



Water Resource Report for the proposed expansion of the Vlakovarkfontein Coal Mine

Mpumalanga, South Africa

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CLIENT



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Report Name	Water Resource Report for the proposed expansion of the Vlakvarkfontein Coal Mine	
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EXECUTIVE SUMMARY

Ntshovelo Mining Resources (Pty) Ltd, a subsidiary of Mbuyelo Coal (Pty) Ltd, has appointed Geo Soil and Water cc (GSW) as the Environmental Assessment Practitioner (EAP) to assist with undertaking the necessary authorisation and amendment processes for Vlaskvarkfontein Coal Mine. In turn GSW has appointed Environmental Impact Management Services (EIMS) as well as various specialist sub-consultants to assist with compiling the necessary reports and undertaking the statutory consultation processes, in support of proposed extensions to the Vlaskvarkfontein Coal Mine.

The Biodiversity Company was commissioned to conduct specialist studies to supplement the abovementioned applications. The water resource assessment comprises wetland and aquatic ecology specialist components. An assessment of the wetland systems was conducted on the 6th November 2017, which constitutes an early wet season survey. The assessment of the local river systems is included in an annual biomonitoring programme, with fieldwork completing during 12th June 2017 (high flow) and 25th October 2017 (early high flow).

The Vlaskvarkfontein mining operations are located approximately 40 km South West of the City of Emalahleni, Mpumalanga Province. The project area is in the B20F and B20E quaternary catchments within the Olifants Water Management Area (WMA2), Highveld – Lower Ecoregion. Three drainage systems and a single NFEPA wetland are associated with the project area. Water resources include the Leeufontein River, Wilge River, and the Blesbok system which is regarded as a wetland.

Standard methodologies were used to determine the Present Ecological Status, Ecological Importance and Sensitivity for the aquatic and wetland ecology components of this study.

One (1) wetland type was identified within the 500m project assessment boundary, namely a depression, which comprised of two units. No other wetlands were identified within the larger 500m study area. The overall wetland health for the systems was determined to be that of a Largely Modified (D) system. The wetland type had overall Intermediate levels of service, with only some water quality enhancement services showing a moderately high level of benefit. The EIS and direct human importance for the wetlands was rated to be Low (D). The hydrological / functional importance was rated as Moderate (C).

The project is for the proposed expansion of the Vlaskvarkfontein Coal Mine. The expansion of the mining area will result in the loss of the delineated wetlands. Alternatively, should the depressions be avoided, and the surrounding areas be mined, the removal of the stockpiles and subsequent change to the topographical features will remove a source for hydrological inputs which will result in the loss of the wetlands. Additionally, the wetlands are considered to be a result of the mining operation, and are not regarded as natural systems. It is apparent that the loss of these wetlands is unavoidable, and no buffer zone is suitable for either of the above-mentioned options.

The loss of these depressions is not regarded as a fatal flaw for this project. The DWS should be consulted in order to determine the need, if any, for a wetland offset strategy.



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Owing to the fact that the Leeuspruit, Blesbok and Wilge systems are in excess of 500m from the proposed expansion area, the focus for the impact assessment were the delineated depressions. These systems are regarded as artificial systems and largely a result of the mining activities, but despite this, these systems do provide some level of ecological service, particularly with regards to water quality enhancement.

The most notable impact is the expectant loss some water resources, the delineated depressions in particular. The significance of the loss if regarded as high, and the loss of wetlands is avoidable due to the nature of the project. It is worth mentioning that the loss of the wetlands is regarded as permissible for this project, owing to the fact that these wetlands are a result of the current mining operation, and are therefore classified as artificial systems. Thus there is no preference to assign a buffer to these areas and avoid disturbances to these systems, because as the landscape changes to accommodate the rest of the proposed expansion, the hydrological inputs to these wetlands will be lost as a result.

Impact	Alternative	Phase	Pre-mitigation	Post-mitigation
Loss of water resources	P1a	Construction	Medium	Medium
Loss of water resources	S1	Construction	Medium	Medium
Altered Hydrological Regime	P1a	Construction	Low	Low
Impaired water quality	P1a	Construction	Low	Low
Erosion and sedimentation of water resources	P1a	Construction	Low	Low
Spread and/or establishment of alien and/or invasive species	P1a	Construction	Low	Low
Altered Hydrological Regime	P1b	Operation	Low	Low
Impaired water quality	P1b	Operation	Low	Low
Impaired water quality	P4a	Operation	Low	Low
Erosion and sedimentation of water resources	P1b	Operation	Low	Low
Spread and/or establishment of alien and/or invasive species	P1b	Operation	Low	Low
Loss of water resources	P1a	Closure	Medium	Medium
Loss of water resources	S1	Closure	Medium	Medium
Impaired water quality	P1a	Closure	Low	Low
Impaired water quality	S1	Closure	Low	Low

The expectant level of risk posed to the Leeuspruit, Blesboks and Wilge systems by the relevant aspects is low both without and with mitigation. These two watercourses are in excess of 500m from the proposed expansion, and the area between the project and water resources is buffered by the local land uses and access routes. As a result of this, the significance of any impact to these two systems is expected to be negligible, if any.

This study has concluded that no significant risks are posed to the local water resources by the proposed expansion of the Vlakkvarkfontein Coal Mine.



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Declaration

I, Christian Fry 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.



Christian Fry

Aquatic Specialist

The Biodiversity Company

20 November 2017



Declaration

I, Andrew Husted 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.



Andrew Husted

Aquatic / Wetland Ecologist

The Biodiversity Company

20 November 2017



1 Introduction

Ntshovelo Mining Resources (Pty) Ltd, a subsidiary of Mbuyelo Coal (Pty) Ltd, has appointed Geo Soil and Water cc (GSW) as the Environmental Assessment Practitioner (EAP) to assist with undertaking the necessary authorisation and amendment processes for Vlakvarkfontein Coal Mine. In turn GSW has appointed Environmental Impact Management Services (EIMS) as well as various specialist sub-consultants to assist with compiling the necessary reports and undertaking the statutory consultation processes, in support of proposed extensions to the Vlakvarkfontein Coal Mine.

Ntshovelo has an approved Mining Right (Reference: MP 30/5/1/2/2/300 MR) and Environmental Management Programme (EMPR), in terms of the Minerals and Petroleum Resources Development Act (Act 28 of 2002, as amended) (MPRDA), for the mining of coal at the Vlakvarkfontein Coal Mine. Ntshovelo wishes to extend the mining operations at the Vlakvarkfontein Coal Mine, located on Portions 5, 13, and 18 of the Farm Vlakvarkfontein 213 IR.

It is proposed to expand the open cast mining operations, using the roll-over mining method, onto Portion 5 of the farm Vlakvarkfontein 213IR. This area is within the existing approved mining right boundary but was not specifically included and assessed in the approved Environmental Management Programme Report (EMPR) and associated environmental permits and authorisations. The proposed new mining operations will necessitate the relocation and re-establishment of the existing ancillary infrastructure associated with the current mining operations, including the Pollution Control Dam (PCD) and the administrative structures. It is also proposed to establish a coal processing plant (wash plant) to decontaminate the Run of Mine (RoM) coal. An application for the amendment to the existing Mine Works Programme (MWP) and EMPR, through an MPRDA Section 102 Application, and a full Environmental Impact Assessment (EIA) for the proposed new mining area is, therefore, required to support an application for environmental authorisation (EA) / waste management licence (WML) as applicable. A new water use licence application (WULA) for the relevant water use triggers associated with the proposed project will also be undertaken.

The Biodiversity Company was commissioned to conduct specialist studies to supplement the abovementioned applications. The water resource assessment comprises wetland and aquatic ecology specialist components. An assessment of the wetland systems was conducted on the 6th November 2017, which constitutes an early wet season survey. The assessment of the local river systems is included in an annual biomonitoring programme, with fieldwork completing during 12th June 2017 (high flow) and 25th October 2017 (early high flow).

This report presents the results of an aquatic and wetland ecological study on the environments associated with the proposed expansion project. This report should be interpreted after taking into consideration the findings and recommendations provided by the specialist herein. Further, this report should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.



1.1 Aim and objective

The aim of the assessment was to provide information to guide the proposed expansion of the coal mine with respect to the current ecological state of the aquatic and wetland ecosystems in the area of study. As part of this assessment, the following objective were established:

- The determination of the baseline Present Ecological Status (PES) of the local river and wetland systems;
- The delineation and assessment of wetlands within 500m of the proposed development area;
- The evaluation of the extent of site-related impacts;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Description of the Project Area

The Vlakvarkfontein mining operations are located approximately 40 km South West of the City of Emalahleni, Mpumalanga Province. The project area is in the B20F and B20E quaternary catchments within the Olifants Water Management Area (WMA2), Highveld – Lower Ecoregion. Three drainage systems and a single NFEPA wetland are associated with the project area. Water resources include the Leeufontein River, Wilge River, and the Blesbok system which is regarded as a wetland. A locality map of the project area is presented in Figure 1.

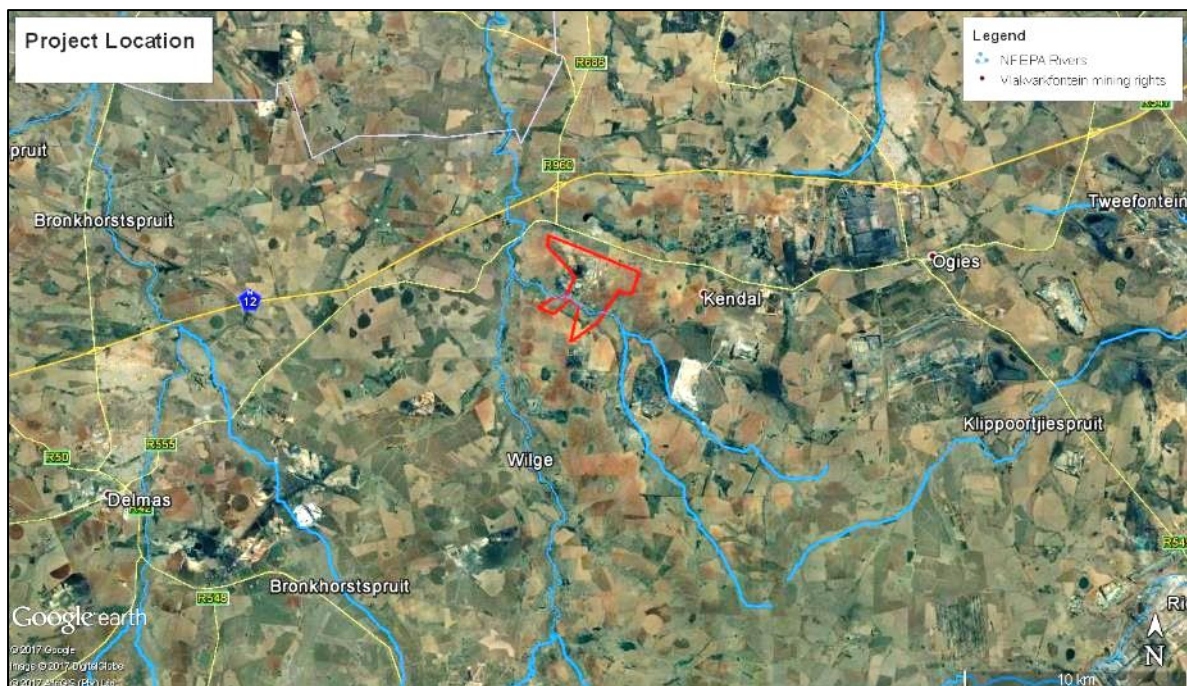


Figure 1: Location of the Vlakvarkfontein Coal Mine



Table 1: The desktop information pertaining to the B20E-1290 Sub Quaternary Reach

Component/Catchment	Leeufontein (B20E-1290)
Present Ecological Status	Largely Modified (Class D)
Ecological Importance Class	Moderate
Ecological Sensitivity	Moderate
Default Ecological Category	Moderately Modified (Class C)

Based on the above table (Table 1) the desktop PES of this reach of the Leeufontein River is a class D or largely modified. The confidence in this classification is low due to the long distance of the considered SQR (32 km). The ecological importance and sensitivity of the river reach was rated as moderate. The defined Default Ecological Category for the river was class C or moderately modified. The current gradient of the considered river reach in proximity to the project area was found to be a class E geoclass. This places the river as a lowland river reach.

Table 2: The desktop information pertaining to the B20F-1150 Sub Quaternary Reach

Component/Catchment	Wilge (B20F-1150)
Present Ecological Status	Moderately Modified (Class C)
Ecological Importance Class	High
Ecological Sensitivity	Very high
Default Ecological Category	Largely Natural (Class A)

Based on the above table (Table 2) the desktop PES of this reach of the Wilge River is a class C or moderately modified. The confidence in this classification is low due to the long distance of the considered SQR (44 km). The ecological importance and sensitivity of the river reach was rated as high and very high respectively. The defined Default Ecological Category for the river was class A or natural. The current gradient of the considered river reach in proximity to the project area was found to be a class D geoclass. This places the river as a lowland river reach.



