3	1
Environmental Risk (Pre-mitigation)					-6.75
Environmental Risk (Post-mitigation)					-1.5
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1

Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-1.50

Table 56: Both Shafts Impact 3 significance during the rehabilitation and closure phase pre- and post-mitigation

Impact Name	**Alterations in hydrological regime (flow of surface and sub-surface water) and surface topography**				
Alternative	**Both Shafts**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	1
Extent of Impact	3	2	Reversibility of Impact	2	1
Duration of Impact	1	1	Probability	2	2
Environmental Risk (Pre-mitigation)					-4
Environmental Risk (Post-mitigation)					-2.5
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-2.50

12.6 Unplanned Events

The planned activities will have known impacts as discussed above; however, unplanned events may occur on any project and may have potential impacts which will need mitigation and management. A summary of the findings from an aquatic ecology perspective is presented in Table 57. Please note that not all potential unplanned events may be captured herein and this must therefore be managed throughout all phases of the project lifecycle.

Table 57: Unplanned Events, Risks and their Management Measures

Unplanned Event	Potential Impact	Mitigation
Hydrocarbon spill into riverine habitat	Contamination of sediments and water resources associated with the spillage.	A spill response kit must be available at all times. The incident must be reported on and if necessary a wetland specialist must investigate the extent of the impact and provide rehabilitation recommendations.
Uncontrolled erosion	Sedimentation of downstream river reach.	Erosion control measures must be put in place.
PCD overflow	The degradation of downstream water quality.	The overflow must be stopped immediately, and the impacted area remediated. Spill protection berms must be in place as well.
Subsidence	Collapse of voids with resultant altered surface topography. This is likely to affect various aspects within the Viskuile River	Appropriate board and pillar mining methods should be implemented to prevent possible subsidence.

12.7 Mitigation Measures

The mitigation actions provided below are important to consider in conjunction with other specialist assessments which include but are not limited to the following specialist studies: Biodiversity and Wetlands. These mitigation measures should be implemented in the Environmental Management Plan (EMP) should the project go-ahead. The mitigation hierarchy proposed by Macfarlane *et al.*, (2016) was considered for this study (Figure 15).

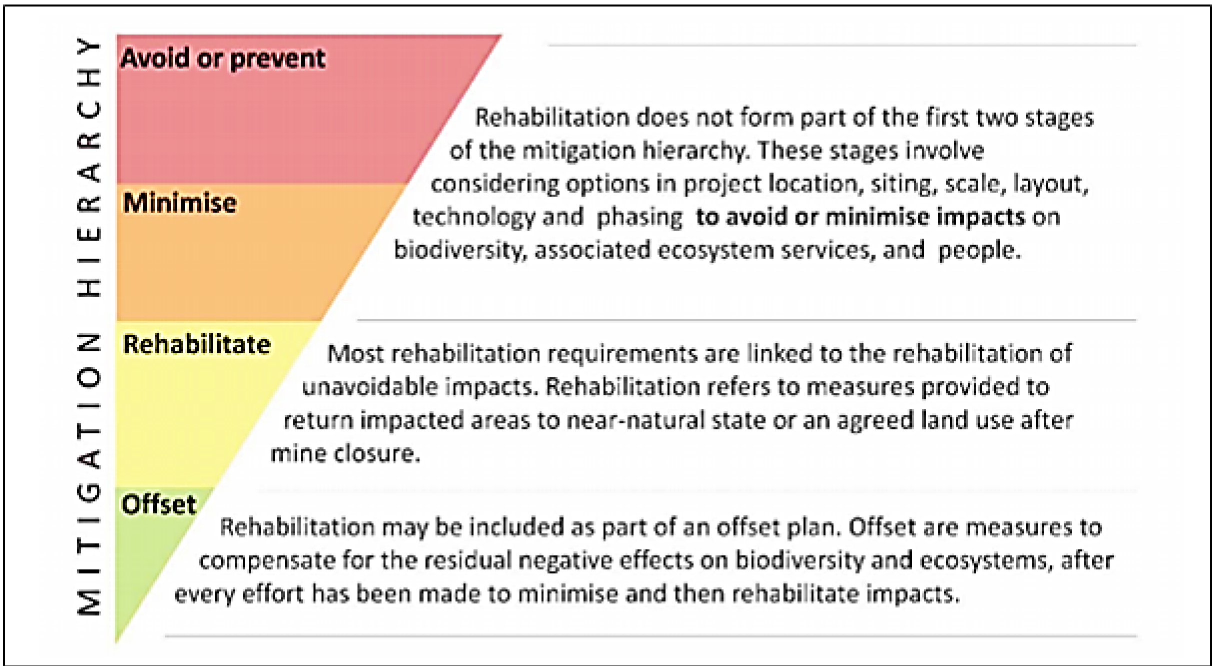


Figure 15: The Mitigation Hierarchy (Macfarlane et al., 2016)