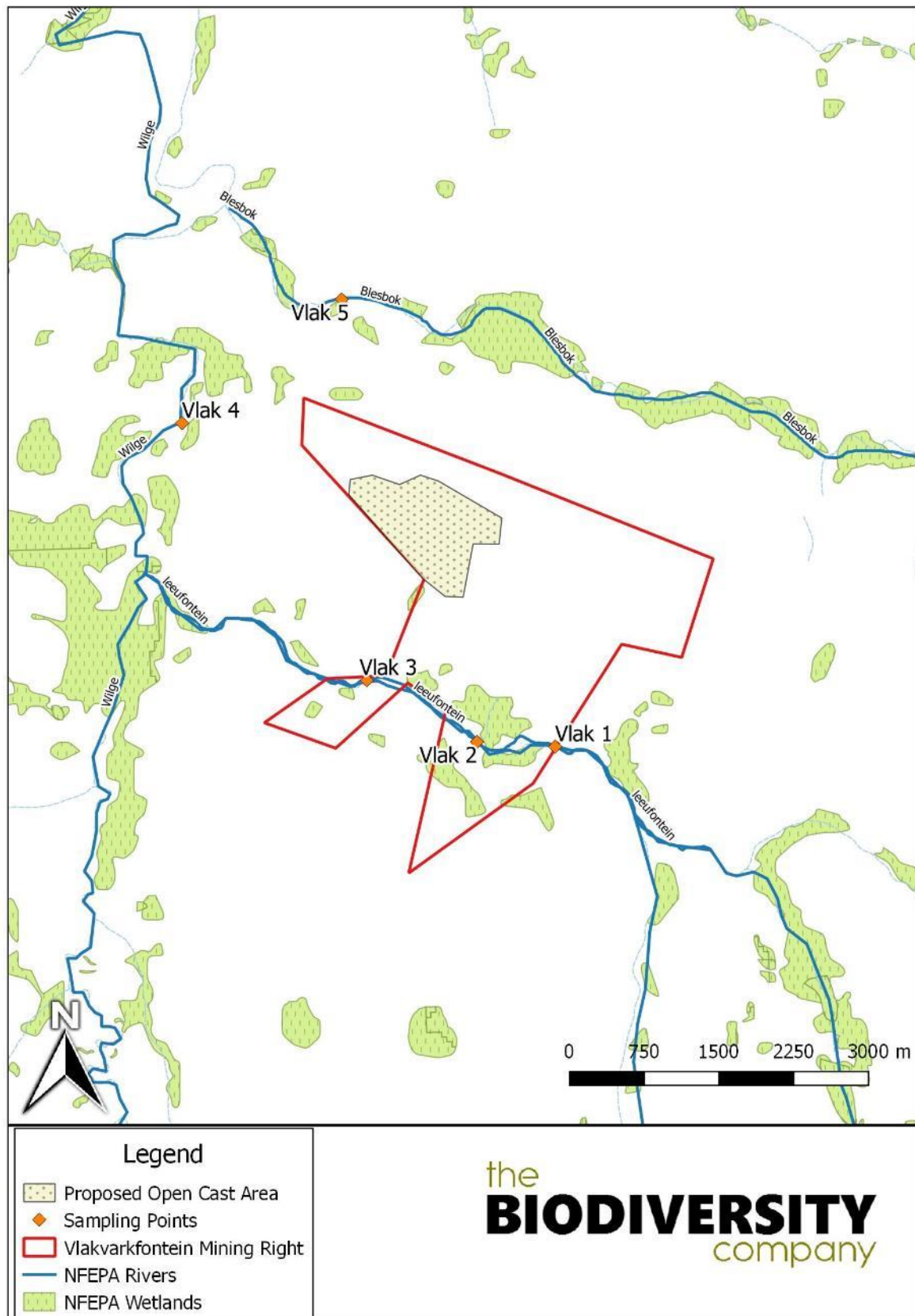










Figure 2: Location of aquatic sampling points











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Table 3: Location of the aquatic sampling points (Photographs: Low flow - June 2017; High flow - October 2017)

VLAKE1	Upstream	Downstream
High Flow		
Low Flow		
GPS	26° 4'31.04"S 28°54'18.44"E	
VLAKE2	Upstream	Downstream
High Flow		
Low Flow		
GPS	26° 4'29.51"S 28°53'50.19"E	







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VLAKE3	Upstream	Downstream
High Flow		
Low Flow		
GPS coordinates	26° 4'9.55"S 28°53'10.39"E	
VLAKE4	Upstream	Downstream
High Flow		
Low Flow		
GPS coordinates	26° 2'46.16"S 28°52'3.63"E	



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VLA5	Upstream	Downstream
High Flow		
Low Flow		
GPS coordinates	26° 2'6.04"S 28°53'1.28"E	



3 Methodology

3.1 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (<http://bgis.sanbi.org>);
- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel, et al. 2011);
- The Mpumalanga Highveld wetlands; and
- Contour data (5m).

3.2 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) was considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels. In addition, the method also includes the assessment of structural features at the lower levels of classification (Ollis, et al. 2013).

3.2.1 Wetland Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 3. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.



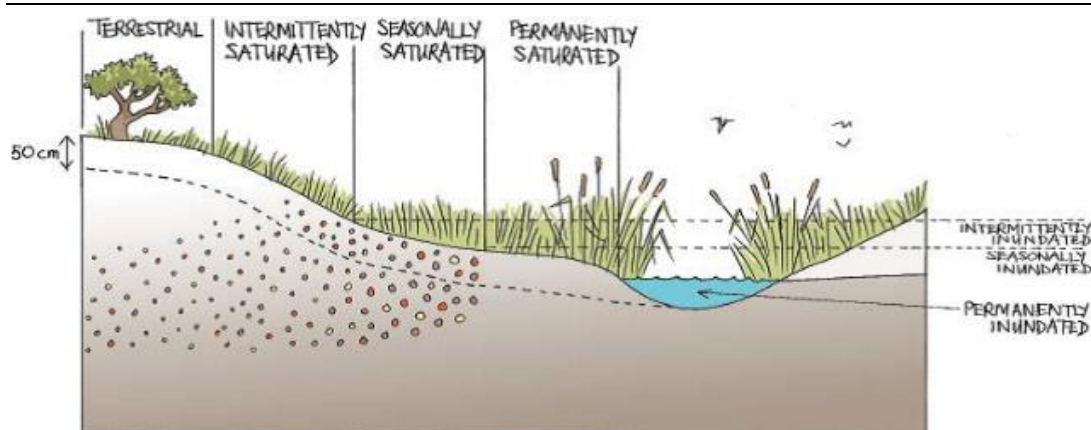


Figure 3: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, et al. 2013)

3.2.2 Wetland Present Ecological Status (PES)

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 4.

Table 4: The PES categories (Macfarlane, et al. 2009)

Impact Category	Description	Impact Score Range	Present State Category
None	Unmodified, natural	0 to 0.9	A
Small	Largely Natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.0 to 1.9	B
Moderate	Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2.0 to 3.9	C
Large	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	Seriously Modified. The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	6.0 to 7.9	E
Critical	Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F



3.2.3 Wetland Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze, et al. 2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 5).

Table 5: Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

3.2.4 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 6..

Table 6: Description of EIS categories.

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	A
High	2.1 to 3.0	B
Moderate	1.1 to 2.0	C
Low Marginal	< 1.0	D

3.3 Buffer Determination

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane, et al., 2014) was used to determine the appropriate buffer zone for the proposed activity.



3.4 Aquatic Assessment

3.4.1 Water Quality

Water quality was measured *in situ* using a handheld calibrated Extech ExStik II meter. The constituents considered that were measured included: conductivity ($\mu\text{S}/\text{cm}$), temperature ($^{\circ}\text{C}$) and Dissolved Oxygen (DO) in mg/l .

3.4.2 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), 1999 were used to define the ecological status of the river reach.

The area covered in this assessment included a 10km reach of the Nonoti River from the upstream site S1 to the downstream S4 sampling point. This habitat assessment model compares current conditions with reference conditions that are expected to have been present.

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 7 and Table 8 respectively.

Table 7: Criteria used in the assessment of habitat integrity (Kleynhans, 1998)

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.



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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. Allochthonous 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 8: 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

3.4.3 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.

3.4.3.1 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



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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 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 (Table 9).

Table 9: Biological Bands / Ecological categories for interpreting SASS data (adapted from Dallas, 2007)

Class	Ecological Category	Description
A	Natural	Unimpaired. High diversity of taxa with numerous sensitive taxa.
B	Largely natural	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.
C	Moderately modified	Moderately impaired. Moderate diversity of taxa.
D	Largely modified	Considerably impaired. Mostly tolerant taxa present.
E/F	Seriously Modified	Severely impaired. Only tolerant taxa present.

* Average Score per Taxa

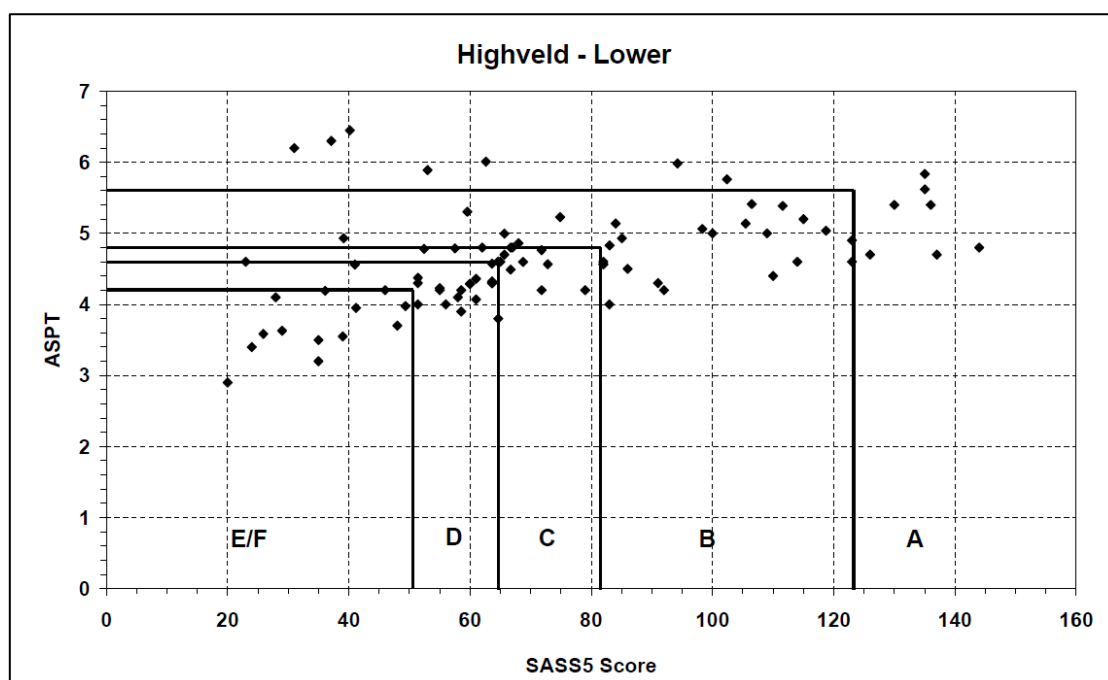


Figure 4: Guidelines used for the interpretation and classification of the SASS5 scores (Dallas, 2007)



3.4.3.2 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.

3.4.4 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 minnow traps, cast nets and 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) and Skelton (2001). It is noted that the FRAI Frequency of Occurrence (FROC) ratings were calculated based on the habitat present at the sites.

3.4.5 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).

3.5 Impact Assessment

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 (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. 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 (PF) which is applied to the ER to determine the overall significance (S).



4 Limitations and Assumptions

- The GPS used for wetland delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.
- Wetland systems identified at desktop level within 500 m of the project area were considered for the identification and desktop delineation, with wetland areas within the project area being the focus for ground truthing.



5 Results and Discussion

5.1 Desktop Soils

According to the land type database (Land Type Survey Staff, 1972-2006) the project area is located within the Ba5 land type. Taking into consideration the relatively flat gradient of the land type, the dominant soil forms expected on the upper and midslopes include Hutton, Glenrosa and Avalon forms. The dominant wetland soils in the lower lying areas are expected to be Rensburg and Longlands forms. The land type is shown in Table 10 and described in the table below.

Table 10: The expected soil features for the land type present

Land Type	Expected Soil Features
Ba5	PLINTHIC CATENA: UPLAND DUPLEX AND MARGALITIC SOILS RARE; Dystrophic and/or mesotrophic; red soils widespread

5.2 Wetland National Freshwater Priority Areas

A total of four (4) FEPA wetland systems were identified within the 500m assessment buffer of the project, with all of the systems classified as wetland flats. The systems are either classified as natural or artificial systems, but owing to the fact that the systems are located in an existing mining area, it is more likely that the wetland are artificial. The integrity of these FEPA wetlands is considered to be in a seriously (Z2) to critically (Z3) modified state. These systems are also a Rank 6, suggesting no ecological significance on any level. The FEPA sites within 500m are listed in Table 11.

Table 11: NFEPA description for the FEPA sites

Classification Levels				Wetland Vegetation Class	Natural / Artificial	Wetland Condition	Wetland Rank
L1 (System)	L2 (Ecoregion)	L3 Landscape Position	L4 HGM Classification				
Inland System	Highveld	Bench	Flat	Mesic Highveld Grassland	Natural & Artificial	Z2 – Z3	Rank 6



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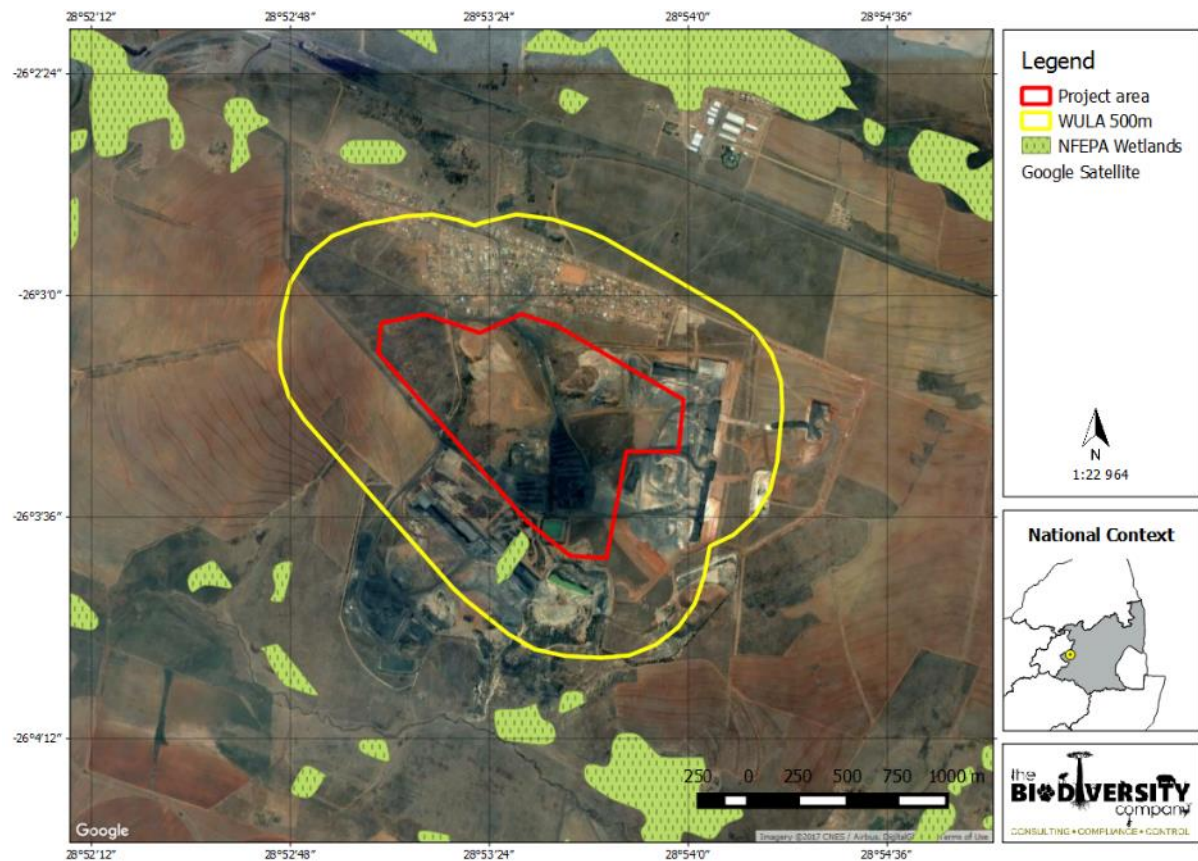


Figure 5: The FEPA wetlands in the project assessment area

5.3 The Mpumalanga Highveld wetlands

The Mpumalanga Highveld (MPHG) wetlands dataset was considered for the proposed expansion, and no systems are located within 500m of the proposed expansion footprint (Figure 6).



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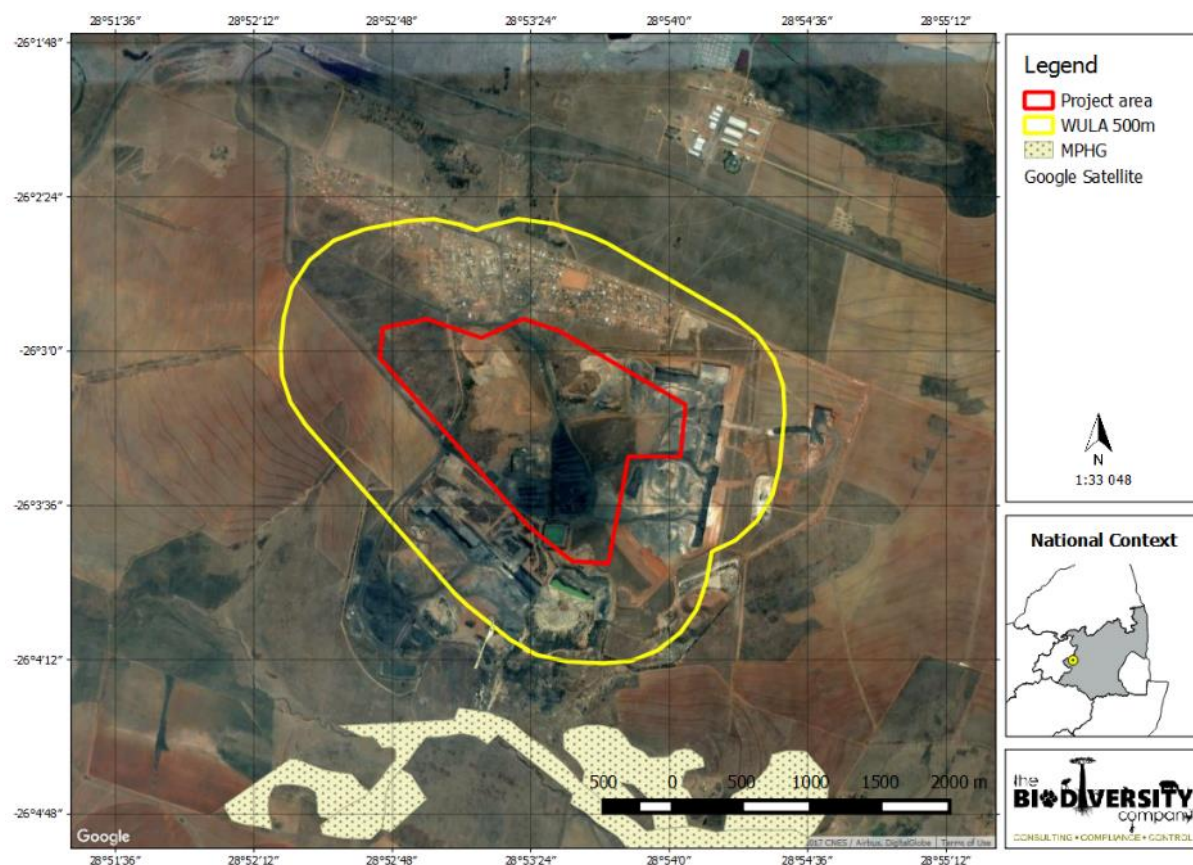


Figure 6: The MPHG wetlands in the project assessment area

5.4 Aquatic National Freshwater Priority Areas

The two sub-quaternary catchments (B20E-1290 and B20F-1150) have a total of 8 freshwater priority areas designated to them (Table 12). Sites VLAK1, VLAK2 and VLAK3 fall under the Leeufontein sub-quaternary reach (SQR) B20E-1290. Site VLAK4 and VLAK5 fall under the Wilge sub-quaternary reach (SQR) B20F-1150.

Table 12: NFEPA's for the two sub-quaternary catchments

Type of FEPA map category	Biodiversity features
B20E-1290	
Number of wetland clusters	1 WetCluster FEPA
Wetland ecosystem type	Mesic Highveld Grassland Group 4_Unchannelled valley-bottom wetland
B20F-1150	
Number of wetland clusters	5 WetCluster FEPAs
Wetland ecosystem type	Mesic Highveld Grassland Group 4_Channelled valley-bottom wetland
Wetland ecosystem type	Mesic Highveld Grassland Group 4_Depression



Wetland ecosystem type	Mesic Highveld Grassland Group 4_Flat
Wetland ecosystem type	Mesic Highveld Grassland Group 4_Seep
Wetland ecosystem type	Mesic Highveld Grassland Group 4_Unchannelled valley-bottom wetland

5.5 Wetland Assessment

The A National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) (V3.0, 1 arcsec resolution) Digital Elevation Model (DEM) was obtained from the United States Geological Survey (USGS) Earth Explorer website. Basic terrain analysis was performed on this DEM using the SAGA GIS software that encompassed a slope and channel network analyses in order to detect catchment areas and potential drainage lines respectively. A 3-dimensional (3-D) representation and watershed delineation with surface flow direction for the project are presented in Figure 7 and Figure 8 respectively.

The normalized difference vegetation index (NDVI) was created to provide a graphical indicator to determine the extent of live green vegetation or not, to assist with the delineation of wetland area. Landsat data was processed for numerous time periods, and an example of the NDVI data generated for data acquired is presented in Figure 9.

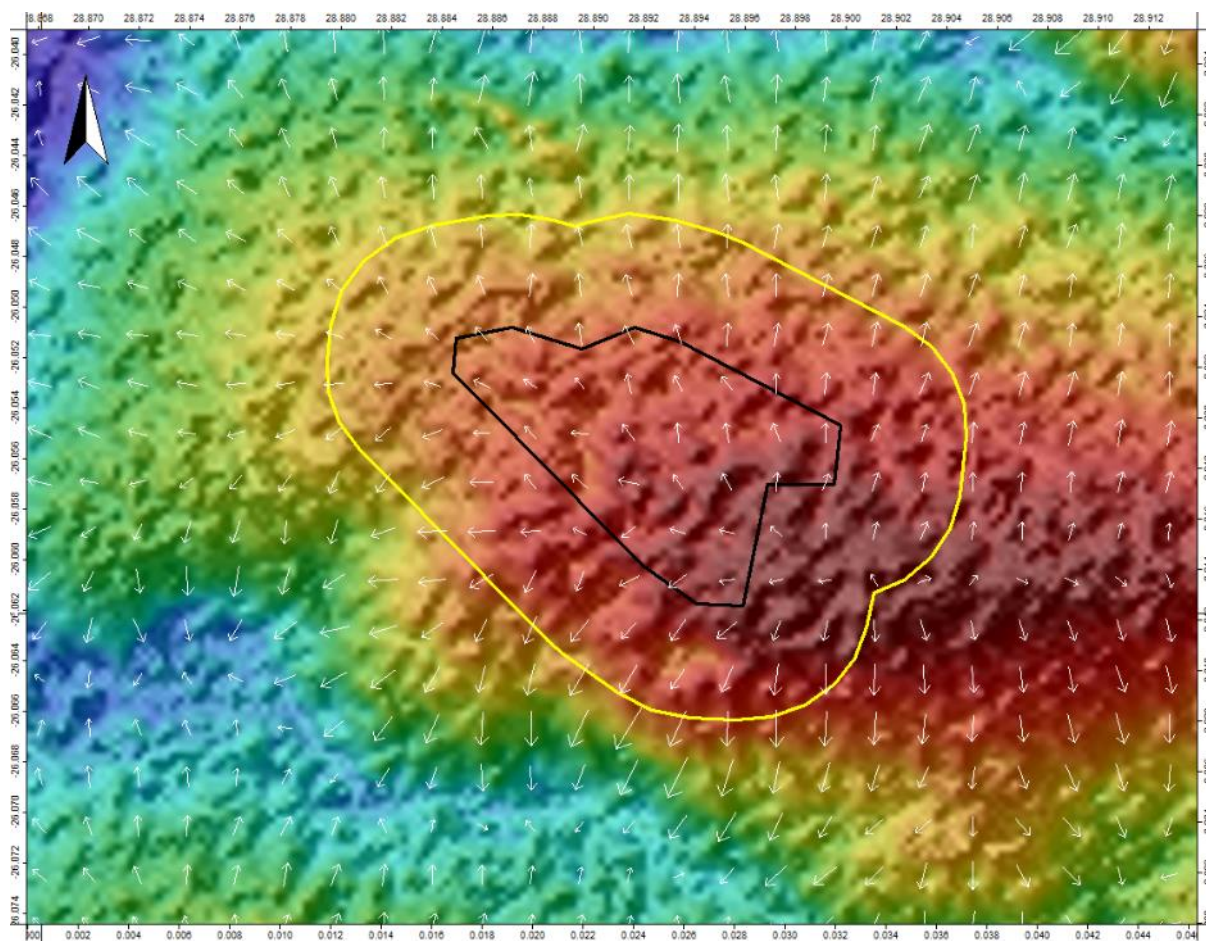


Figure 7: A 3D representation for the project area



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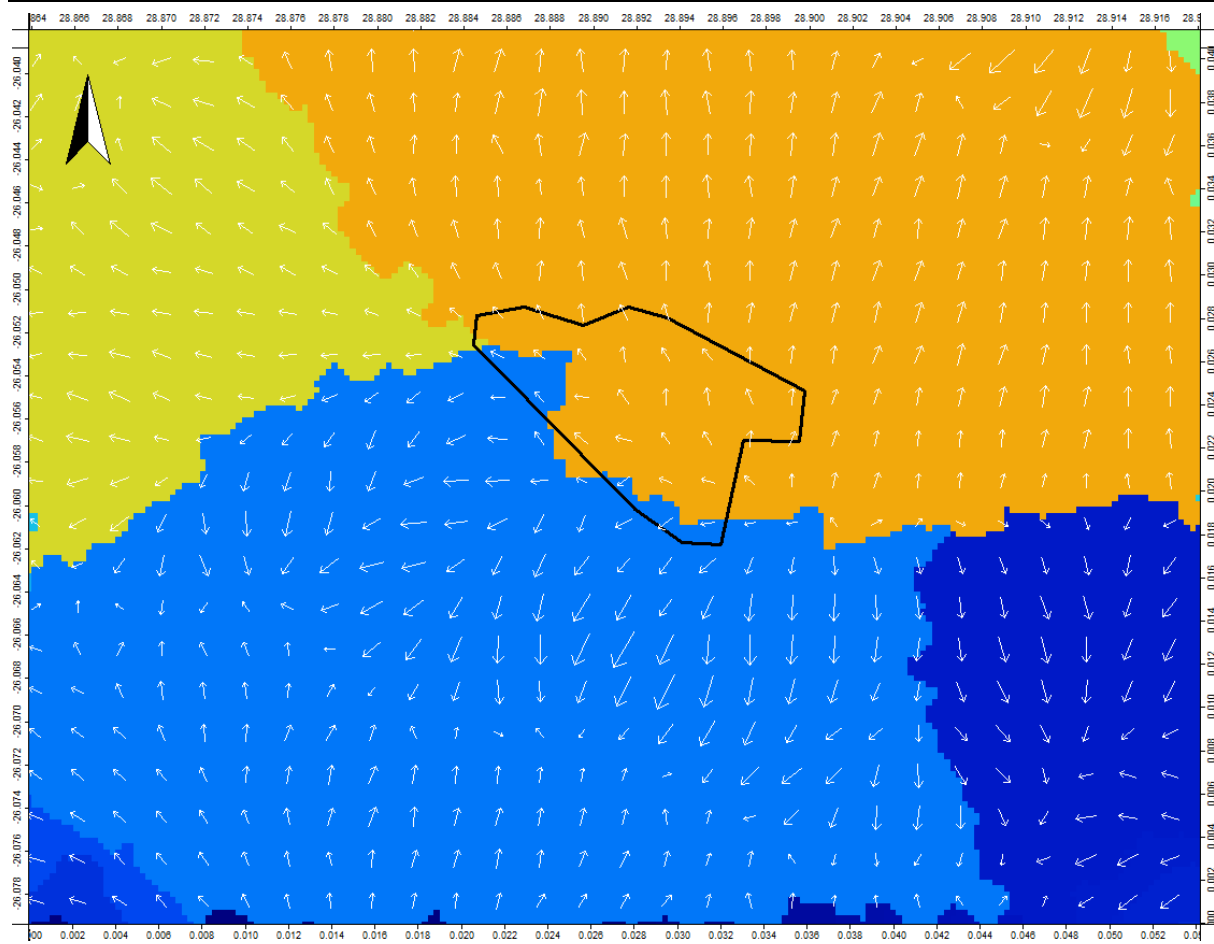