As observed above, avoiding and preventing loss of sensitive landscapes are the first stage of the mitigation hierarchy. Considering this, the layout of the proposed infrastructure within the Kalabasfontein project area should, wherever possible, remain away from areas that are defined as sensitive as outlined in this report.

A number of general mitigation measures are recommended for the project as a whole, while more specific measures are detailed in the following sections which relate to impacts to aquatic ecology specifically. The mitigation measures supplied below must be read with, and implemented, in conjunction with those mitigation measures recommended in the specialist wetland and biodiversity reports.

It is recommended that an Erosion Risk Assessment and Management Plan is completed and implemented to derive the areas at highest risk for erosion. These high-risk areas should then be key points for erosion management throughout the entirety of the project lifecycle.

Areas where high subsidence risk has been determined should be completely avoided to reduce the risk for surface hydrology alterations. Should unavoidable subsidence occur, rehabilitation actions must be implemented to avoid further effects to downstream river reaches. This may include the implementation of a river diversion around impacted areas. This would require additional environmental approvals and additional specialist studies should this be required.

The establishment of a clearly marked buffer zone, which is defined as a region of natural vegetation between the rivers/wetlands and the proposed activity, is the primary management action that should take place. Literature suggests that a buffer zone can reduce aquatic habitat and water quality impacts of large developments, making this management action of particular importance (WRC, 2014). According to WRC (2014) the efficacy of a buffer is related to the distance between the river system and the zone of disturbance. Therefore, by increasing the length of a buffer, the potential aquatic modification related to the proposed activity is reduced. The Wetland Ecology Study for this project defined the proposed buffer zones from delineated wetland areas (TBC, 2018). The designated buffer zones should then be demarcated using signage or fences.

During the various phases of the proposed project, waste generated and stored can result in the runoff and seepage of contaminated water from the various activities which can cause degradation of the aquatic ecosystems PES. In order to prevent this, the compilation of a stormwater management plan is advised, this would typically form a component of the surface water assessment. The use of diversion and containment management is of significant importance. This can be achieved through effective groundwater and surface water management.

- Diversion trench and berm systems which diverts clean stormwater around pollution sources and convey and contain dirty water to central pollution control impoundments;
- Barrier systems, including synthetic, clay and geological liners or other approved mitigation methods to minimise contaminated seepage and runoff from entering the local aquatic systems;
- Where storm water enters river systems from disturbed sites, sediment and debris trapping, as well as energy dissipation control measures must be put in place; and
- The planting of indigenous vegetation around pollution control impoundments and structures should be completed as this has been shown to be effective in erosion and nutrient control (phytoremediation).

The construction of linear infrastructure such as the powerline, ventilation shafts, roadways and conveyor systems should consider the following mitigation actions when encountering wetland systems and watercourses:

- No crossings over riffle/rapid habitats. These should be avoided as these are the most sensitive; slow deep/shallow habitats should be favoured for crossings;
- The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation;
- The amended powerline should be suspended over the river crossings rather then buried underneath rivers. It can be attached to existing river crossing structures (bridges and culverts) such as those as sites J1 and V3;
- Structures must not be damaged by floods exceeding the magnitude of those which may occur on average once in every 50 years;
- The indiscriminate use of heavy vehicles and machinery within the instream and riparian habitat will result in the compaction of soils and vegetation and must be controlled;
- Erosion prevention mechanisms such as gabions must be employed to ensure the sustainability of all structures to prevent instream sedimentation;
- The crossing points should be unobtrusive (outside riparian and instream habitat) to prevent the obstruction and subsequent habitat modification of downstream portions;
- Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. These trenches and ditches can be vegetated to improve soil stability and clean the water;
- Soils adjacent to the river that have been compacted must be loosened to allow for germination of vegetation; and
- Stockpiling of removed soil and sand must be done outside the 1:100 flood line or riverine buffer (whichever is greater). This will prevent solids from washing into the river during high flow events.

The removal of vegetative cover, as well as the construction of roads has been recognised as being responsible for increased runoff, sedimentation and subsequent water and habitat quality degradation in downstream portions of river systems (WRC, 2014). As such the careful management of vegetation removal and sedimentation control should take place. This can be achieved through the brief points below:

- Minimise the removal of vegetation in the infrastructure footprint area;
- Re-vegetation of the construction footprint as soon as possible;
- Where storm water enters river systems, sediment/silt and debris trapping, as well as energy dissipation control measures must be put in place;
- 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;

- Sequential removal of the vegetation (not all vegetation immediately); and
- The vegetation of unpaved roadsides/margins.

During the operational phase of the proposed project, the storage and handling of carboniferous material can result in the degradation of downstream aquatic ecosystems. In order to prevent this, the use of diversion and containment management is of importance. This can be achieved through effective groundwater and surface water management. Important management actions are briefly listed below:

- Diversion trench and berm systems which diverts clean storm water around pollution sources and convey and contain dirty water to central pollution control impoundments;
- Barrier systems, including synthetic, clay and geological or other approved mitigation methods to minimise contaminated seepage and runoff from stockpiles and pollution control facilities from entering the local aquatic systems;
- Where storm water enters river systems from disturbed sites, sediment and debris trapping, as well as energy dissipation control measures must be put in place; and
- The planting of indigenous vegetation around pollution control impoundments and structures as well as along road sides on routes used to transport coal should be completed as this has been shown to be effective in erosion and nutrient control.

As described in the potential impacts of this proposed project, there is potential for Acid Mine Drainage to develop as a result of underground mining activities. The only mitigation possible for potential mine water decant is the use of passive or active water treatment. This is therefore recommended.

General mitigation measures would include the following:

- An experienced, qualified environmental control officer must be on site when construction begins to oversee environmental compliance to the proposed mitigation;
- Dust-reducing mitigation measures must be put in place and must be strictly adhered to;
- Any topsoil that is removed during construction must be appropriately removed and stored according to the national and provincial guidelines. This includes on-going maintenance of such topsoil piles so that they can be utilised during decommissioning phases and re-vegetation;
- All dumping of waste material, especially bricks and contaminated materials or soils, must be prevented; and
- Compilation of and implementation of an alien vegetation management plan for the entire site, including the surrounding project area and especially the aquatic and wetland areas.

12.8 Recommendations and Environmental Management Plan

Based on the outcomes of this study, the following actions are recommended.

- Completion of erosion risk assessment and management plan;

- An adaptive Stormwater Management Plan; and
- Bi-annual Aquatic Biomonitoring.

The bi-annual aquatic biomonitoring and environmental monitoring plan is provided in Table 58. It is noted that the mitigation actions provided in this assessment must make use of the proposed mitigation actions as an Environmental Management Plan.

Table 58: Environmental Monitoring Programme

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
Current sites should be monitored	Overall PES	Bi-annual	Standard River Ecosystem Monitoring Programme (Ecostatus) methods
Current sites should be monitored	Determine if water quality deterioration is occurring.	Bi-annual	SASS5 scores should not decrease as a result of mining related activities.
Current sites should be monitored	Determine if water quality deterioration is occurring.	Monthly	Standard water quality monitoring
Current sites should be monitored	Determine if water/habitat quality deterioration is occurring.	Bi-annual	Monitor for presence of fish.

An important consideration for cumulative regional scale impacts includes the assessment of the salt loading potential of the anticipated Acid Mine Drainage should it enter into the Olifants Water Management Area. It is likely salt loads in the watercourses will be altered should this occur. This modification will have an influence on the management decisions for water resource objectives.

The watercourses considered in this assessment as defined in Classes and Resource Quality Objectives of Water Resources for Catchments of the Olifants (DWS, 2016). are located in HN1 (B11A) of the Upper Olifants River Catchment Integrated Unit of Analysis (IUA). The Resource Quality Objectives (RQO) for the defined IUA are provided in Table 59.