Figure 8: The watershed and flow direction for the project area



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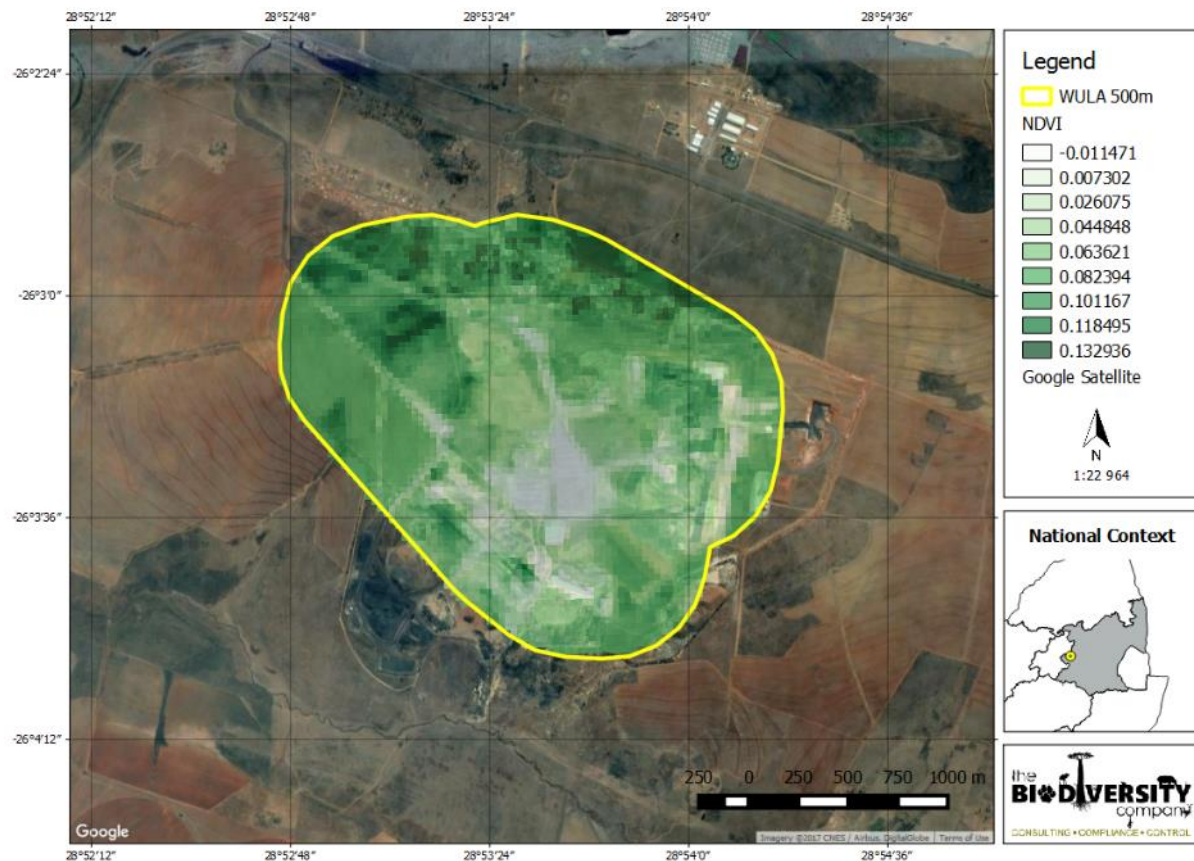


Figure 9: The NDVI data created for the study area

The wetland delineation is shown in Figure 10. The wetland classification as per SANBI guidelines (Ollis *et al.*, 2013) in Table 13. One (1) wetland type was identified within the 500m project assessment boundary, namely depressions.

Two small depressions were identified and delineated within the project area. No other wetlands were identified within the larger 500m study area. These two wetland units are approximately 100m apart from one another, and have been collectively assessed for this study. The vegetation associated with the wetland areas has been cleared for the mining operation, and the Katspruit soil form was confirmed for these depressions. According to the DWAF (2005) delineation guidelines, this soil form is indicative of a permanent wetland zone.

A Katspruit soil form has been classified next to a large disturbed area. This soil form is fully saturated and indicates a small wetland area. The disturbed area up-slope from the wetland has been severely compacted. This compaction can be explained by a combination of heavy machinery and vehicles crossing this area over the past few years as well as probable salinization that has increased dispersion and ultimately crust formation of which the latter is well documented by (Ghadiri *et al.*, 2004). To confirm the latter, sufficient sampling and laboratory tests will be required to establish the concentration of sodium within the soil. The intense compaction/crusting in the area has led to intense run-off which ultimately accumulated in the small depression which has therefore been classified as a wetland. Furthermore, run-off has ensured that fine clay particles have accumulated within this depression which ultimately contributes to the water holding potential of the soil form. The



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Katspruit soil form is characterised by an orthic top soil with high amounts of clay (45-60%) which is approximately 200mm deep. This layer is on top of a saturated G horizon which is approximately 400mm deep. The total soil profile is approximately 600-800mm deep with 10-15% rockiness.

An illustration of the two systems in the relevant landscape, and the hydro-dynamics of the systems are presented in Figure 11.

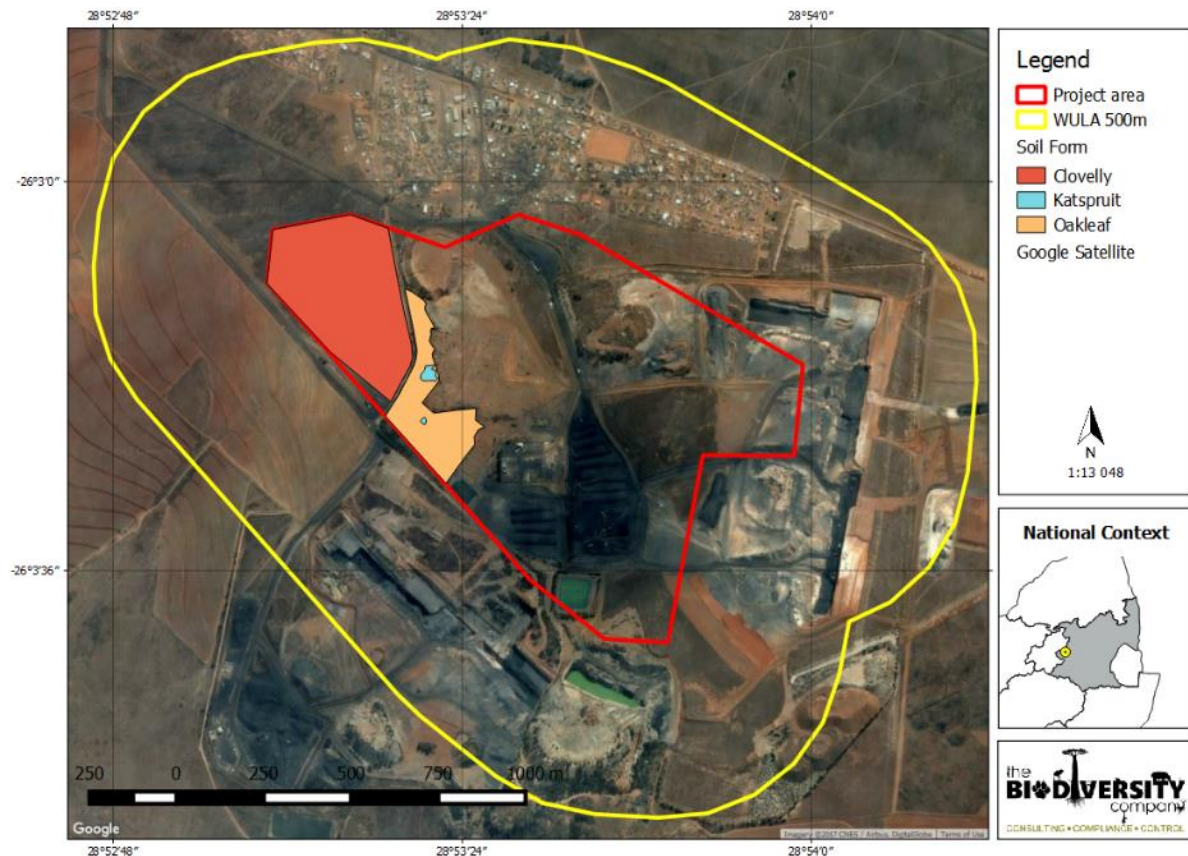


Figure 10: The delineated watercourses within 500m of the project area

Table 13: Wetland classification as per SANBI guideline (Ollis *et al.*, 2013)

Level 1	Level 2		Level 3	Level 4		
System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
Inland	Highveld	Mesic Highveld Grassland	Slope	Depression	Endorheic	Without outflow



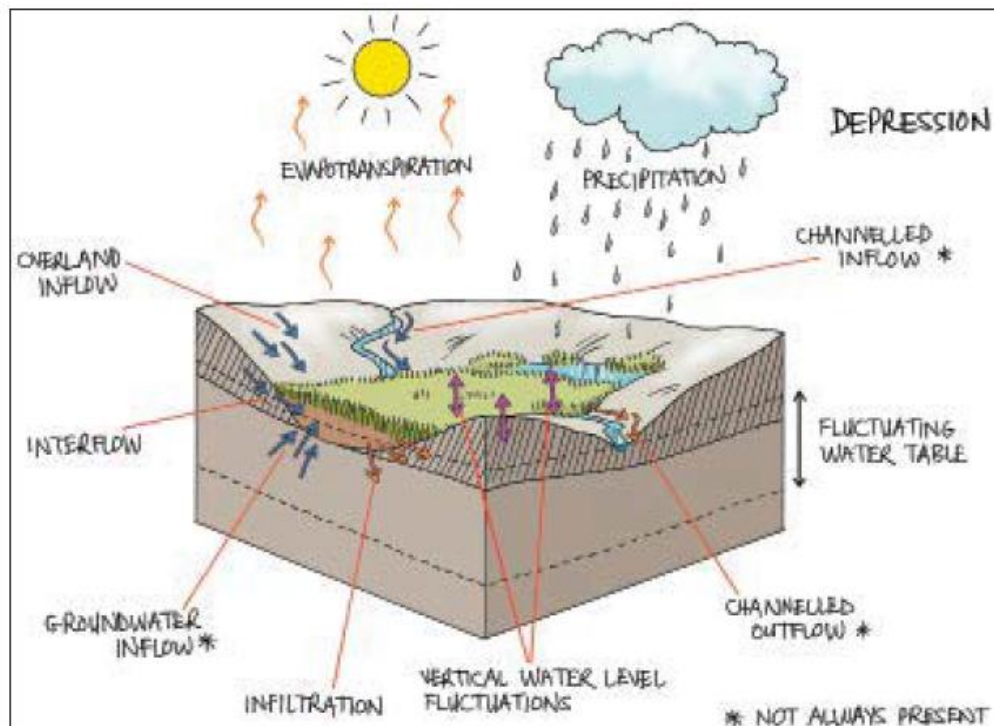

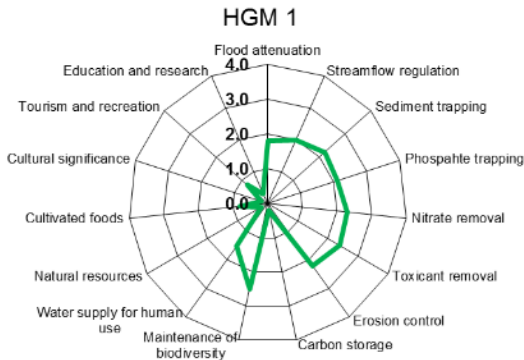


Figure 11: Conceptual illustration of a wetlands, showing the typical landscape setting and the dominant inputs, throughputs and outputs of water (Ollis et al., 2013)



Table 14: A summary of the results for the HGM type

	Depression(s)
Description:	The Clovelly and Oakleaf soil forms were identified within the non-wetland areas. The Katspruit form was identified within the depression, this is indicative of a permanent wetland zone. The depression has been formed due to the mining operation, with run-off being directed to the depression area. The vegetation of the depression is not typically characteristic of a wetland, and represents grassland species, with stands of Black Wattle.
Photograph: Overall Wetland	
Overall Present Ecological State	Largely Modified (D)
Hydrology	Largely Modified
Geomorphology	Largely Modified
Vegetation	Seriously Natural (F)
WET-EcoServices description: The following shows services with moderately high levels or higher for: <ul style="list-style-type: none"> • Phosphate assimilation; • Toxicant assimilation; and • Erosion control. 	
EIS	Low (D)
Hydrological/Functional Benefit	Moderate (C)
Direct Human Benefits	Low

5.5.1 Present Ecological State (PES)

The PES for the assessed HGM units is presented in Table 15. Photographs of aspects that has contributed to the modifications of the systems are presented in Figure 12. The overall wetland health for HGM 1 was determined to be that of a Largely Modified (D) system. Figure 13 depicts the PES of the wetland systems.



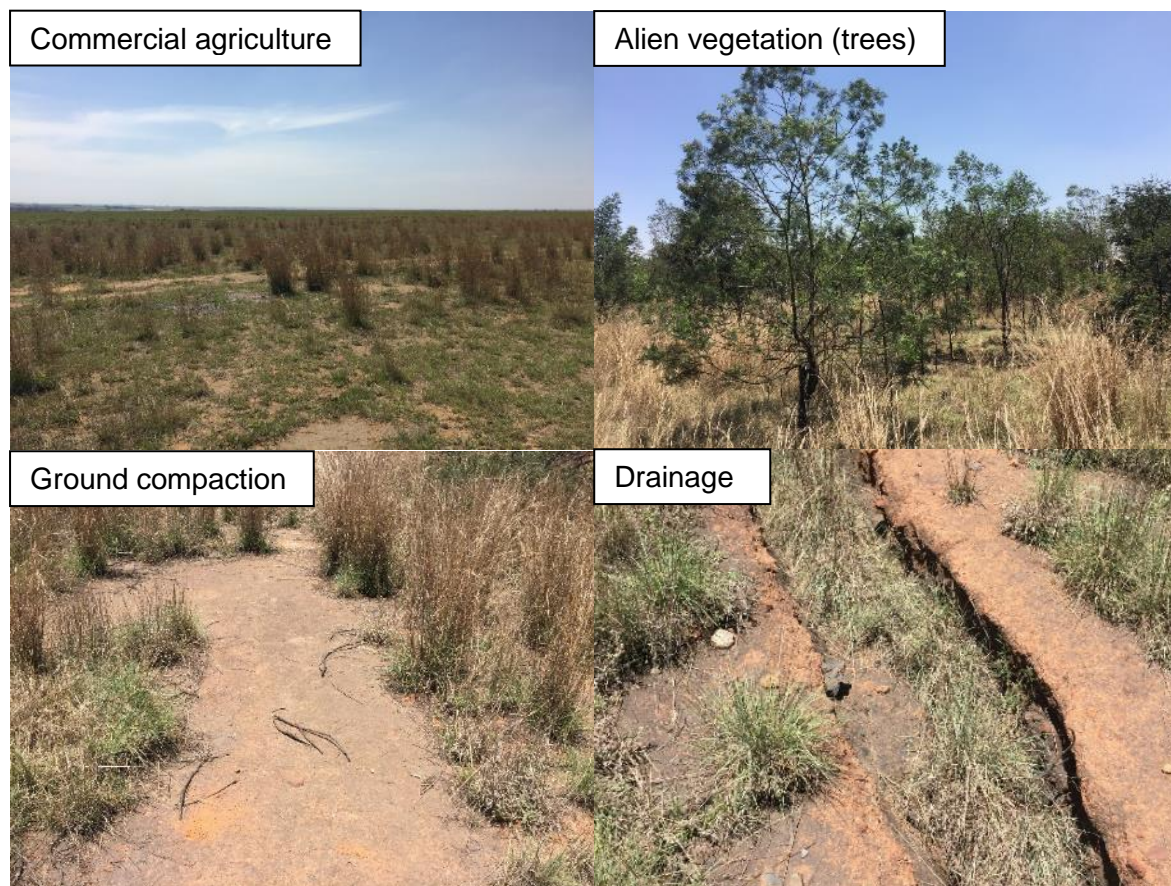


Figure 12: Photographs of aspects impacting on the wetlands

The hydrology of the systems has been largely modified due to the adjacent mining operations. Run-off from the mining stockpiles has diverted and increased the volume of stormwater in these systems. Due to this, the hydrological inputs are not necessarily considered to be natural, and the removal or loss of the stormwater input is likely to result in the loss of the wetland. This status indicates that a large change in ecosystem processes and loss of natural habitat and biota and has occurred.

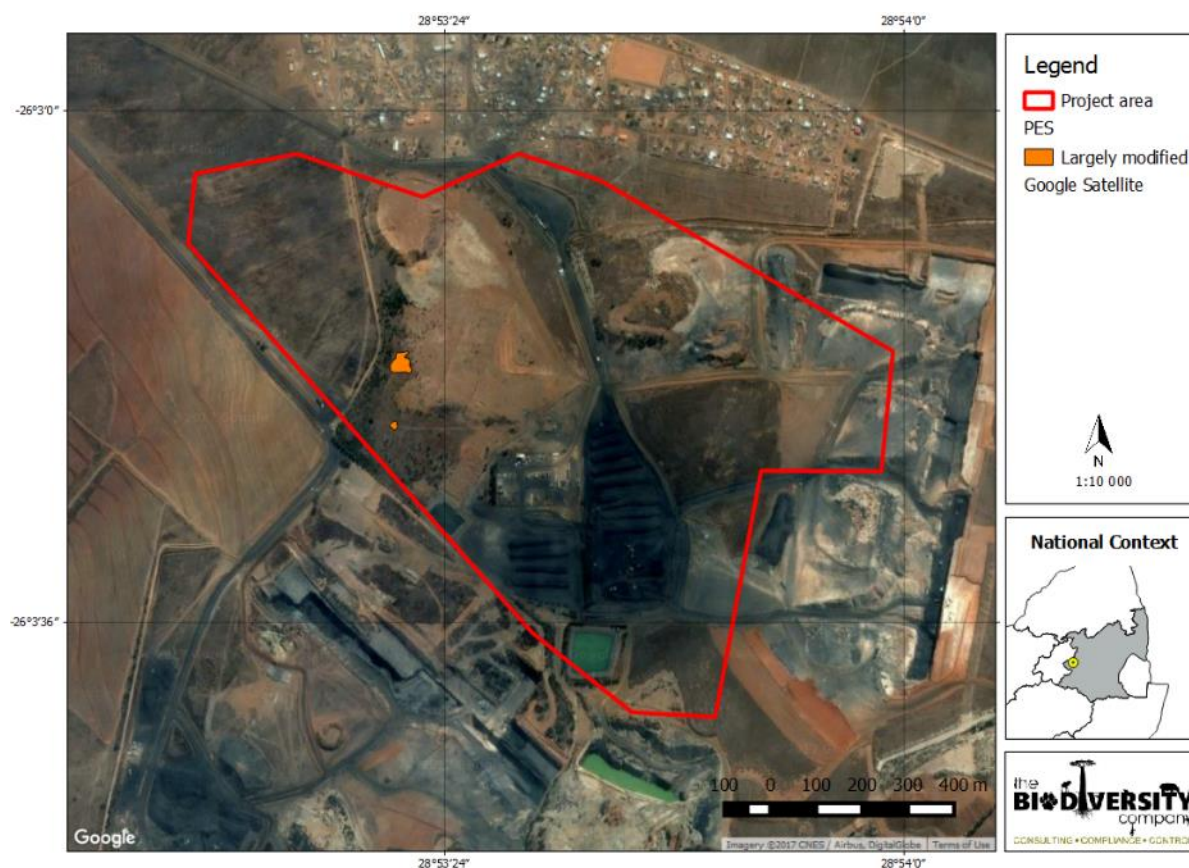
The geomorphology of the systems is also considered to be largely modified, but largely represents a depression system on a slope. The depressions have not been directly impacted on or altered by the local agricultural and mining activities, but are rather the likely result of the mining operation. This status indicates that a large change in geomorphic processes has occurred and the system is appreciably altered.

The vegetation of the wetlands is considered to be in a seriously modified state, with characteristic secondary grasslands and stands of alien trees (*Acacia mearnsii*). This status indicates that the vegetation composition has been totally or almost totally altered, and if any characteristic species still remain, their extent is very low.



Table 15: Summary of the scores for the wetland PES

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Score	Rating	Score	Rating	Score
HGM 1	D: Largely Modified	4.0	D: Largely Modified	4.1	F: Seriously Natural	8.6
Overall PES Score	5.4		Overall PES Class		D: Largely Modified	

**Figure 13: The depicted PES of the wetlands**

5.5.2 Ecosystem Services Assessment

The Ecosystem services provided by the HGM type present at the site were assessed and rated using the WET-EcoServices method (Kotze *et al.*, 2009). The summarised results for the HGM type are shown in Table 16.

The wetland type had overall Intermediate levels of service. The following shows services with moderately high levels or higher for HGM 1:

- Phosphate, nitrate and toxicant assimilation; and
- Erosion control.

The remaining services were scored as intermediate or lower.



Table 16: The Eco-Services being provided by the wetland type

Wetland Unit					Depression
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		2.0
			Streamflow regulation		0.3
			Water Quality enhancement benefits	Sediment trapping	1.3
				Phosphate assimilation	2.2
				Nitrate assimilation	1.5
				Toxicant assimilation	2.4
				Erosion control	2.2
			Carbon storage		1.7
	Direct Benefits	Biodiversity maintenance			0.9
		Provisioning benefits	Provisioning of water for human use		0.4
			Provisioning of harvestable resources		0.8
			Provisioning of cultivated foods		0.8
		Cultural benefits	Cultural heritage		1.0
			Tourism and recreation		0.1
			Education and research		0.3
Overall					17.8
Average					1.2

5.5.3 Ecological Importance & Sensitivity (EIS)

The EIS assessment was applied to the HGM type described in the previous section in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in Table 17. Figure 14 depicts the PES of the wetland systems

The EIS and direct human importance for the wetlands was rated to be Low (D). The hydrological / functional importance was rated as Moderate (C). These low ratings may be attributed to the fact that the wetlands are located in an already disturbed area, due to agricultural and mining activities. Additionally, the wetlands are largely the result of the local mining operations which have directed run-off to these area, with artificial hydrological inputs. Despite the unnatural hydrological inputs, the depressions to provide some level of services with regards to the enhancement of water quality.



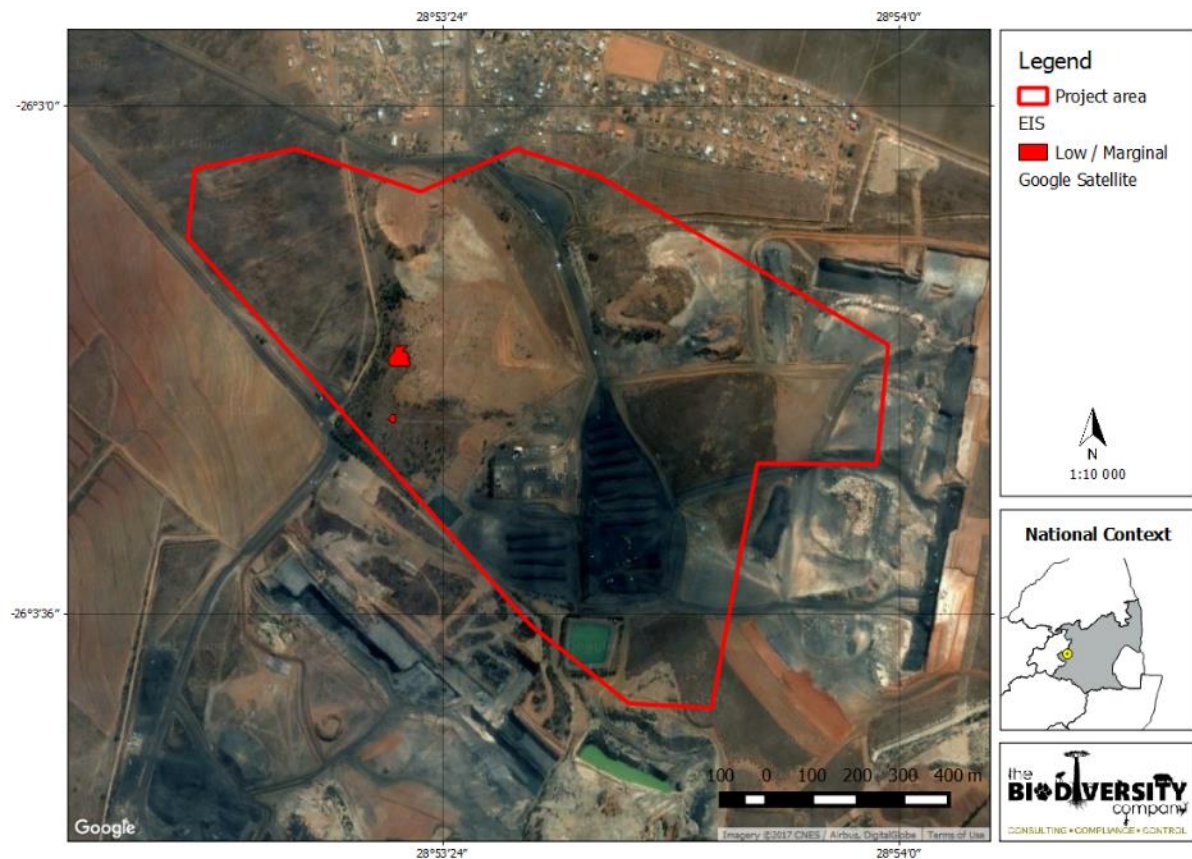


Figure 14: The depicted EIS of the wetlands

Table 17: The EIS results for the delineated wetlands

WETLAND IMPORTANCE AND SENSITIVITY	
<i>HGM 1</i>	
ECOLOGICAL IMPORTANCE & SENSITIVITY	0.7
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.7
DIRECT HUMAN BENEFITS	0.7

5.6 Buffer Zones

The project is for the proposed expansion of the Vlakvarkfontein Coal Mine. The expansion of the mining area will result in the loss of the delineated wetlands. Alternatively, should the depressions be avoided, and the surrounding areas be mined, the removal of the stockpiles and subsequent change to the topographical features will remove a source for hydrological inputs which will result in the loss of the wetlands. Additionally, the wetlands are considered to be a result of the mining operation, and are not regarded as natural systems. It is apparent that the loss of these wetlands is unavoidable, and no buffer zone is suitable for either of the above-mentioned options.



5.7 Aquatic Ecology

5.7.1 Water Quality

In situ water quality analysis was conducted at all sites during the survey. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. The results of the low flow survey are presented in Table 18.

Table 18: *In situ* water quality results (June 2017)

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	6.5-9.0	<700**	>5.00	5-30
VLAK1	7.89	1149	13.45	12.5
VLAK2	7.92	1116	11.32	13.8
VLAK3	7.72	1134	13.78	11.8
VLAK4	8.40	445	13.14	13.8
VLAK5	8.56	600	14.2	12.9
*Levels exceeding Target Water Quality Range levels are indicated in red				
**Expert interpretation for conductivity levels.				

Table 19: *In situ* water quality results (October 2017)

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	6.5-9.0	<700**	>5.00	5-30
VLAK1	7.54	1275	8.73	24.8
VLAK2	7.83	1163	10.16	27.4
VLAK3	8.26	1090	10.43	25.0
VLAK4	7.81	568	8.67	22.4
VLAK5	8.95	487	11.98	27.0
*Levels exceeding Target Water Quality Range levels are indicated in red				
**Expert interpretation for conductivity levels.				

In situ water quality results indicate elevated dissolved solids stemming from upstream reaches of the Leeufontein system as indicated by VLAK1 (1149 µS/cm during the low flow survey and 1275 µS/cm during the high flow survey). Dissolved solid concentrations remain stable until the confluence with the Wilge River. The dissolved solid concentrations within the Leeufontein system exceed guideline limits and would present adverse conditions to local aquatic biota. The pH levels within the aquatic systems associated with the Vlakovarkfontein Coal Mine are neutral to basic. The pH levels are stable within the Leeufontein and Wilge Rivers and fall within the Target Water Quality Range (TWQR) and would not be a limiting



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factor to local aquatic biota. The dissolved oxygen levels within the aquatic systems associated with the Vlakovfontein systems were above the 5.0 mg/l limit and would not present adverse conditions to local aquatic biota. Water temperatures measured during the high and low flow survey fell within expected ranges for Highveld aquatic systems.

5.7.1.1 Spatial and Temporal Trends

Spatial and temporal trends indicate pH levels have improved and stabilised within the Leeufontein River from the 2015 and 2016 surveys conducted (Figure 15). Similar result were observed within the Wilge system (Vlak4), with similar pH levels recorded between 2016 and 2017. During the 2014 and 2015 surveys the system was acidic (Figure 16). The pH trends of the Blesbok system indicate the system is becoming more basic from the 2015 to 2017 surveys (Figure 16). Agriculture and livestock activities within the system are likely contributing to the change in pH. The pH trend within the Blesbok system should be monitored, as levels exceeding 9.0 will limit aquatic biota.