Table 59: The Resource Quality Objectives for River Instream Habitat and Biota in the Olifants Catchment (DWS, 2016)

Integrated Unit of Analysis	Resource Quality Objective	Numerical Limits
Upper Olifants River catchment	Instream habitat must be in a largely modified or better condition to support the ecosystem and for ecotourism users. Instream biota must be in a largely modified or better conditions and at sustainable levels. Low and high flows must be suitable to maintain the river habitat for ecosystem condition and ecotourism. <u>Water quality:</u> Nutrient concentrations must be improved to prevent nuisance conditions for ecotourism	Instream Habitat Integrity category ≥ D (≥ 42) Fish ecological category: ≥ D (≥ 42) Macroinvertebrate category: ≥ D (≥ 42) Instream Ecostatus category ≥ D (≥ 42) Hydrological category ≥ D (≥ 42) Water Quality category: ≥ D (≥ 42)

	Salt concentrations must be maintained at levels where they do not render the ecosystem unsustainable	

Both the default and recommended ecological category (REC) for the project area watercourses are moderately modified (class C) according to DWS (2018a) and DWS (2018b), respectively. During this baseline assessment, the ecological category was achieved for the Joubertsvleispruit and partially achieved (class C/D) for the Viskuile River. The precautionary approach has been adopted, and resources management should maintain for the default and recommended ecological category with possibility of bettering it going forward. Should the proposed project go-ahead, and successfully implement mitigation and avoidance actions, the cumulative impact to the SQR's will be low to moderate. However, should mitigation actions not occur successfully, there is potential for further impacts to SQR's.

13 Conclusion

The results of the PES assessments indicated that the project area has been altered (historically and currently) predominantly by agricultural land use. The assessed Joubertsvleispruit river reach was classed as moderately modified (class C). Flow and instream habitat modification has resulted in modified biological responses. Instream habitat modification can be attributed to local agricultural activities compounded by poor rainfall. The assessed Viskuile River reach was classed as moderately to largely modified (class C/D). Water quality modification in the upper reaches of the watercourse compounded by modified flow in the reach resulted in modified aquatic ecology. The modification of the watercourse can be attributed to poor connectivity due to poor rainfall, agricultural activities and alteration of the river for water storage.

No red listed fish species were expected or sampled within the river reaches in the project area. However, total of nine fish species, comprising five native, two translocated native and two alien invasive species were captured during this study. The fish community structures are largely intact, despite introductions of additional species. This diversity is indicative of the importance of these systems to collectively provide refugia and corridors for dispersal throughout the project area. Despite modification, the preservation of these systems is of importance for the consideration of the proposed mining project.

Owing to the absence of typical riparian features, no riparian delineation could be completed for the project area.

Underground mining requires the placement of new infrastructure (ventilation shaft, powerline and infrastructure associated with new underground area) and associated mining activities. These activities will have a significant impact on the local environment and ecological processes. Both of the proposed infrastructure areas (underground area and powerline/ventilation shafts area) at Kalabasfontein are situated in proximity to, underlay or traverse watercourses considered sensitive to further modification.

Careful consideration must be afforded to each of the recommendations provided in this report. In the event that environmental authorisation is issued for this project, proven ecological (or environmental) controls and mitigation measures must be entrenched in the management framework. It is recommended that the existing aquatic biomonitoring plan be reassessed to ensure that it is comprehensive and covers all associated project areas prior to the issuing of any environmental authorisation.

The following recommendations were reached based on the results of this assessment:

- The RQO's for the WMA should be honoured with the aim to meet the default and recommended ecological category (REC) of moderately modified (class C) for the project area watercourses;
- The primary recommended mitigation measure for this project is to ensure that an appropriate, proactive and adaptive Acid Mine Drainage management plan be implemented from the onset of the proposed project; and
- A secondary recommended mitigation measure is to ensure that the powerline be attached to existing river crossing infrastructure before undisturbed areas are considered.

13.1 Impact Statement

An impact statement is required as per the NEMA regulations with regards to the proposed development.

Considering the above-mentioned conclusions, it is the opinion of the specialist that no significant fatal flaws for the Kalabasfontein project with the current proposed infrastructure layout areas were identified. The Kalabasfontein project area, although predominantly classed as moderately to largely modified, does have sensitivity to further modification and should be preserved throughout all phases of the project lifecycle.

Due to the sensitivities of the project environment, and should authorisation be approved for this project, all mitigation measures and recommendations must be strictly adhered to.

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