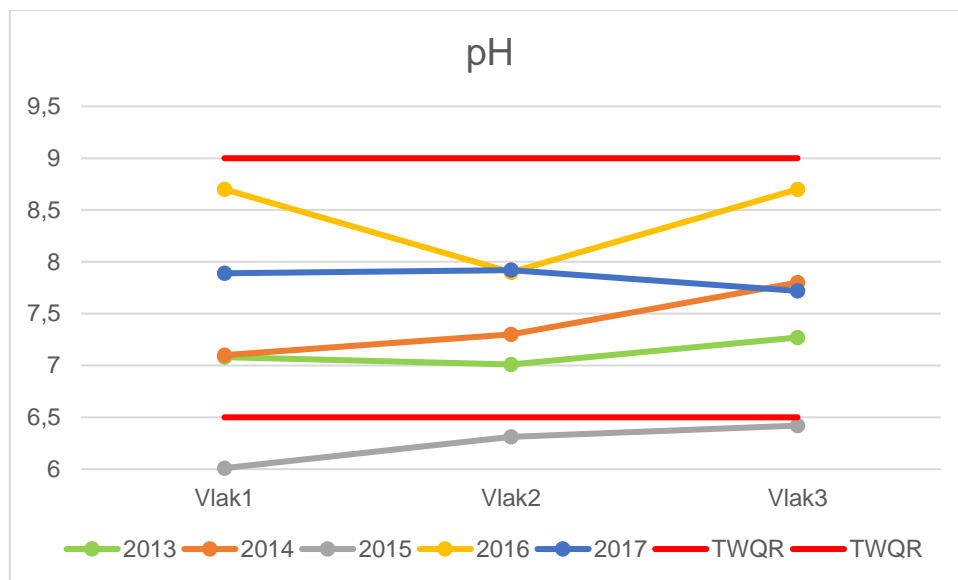


Figure 15: Spatial and Temporal trends of the pH values within the Leeufontein River

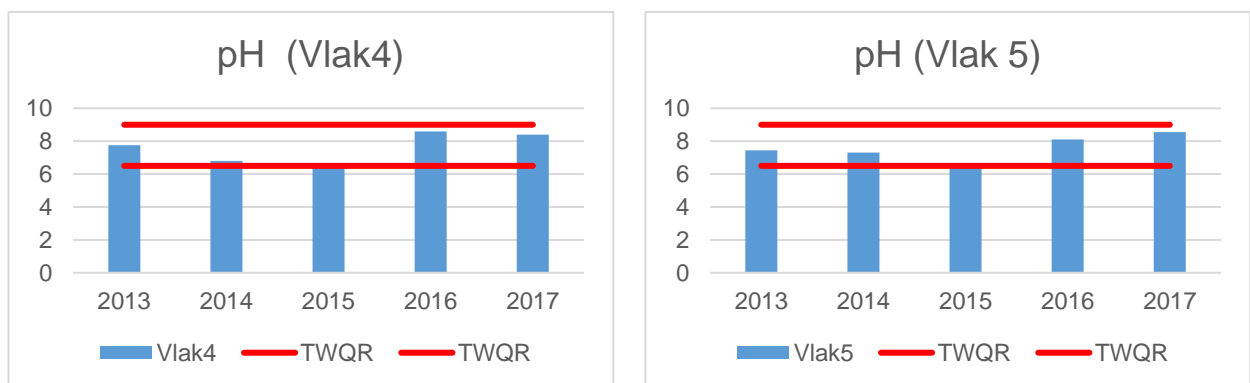


Figure 16: Spatial and Temporal trends of the pH values within the Wilge (Vlak4) and the Blesbok (Vlak5) systems



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Spatial and temporal trends of the Leeufontein indicate a gradual increase in dissolved solids within the system (Figure 17). The gradual deterioration of water quality within the Leeufontein presents adverse conditions to local aquatic biota. Upstream management is required to reduce further modifications to the system. Despite continued elevated conductivity levels within the Leeufontein system, the dissolved solid concentration has decreased during the 2017 survey within the Wilge River. The dissolved solid levels are the lowest recorded since monitoring of the system (Figure 18). The dissolved solid levels within the Blesbok system are the highest recorded since the 2013 survey. This indicates a continued influx of dissolved solids into the system. Upstream management of the Blesbok system is required to reduce impacts to downstream aquatic systems.

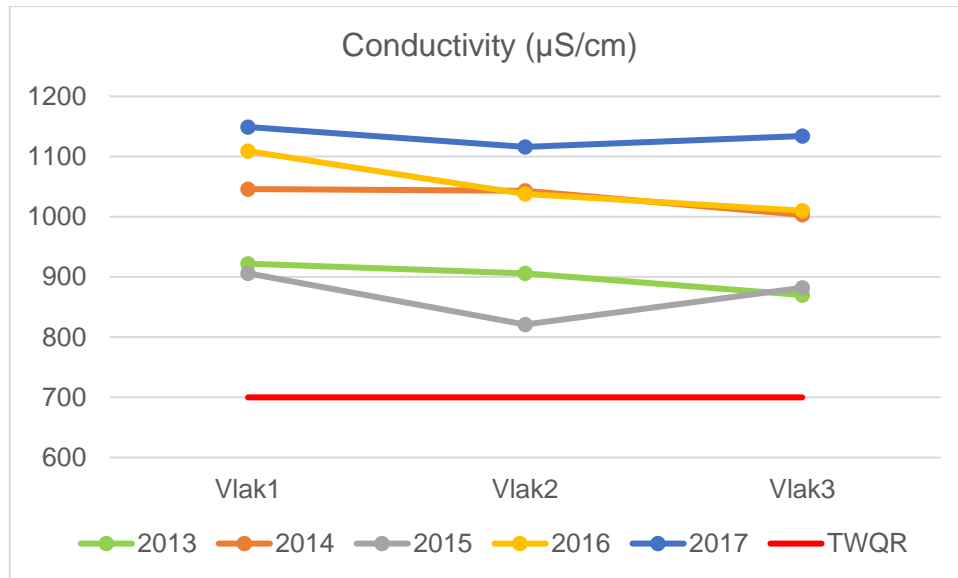


Figure 17: Spatial and Temporal trends of the conductivity levels within the Leeufontein River

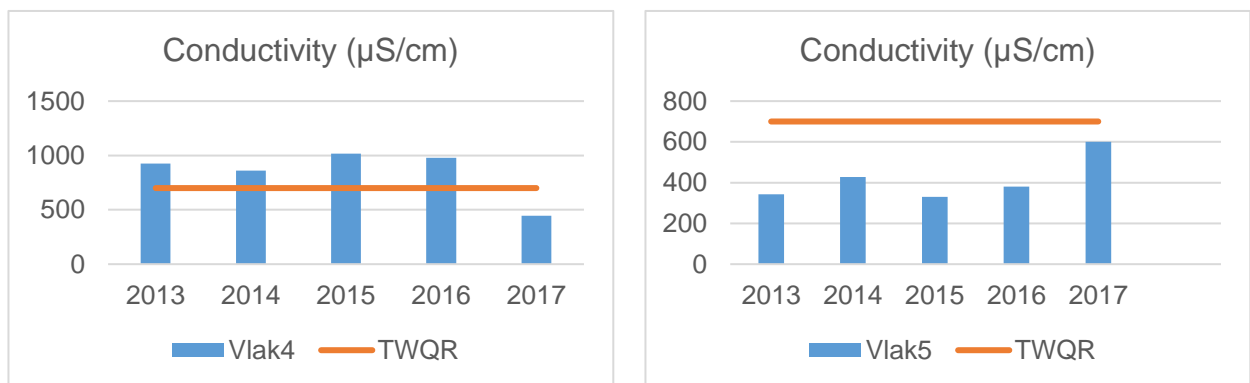


Figure 18: Spatial and Temporal trends of the conductivity levels within the Wilge (Vlak4) and the Blesbok (Vlak5) systems



5.7.2 Intermediate Habitat Integrity Assessment

The results for the instream and riparian habitat integrity assessment for the River reach are presented in Table 20.

Table 20: Results for the instream and riparian habitat integrity assessment

Instream Habitat	Leeufontein	Wilge	Blesbok	Average	Score
Water abstraction	13	15	19	15,7	8,7
Flow modification	12	16	20	16.0	8,3
Bed modification	18	15	20	17,7	9,2
Channel modification	16	15	18	16,3	8,5
Water quality	15	8	9	10,7	6.0
Inundation	13	14	20	15, 7	6,3
Exotic macrophytes	5	11	12	9,3	3,4
Exotic fauna	0	5	10	5.0	1,6
Solid waste disposal	4	4	7	5.0	1,2
Total Instream				46.8	
Category			D		
2016 Category			D		
Riparian Habitat	Leeufontein	Wilge	Blesbok	Average	Score
Indigenous vegetation removal	18	14	15	15,66666667	9,36
Exotic vegetation encroachment	20	17	20	19	9,6
Bank erosion	18	14	15	15,66666667	10,08
Channel modification	14	14	18	15,33333333	6,72
Water abstraction	12	9	10	10,33333333	6,24
Inundation	13	11	18	14	5,72
Flow modification	11	17	17	15	5,28
Water quality	7	8	9	8	3,64
Total Riparian				43.4	
Category			D		
2016 Category			D		



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According to the IHIA results, instream and riparian habitat integrity in the reach is rated as Class D, or largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred within the water resources. Modifications are predominantly associated with habitat modifications such as bed and channel modifications due to erosion, inundation from farm dams, and water quality modifications within the Leeufontein system. Further riparian modifications are due to exotic vegetation encroachment and the clearing of indigenous vegetation. Channel modifications are reducing the access riparian vegetation to water and banks become steeper and more eroded.

5.7.3 Aquatic Macroinvertebrate Habitat Assessment

5.7.3.1 Invertebrate Habitat Assessment System

The Invertebrate Habitat Assessment System (IHAS) index was developed by McMillan (1998) for use in conjunction with the SASS5 protocol. The IHAS results for the survey are presented in Table 21.

Table 21: IHAS Score at each site during the survey (2017)

Season	Site	Score	Suitability
2017	VLAK1	54	Poor
	VLAK2	62	Adequate
	VLAK3	70	Good
	VLAK4	69	Good

IHAS scores within the Leeufontein ranged from Poor to Good (VLAK1 to VLAK3 respectively). Habitat at the upstream, site VLAK1 was characterised by slow moving waters over stones and mud substrate. Good marginal vegetation was present. VLAK2 was characterised by slow moving waters over rocky and sandy substrate. A large pool is present upstream of the level crossing. Habitat availability was rated as adequate and would not be a limiting factor to aquatic macroinvertebrates. Habitat availability at site VLAK3 was rated as Good. This site was predominantly slow-moving waters over scattered stones with sandy and muddy substrate. A small amount of algae was present during the low flow survey. Habitat availability within the Wilge system (VLAK4), was rated as good. Habitat included stones in and out of current, gravel, sand and mud. Good aquatic and marginal vegetation was present at the site. The site did present several impacts which have increased over the last studies conducted at the site. This was due to erosion, bank scouring, instream sedimentation and excessive algal growth. The habitat with the system was deteriorating and attention is required.



5.7.3.2 Biotope Assessment

The results of the SASS5 biotope assessment are provided in the table below (Table 22).

Table 22: Aquatic invertebrate biotope ratings (October 2017)

Biotope	Vlak1	Vlak2	Vlak3	Vlak4
Stones in current	1	2	2	4
Stones out of current	1	2	2	3
Bedrock	0	0	1	2
Aquatic Vegetation	1	3	2	2
Marginal Vegetation In Current	1	2	3	2
Marginal Vegetation Out Of Current	3	3	3	3
Gravel	1	1	2	3
Sand	1	1	2	2
Mud	2	2	2	2
Biotope Score	11	16	19	23
Weighted Biotope Score (%)	24	39	43	57
Biotope Category (Tate and Husted, 2015)	F	E	D	C

The watercourses assessed in this study were assigned a slope class E, indicating a lowland reach river system with typical lowland river features. Macroinvertebrate habitats consisted largely of a combination of marginal vegetation within the Leeufontein River and mud and limited stones substrates. Biotope ratings ranged from class F at Vlak1 to class D at Vlak3. Biotope ratings within the Wilge River were class C. Good abundance and diversity of stones in and out of current were present. Good marginal vegetation diversity was present.



5.7.4 Aquatic macroinvertebrates

The aquatic macroinvertebrate results for the survey is presented in Table 23. Based on the ASPT scores the aquatic macroinvertebrate communities for the sampled reaches comprised primarily of tolerant taxa (Intolerance Rating < 5) while moderately tolerant taxa (Intolerance Rating 6 - 10) were sampled in low abundances during both surveys.

Table 23: Macroinvertebrate assessment results recorded during the survey

Site	VLAK1	VLAK2	VLAK3	VLAK4
Low Flow				
SASS Score	68	53	52	81
No. of Taxa	17	13	11	19
ASPT*	4.0	4.1	4.7	4.3
Category	C	D	D	B/C
High Flow				
SASS Score	70	55	60	141
No. of Taxa	17	14	14	30
ASPT*	4.1	3.9	4.3	4.7
Category	C	D	D	A

5.7.4.1 Biotic Integrity Based on SASS5 Results

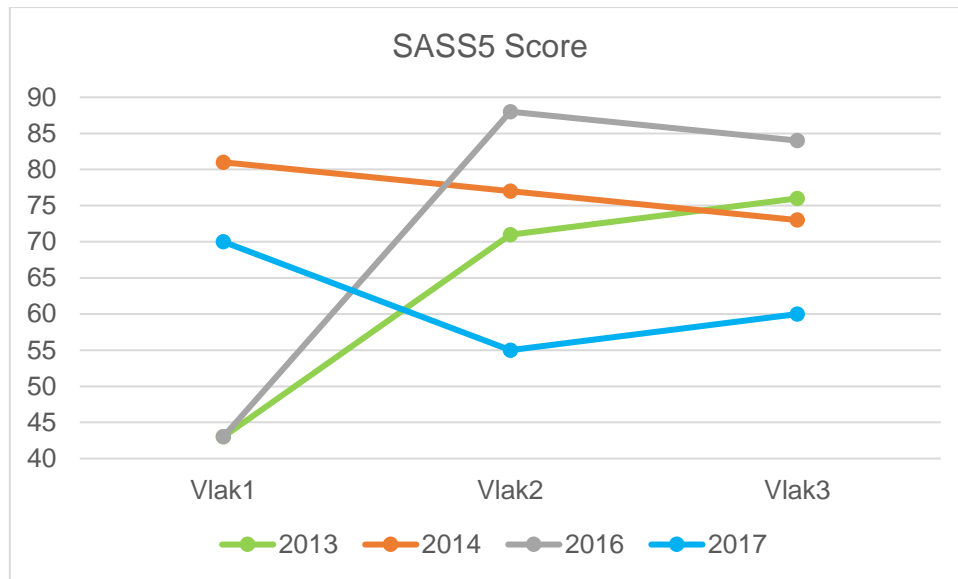
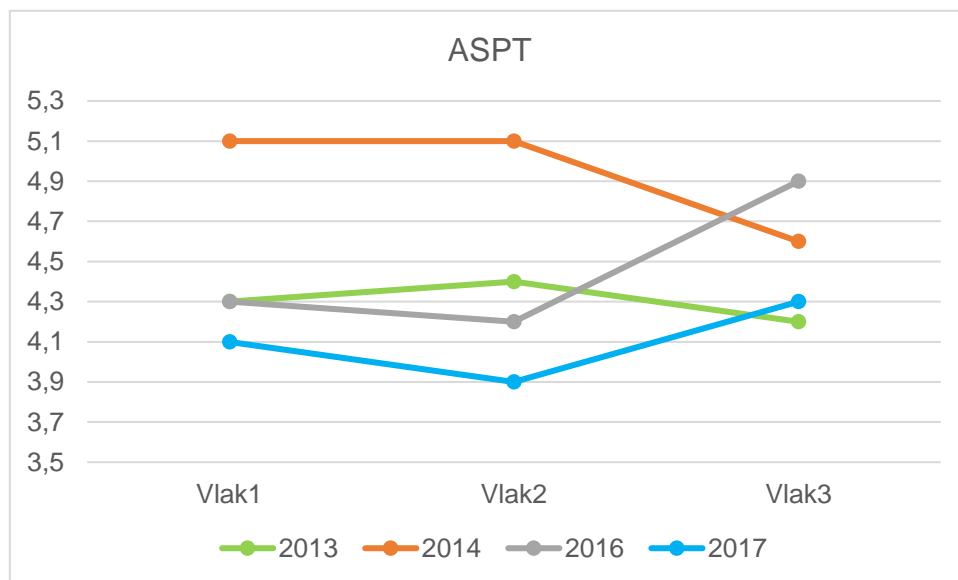
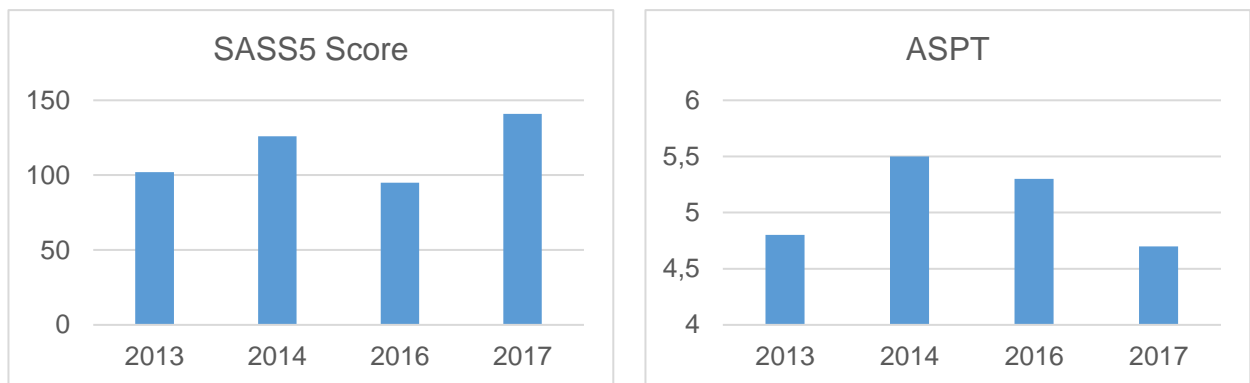
The biotic integrity within the Leeufontein reach assessed ranged from moderately modified (VLAK1), to largely modified (VLAK2 and VLAK3) during both low and high flow surveys. A decrease in total sensitivity score was observed from the upstream to downstream sites during the low flow survey (Table 12). A decrease in sensitivity score from site Vlakov1 to Vlakov2 and Vlakov3 was observed during the high flow survey. This was in contradiction with the habitat availability scores, indicating poor water quality was reducing the biotic integrity of the reach. The biotic integrity of site VLAK4 on the Wilge system was classed as moderately modified to largely natural during the low flow survey, and natural during the high flow survey.

Spatial and temporal trends of the Leeufontein River indicate an increase in sensitivity score at Vlakov1, however, a marked decrease in sensitivity score was observed at sites Vlakov2 and Vlakov3 (Figure 19). A decrease in ASPT was observed within the Leeufontein system from previous surveys was observed (Figure 20). This indicates a general deterioration of the Leeufontein biotic integrity as taxa collected are predominantly tolerant to water and habitat modifications.

Temporal trends of the Wilge River are presented in Figure 21. Results indicate increased total sensitivity score within the Wilge River since the 2013 survey. This is attributed to the collection of 30 taxa, more than previous surveys. However, a lower ASPT score is observed, indicating predominantly tolerant taxa were collected.



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Figure 19: Spatial and temporal trends of sensitivity scores of the Leeufontein

Figure 20: Spatial and temporal trends of ASPT scores of the Leeufontein

Figure 21: Temporal trends of SASS5 scores and ASPT of the Wilge River


5.7.4.2 Macroinvertebrate Response Assessment Index (MIRAI)

The Macroinvertebrate Response Assessment Index (MIRAI) methodology was conducted according to Thirion, 2007. Data collected from the SASS5 method was applied to the MIRAI model. The MIRAI model provides a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community (assemblage) from the reference condition. Results of the MIRAI indicate that ecological category of the of the Leeufontein River is in a seriously modified state (Class E) (Table 24). This is attributed to all three drivers, including flow, water quality, and habitat modifications.

The MIRAI results from the Wilge River indicate the system is in a largely modified state from reference conditions. Numerous expected sensitive taxa were absent from the system. According to the MIRAI metric groups, flow modification is the predominant cause for modified macroinvertebrate assemblages.

Table 24: Macroinvertebrate Response Assessment Index for the Leeufontein River based on results obtained in 2017

Invertebrate Metric Group	Score Calculated
Flow Modification	29,2
Habitat	40,9
Water Quality	36,8
Ecological Score	35,6
Invertebrate Category	E

Table 25: Macroinvertebrate Response Assessment Index for the Wilge River based on results obtained in 2017

Invertebrate Metric Group	Score Calculated
Flow Modification	51,5
Habitat	59,8
Water Quality	53,6
Ecological Score	54,9
Invertebrate Category	D



5.7.5 Fish Community

5.7.5.1 Expected Fish Species

A list of the eleven expected fish species is presented in Table 26 (Skelton, 2001; DWS, 2013). The species richness within the Leeufontein sub-quaternary catchment is considered moderate, while high in the Wilge sub-quaternary catchment. The species within the Wilge reach are generally considered to require largely unmodified physico-chemical conditions to survive and breed. Furthermore, species in the reach require flow during all phases of their life-cycle, often preferring fast flow clear waters for breeding and survival (DWAF, 2013).

Table 26: Expected species list for the project area

Scientific name	Common name	IUCN Status	VLAK1, 2 & 3	VLAK4 & 5
<i>Amphilius uranoscopus</i>	Stargazer (Mountain Catfish)	LC		X
<i>Barbus anoplus</i>	Chubbyhead Barb	LC	X	X
<i>Barbus neefi</i>	Sidespot Barb	LC	X	X
<i>Barbus paludinosus</i>	Straightfin Barb	LC	X	X
<i>Barbus trimaculatus</i>	Threespot Barb	LC		X
<i>Chiloglanis pretoriae</i>	Shortspine Suckermouth (Rock Catlet)	LC		X
<i>Clarias gariepinus</i>	Sharptooth catfish	LC	X	X
<i>Labeobarbus marequensis</i>	Largescale Yellowfish	LC		X
<i>Labeobarbus polylepis</i>	Smallscale Yellowfish	LC		X
<i>Pseudocrenilabrus philander</i>	Southern mouthbrooder	LC	X	X
<i>Tilapia sparrmanii</i>	Banded tilapia	LC	X	X

LC - Least Concern

X – Expected at site

Table 27: Fish Collected during the 2017 survey

Scientific name	Common name	IUCN Status	Leeufontein	Wilge
<i>Barbus anoplus</i>	Chubbyhead Barb	LC	✓	✓
<i>Gambusia affinis</i>	Mosquito fish (Exotic)	-	✓	✓
<i>Pseudocrenilabrus philander</i>	Southern mouthbrooder	LC	✓	✓
<i>Tilapia sparrmanii</i>	Banded tilapia	LC	✓	✓

LC - Least Concern

As can be observed in Table 27, 4 of the 11 fish species were collected within the Leeufontein and Wilge Rivers. Fish were predominantly collected in slow moving to standing waters. Notable absent species include *Labeobarbus marequensis* and *Labeobarbus polylepis* from the Wilge River. No species of conservational concern were collected during the survey. The results of the FRAI are presented in Table 28 .



Table 28: Observed fish species (October 2017)





Fish Species	Photograph
<i>Barbus anoplus</i>	
<i>Gambusia affinis</i>	
<i>Pseudocrenilabrus philander</i>	
<i>Tilapia sparrmanii</i>	

Table 29: Fish Response Assessment Index for the Leeufontein River, October 2017 survey

FRAI% (Automated)	40,4
EC FRAI	Class D/E

Table 30: Fish Response Assessment Index for the Wilge River, October 2017 survey

FRAI% (Automated)	29.1
EC FRAI	Class E

The results of the FRAI derived a largely modified (class D) fish community structure within the Leeufontein River. This modified fish community was largely attributed to the absence of several species from the reach. FRAI results of the Wilge River indicate the fish community is in a seriously modified state. This is attributed to the absence of a number species including *Labeobarbus marequensis*, *Labeobarbus polylepis*, and *Chiloglanis pretoriae*.



5.7.6 Overall Aquatic Ecology Present Ecological Status

The results of the PES assessment are provided in the table below (Table 31).

Table 31: Present Ecological Status of the Leeufontein reach assessed in the 2017 survey

Aspect Assessed	Ecological Category
Instream Ecological Category	D
Riparian Ecological Category	D
Aquatic Invertebrate Ecological Category	E
Fish Ecological Category	D/E
Ecostatus	D

Table 32: Present Ecological Status of the Wilge River reach assessed in the 2017 survey

Aspect Assessed	Ecological Category
Instream Ecological Category	D
Riparian Ecological Category	D
Aquatic Invertebrate Ecological Category	D
Fish Ecological Category	E
Ecostatus	D

The results of the PES assessment derived largely modified (class D) conditions of the Leeufontein and Wilge River reaches considered in this assessment. The modified conditions were largely attributed to cumulative habitat and water quality level impacts which have resulted in the modification of instream habitat, invertebrate and fish communities.



6 Impact Assessment

6.1 Existing impacts

The following existing impacts were observed in or adjacent to the proposed project area:

- The removal of vegetation to accommodate local agricultural activities, the existing mining operation and local developments. This has resulted in the establishment and encroachment of alien vegetation in the general area, including the water resources.
- The flow of the Leeufontein, Blesbok and Wilge systems has been modified due to the altered hydrology of these systems. The construction of impoundments within the channels, and also the input of stormwater from local developments has also resulted in channel modifications, and erosion and sedimentation of these systems. The water quality of these systems has also been impaired due to the local land uses.
- The mining and agricultural activities have also contributed to wetland modifications, which include altered flows caused by compaction and drainage, and also the establishment of alien vegetation within the systems. These wetlands are expected to have surface hydrological inputs, and the adjacent mining operation is not expected to have an impacted on any seepage or interflow for these wetlands.

6.2 Project Alternatives

The following is relevant to the process alternatives for consideration in the EIA phase (Table 33). A comment has been provided herein for the alternative categories with regards to the local water resources. Owing to the fact that the Leeuspruit, Blesbok and Wilge systems are in excess of 500m from the proposed expansion area, the focus for this component of the project are the delineated depressions. These systems are regarded as artificial systems and largely a result of the mining activities, but despite this, these systems do provide some level of ecological service, particularly with regards to water quality enhancement.

None of the provided alternative categories are regarded as unacceptable for this project, with no preference afforded to the majority of the categories provided. With regards to the dewatering of the underground workings, preference is given to the treatment of water prior to discharge, but the storage of water on-site, and then treatment and discharge of the water is permissible. Regarding micro site alternatives, owing to the fact that the wetlands are largely a result of the mining operation, and also taking into account the PES / EIS and ecological functioning, there is no need to avoid these systems and maximum mining of the area is permissible.



Table 33: The project alternative considered for the study

Alternative Category		Alternative description	Comment (Preference)
Process Alternatives	Process alternatives - Mining methods.	Open Cast	N/A
	Filter cake	Stockpile for use as non-select product.	None
		Disposal	None
	Disposal of carboniferous wastes (wash plant waste rock and possibly filter cake)	Disposal to surface waste disposal facility- located on old rehabilitated mine area.	None
		Disposal to surface waste disposal facility- located on un-mined area.	None
		Disposal of beneficiation plant waste rocks and filter cake to pit.	None
	Old underground workings - Dewatering options	Pump-treat-discharge.	Preferred
		Pump-store (in existing penstock area)- treat-discharge.	Permissible
	Wash plant water supply	Water obtained from dirty water containment facilities (e.g. penstock storage area, PCD's etc).	N/A
Technology Alternatives	Coal Beneficiation - Washing processing technology	Wet washing	None
	Coal product transport options	Road	None
Activity Alternatives	Land-use Alternatives	Land used for mining	None
		No-go alternative	None
Location Alternatives	Micro siting alternatives	Maximum mining over entire area	Permissible
		Sensitivity-based approach (avoid / buffer sensitive areas).	Not required
	Relocation alternatives	Relocation of highly impacted community members	N/A



6.3 Potential Impacts

The proposed project could result in the loss and modifications of water resources, notably the delineated wetland areas. The following list provides a framework for the anticipated major impacts associated with the project.

1. Loss of water resources areas
 - a. Project activities that can cause loss of wetland areas
 - i. Soil excavations [Construction, Operation and Closure]
 - b. Secondary impacts associated with direct loss of wetlands
 - i. Loss of ecosystem services
2. Altered hydrological regime
 - a. Project aspects that can causes changes to surface hydrology
 - i. Vegetation removal [Construction, Operation and Closure]
 - ii. Soil excavations [Construction, Operation and Closure]
 - iii. Separation of clean & dirty water [Construction, Operation and Closure]
 - iv. Stormwater management [Construction, Operation and Closure]
 - b. Secondary impacts associated with an altered regime
 - i. Loss of ecosystem services
 - ii. Worsening of the ecological status of wetlands
 - iii. Increased or reduced runoff dependent on system manipulation
 - iv. Loss of soil fertility and topsoil recharge through interruption of seasonal recharge and natural flow, including natural sedimentation
 - v. Scouring and erosion of wetlands
3. Impaired water quality
 - a. Project activities that can impact on the local water quality
 - i. Clearing of vegetation [Construction and Operation]
 - ii. Earth moving (removal and storage of soil) [Construction, Operation and Closure]
 - iii. Blasting and excavation [Operation]
 - iv. Pollution of water courses due to dust effects, chemical spills, acid mine drainage etc. [Construction, Operation and Closure]
 - v. Soil dust precipitation [Construction, Operation and Closure]
 - vi. Chemical (organic/inorganic) spills [Construction, Operation and Closure]
 - vii. Erosion [Construction, Operation and Closure]
 - viii. Untreated runoff or effluent [Construction, Operation and Closure]
4. Erosion and sedimentation of water resources
 - a. Project activities that can cause increased erosion and sedimentation
 - i. Vegetation removal [Construction, Operation and Closure]
 - ii. Soil excavations and stockpiles [Construction, Operation and Closure]
 - iii. Erosion [Construction, Operation and Closure]
 - iv. Stormwater management [Construction, Operation and Closure]
 - b. Secondary impacts associated with sedimentation
 - i. Loss of ecosystem services
5. Spread and/or establishment of alien and/or invasive species



- a. Project activities that can cause the spread and/or establishment of alien and/or invasive species
 - i. Vegetation removal [Construction, Operation and Closure]
 - ii. Soil excavations, transportation and stockpiles [Construction, Operation and Closure]
 - iii. Transportation vehicles potentially spreading seed while moving on, to and from working areas [Construction, Operation and Closure]
 - iv. Unsanitary conditions surrounding infrastructure promoting the establishment of alien and/or invasive rodents [Construction and Operation]
- b. Secondary impacts associated with the spread and/or establishment of alien and/or invasive species
 - i. Worsening of the ecological status of wetlands

6.4 Assessment of Significance

The tables below show the significance of potential impacts associated with the proposed expansion project before and after implementation of mitigation measures.

The most notable impact is the expectant loss some water resources, the delineated depressions in particular. The loss of wetlands is expected for the mining of the entire footprint area, and also by avoiding these systems and changing the topography of the area. The significance of the loss is regarded as high, and because avoidance is not possible for this project, mitigation has not been considered and the significance remains high.

The loss of these depressions is not regarded as a fatal flaw for this project, owing to the fact that these wetlands are a result of the current mining operation, and are therefore classified as artificial systems. The DWS should be consulted in order to determine the need, if any, for a wetland offset strategy. Thus there is no preference to assign a buffer to these areas and avoid disturbances to these systems, because as the landscape changes to accommodate the rest of the proposed expansion, the hydrological inputs to these wetlands will be lost as a result.

Taking into account that these artificial wetlands will be lost for the proposed expansion, and then focussing on other noteworthy water resources, the Leeuspruit, Blesboks and Wilge systems in particular, the expectant level of risk posed to these systems by the relevant aspects is low both without and with mitigation. These two watercourses are in excess of 500m from the proposed expansion, and the area between the project and water resources is buffered by the local land uses and access routes. As a result of this, the significance of any impact to these two systems is expected to be negligible, if any.

A. Loss of water resources - Alternative P1a					
Impact Name	Loss of water resources				
Alternative	Alternative P1a				

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Phase	Construction & Operation & 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	2	2	Reversibility of Impact	3	3
Duration of Impact	5	5	Probability	5	5
Environmental Risk (Pre-mitigation)					-16.25
Mitigation Measures					
<i>The loss of wetland is unavoidable, and the only mitigation would be to avoid the wetland area. However, changes to the topography will likely also result in the loss of the wetland due to hydrological changes. The DWS should be consulted for an offset strategy to determine the need thereof. An artificial wetland must be considered for any possible decant post closure.</i>					
Environmental Risk (Post-mitigation)					-16.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
<i>Issue has received a meaningful and justifiable public response</i>					
Cumulative Impacts					2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>					
Degree of potential irreplaceable loss of resources					1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>					
Prioritisation Factor					1.33
Final Significance					-21.67

A. Loss of water resources - Alternative S1					
Impact Name	Loss of water resources				
Alternative	Alternative P1a				
Phase	Construction & Operation & 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	2	2	Reversibility of Impact	3	3
Duration of Impact	5	5	Probability	5	5
Environmental Risk (Pre-mitigation)					-16.25
Mitigation Measures					
The loss of wetland is unavoidable, and the only mitigation would be to avoid the wetland area. However, changes to the topography will likely also result in the loss of the wetland due to hydrological changes. The DWS should be consulted for an offset strategy to determine the need thereof. An artificial wetland must be considered for any possible decant post closure.					
Environmental Risk (Post-mitigation)					-16.25
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					



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Cumulative Impacts	2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>	
Degree of potential irreplaceable loss of resources	1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>	
Prioritisation Factor	1.33
Final Significance	-21.67

B. Altered Hydrological Regime - Alternative P1a					
Impact Name	Altered Hydrological Regime				
Alternative	Alternative P1a				
Phase	Construction				
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	3	3
Duration of Impact	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-8.25
Mitigation Measures					
Compile a suitable stormwater management plan, The stormwater management plan should incorporate “soft” engineering measures as much as possible, limiting the use of artificial materials. These measures may include grassy swales, bio-retention ponds / depressions filled with aquatic vegetation or the use of vegetation to dissipate flows at discharge locations, Stormwater channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion, Rehabilitation of old workings must be re-profiled to the natural topography, Stockpiles must be sloped to limit the run-off velocity of the area.					
Environmental Risk (Post-mitigation)					-5.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
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					1.33
Final Significance					-6.67

C. Impaired water quality - Alternative P1a					
Impact Name	Impaired water quality				
Alternative	Alternative P1a				



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Phase	Construction				
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	3	3
Duration of Impact	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-8.25
Mitigation Measures					
Separate clean and dirty water, continue with surface water and biomonitoring programmes, Compile a suitable stormwater management plan, All chemicals and toxicants during construction must be stored in bunded areas, All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site, All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”, Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area, Have action plans on site, and training for contractors and employees in the event of spills, leaks and other impacts to the aquatic systems; All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported.					
Environmental Risk (Post-mitigation)					-5.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
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					1.33
Final Significance					-6.67

D. Erosion and sedimentation of water resources - Alternative P1a					
Impact Name	Erosion and sedimentation of water resources				
Alternative	Alternative P1a				
Phase	Construction				
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	2	2	Reversibility of Impact	3	3
Duration of Impact	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-7.50
Mitigation Measures					
Compile a suitable stormwater management plan, Construct cut-off berms downslope of working areas, demarcate footprint areas to be cleared to avoid unnecessary clearing, Exposed areas must be ripped and vegetated to increase surface roughness, Create energy dissipation at discharge areas to prevent scouring, Temporary and permanent erosion control methods may include silt fences, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed areas, erosion mats, and mulching.					

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Environmental Risk (Post-mitigation)	-5.00
Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	2
<i>Issue has received a meaningful and justifiable public response</i>	
Cumulative Impacts	2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>	
Degree of potential irreplaceable loss of resources	1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>	
Prioritisation Factor	1.33
Final Significance	-6.67

E. Spread and/or establishment of alien and/or invasive species - Alternative P1a					
Impact Name	Spread and/or establishment of alien and/or invasive species				
Alternative	Alternative P1a				
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	2
Environmental Risk (Pre-mitigation)					-6.75
Mitigation Measures					
An alien invasive plant management plan needs to be compiled and implemented prior to construction to control and prevent the spread of invasive aliens, Clean vehicles on-site, and prioritise vehicles gaining access from surround areas					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
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					1.33
Final Significance					-5.33



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F. Altered Hydrological Regime - Alternative P1b					
Impact Name	Altered Hydrological Regime				
Alternative	Alternative P1b				
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Stormwater channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion, Rehabilitation of old workings must be re-profiled to the natural topography, Stockpiles must be sloped to limit the run-off velocity of the area.					
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					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					1.33
Final Significance					-7.33

P. Impaired water quality - Alternative P1b					
Impact Name	Impaired water quality				
Alternative	Alternative P1b				
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Separate clean and dirty water, continue with surface water and biomonitoring programmes, All chemicals and toxicants during operation must be stored in bunded areas, All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site, All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good					



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<i>“housekeeping”, Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area, Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems; All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported.</i>	
Environmental Risk (Post-mitigation)	-5.50
Degree of confidence in impact prediction:	Medium
Impact Prioritisation	
Public Response	2
<i>Issue has received a meaningful and justifiable public response</i>	
Cumulative Impacts	2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>	
Degree of potential irreplaceable loss of resources	1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>	
Prioritisation Factor	1.33
Final Significance	-7.33

P. Impaired water quality - Alternative P4a					
Impact Name	Impaired water quality				
Alternative	Alternative P4a				
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Separate clean and dirty water, continue with surface, groundwater and biomonitoring programmes, Ensure the discharge of water is within the prescribed thresholds for the respective programmes,					
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
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					1.33
Final Significance					-7.33



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Q. Erosion and sedimentation of water resources - Alternative P1b					
Impact Name	Erosion and sedimentation of water resources				
Alternative	Alternative P1b				
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Implement the stormwater management plan, Construct cut-off berms downslope of working areas, demarcate footprint areas to be cleared to avoid unnecessary clearing, Exposed areas must be ripped and vegetated to increase surface roughness, Create energy dissipation at discharge areas to prevent scouring, Temporary and permanent erosion control methods may include silt fences, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed areas, erosion mats, and mulching.					
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					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					1.33
Final Significance					-7.33

R. Spread and/or establishment of alien and/or invasive species - Alternative P1b					
Impact Name	Spread and/or establishment of alien and/or invasive species				
Alternative	Alternative P1b				
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	2	2	Reversibility of Impact	2	2
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-6.75
Mitigation Measures					
An alien invasive plant management plan needs to be compiled and implemented prior to construction to control and prevent the spread of invasive aliens, Clean vehicles on-site, and prioritise vehicles gaining access from surround areas					



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Environmental Risk (Post-mitigation)	-4.50
Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	2
<i>Issue has received a meaningful and justifiable public response</i>	
Cumulative Impacts	2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>	
Degree of potential irreplaceable loss of resources	1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>	
Prioritisation Factor	1.33
Final Significance	-6.00

S. Impaired water quality - Alternative P1a					
Impact Name	Impaired water quality				
Alternative	Alternative P1a				
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
An artificial wetland must be considered for any possible decant post closure. Input must be sought from surface and groundwater experts.					
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
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					1.33
Final Significance					-7.33

T. Impaired water quality - Alternative S1



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Impact Name					
Impaired water quality					
Alternative					
Alternative S1					
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	3	3
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
<i>An artificial wetland must be considered for any possible decant post closure. Input must be sought from surface and groundwater experts.</i>					
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					2
<i>Issue has received a meaningful and justifiable public response</i>					
Cumulative Impacts					2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>					
Degree of potential irreplaceable loss of resources					1
<i>The impact is unlikely to result in irreplaceable loss of resources.</i>					
Prioritisation Factor					1.33
Final Significance					-7.33

6.5 Mitigation measures

Table 34 presents the recommended mitigation measures and the respective timeframes, targets and performance indicators.



Table 34: Mitigation measures including requirements for timeframes, roles and responsibilities

No.	Mitigation Measures	Phase	Timeframe	Responsible Party for Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)
Water Resources							
	<i>The loss of wetland is unavoidable, and the only mitigation would be to avoid the wetland area. The DWS should be consulted for the need of a potential offset strategy</i>	Construction Operation Closure	Permanent	Applicant / EAP	N/A	Compensate for loss of wetland area, target to be determined	Wetland offset: A best practice guideline (DWS / SANBI, 2013)
	<i>Construct cut-off berms downslope of working areas, demarcate footprint areas to be cleared to avoid unnecessary clearing. Exposed areas must be ripped and vegetated to increase surface roughness, Create energy dissipation at discharge areas to prevent scouring. Temporary and permanent erosion control methods may include silt fences, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed areas, erosion mats, and mulching.</i>	Construction Operation	Ongoing	Applicant / Contractor	Biomonitoring (bi-annual) Water quality monitoring, frequency to be advised by hydrology specialist	Maintain drinking water quality standards	Water quality guidelines (DWS,1996)
	<i>Compile and implement a suitable stormwater management plan. The stormwater management plan should incorporate “soft” engineering measures as much as</i>	Construction Operation	Ongoing	Applicant / Contractor	Biomonitoring (bi-annual) Water quality monitoring,	Maintain drinking water quality standards	Water quality guidelines (DWS,1996)



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	<i>possible, limiting the use of artificial materials. These measures may include grassy swales, bio-retention ponds / depressions filled with aquatic vegetation or the use of vegetation to dissipate flows at discharge locations. Stormwater channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion, Rehabilitation of old workings must be re-profiled to the natural topography, Stockpiles must be sloped to limit the run-off velocity of the area.</i>				frequency to be advised by hydrology specialist		
	<i>Separate clean and dirty water, continue with surface water and biomonitoring programmes. All chemicals and toxicants during construction must be stored in bunded areas. All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site. All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping". Adequate sanitary facilities and ablutions must be</i>	Construction Operation	Ongoing	Applicant / Contractor	Biomonitoring (bi-annual) Water quality monitoring, frequency to be advised by hydrology specialist	Maintain drinking water quality standards	Water quality guidelines (DWS,1996)



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	<i>provided for all personnel throughout the project area. Have action plans on site, and training for contractors and employees in the event of spills, leaks and other impacts to the aquatic systems. All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported.</i>						
	<i>An alien invasive plant management plan needs to be compiled and implemented prior to construction to control and prevent the spread of invasive aliens. Clean vehicles on-site, and prioritise vehicles gaining access from surround areas</i>	Construction Operation Closure	Ongoing	Applicant / Contractor	Monthly inspections, with removal to be determined on a needs basis	Maintain drinking water quality standards	National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEM:BA): Category 1a/b: Invasive species requiring compulsory control. Remove and destroy.
	<i>An artificial wetland must be considered for any possible decant post closure. Input must be sought from surface and groundwater experts</i>	Closure	Ongoing	Applicant	Biomonitoring (bi-annual) Water quality monitoring, frequency to be advised by hydrology specialist	Maintain drinking water quality standards	Water quality guidelines (DWS,1996)



6.6 Monitoring programme

Aquatic biomonitoring is currently being undertaken for the Vlakvarkfontein Coal Mine as per conditions of the Water Use Licence (WUL, No. 4/B20F/AGJ/1131). The WUL conditions stipulate the following as a minimum requirement for the biomonitoring study:

- An Aquatic Scientist approved by the Regional Head must establish a monitoring programme for the following indices: Invertebrate Habitat Assessment System (IHAS) and the latest SASS (South African Scoring System). Sampling must be done once during the summer season and once during the winter season, annually, to reflect the status of the river upstream and downstream of the mining activities.

It is recommended that this biomonitoring programme be continued, and consider the proposed expansion project.

An aquatic biomonitoring programme is an essential management tool. The monitoring programme should be designed to enable the detection of potential negative impacts brought about by the proposed project. Table 35 highlights some important aspects to monitor in reference to aquatic biota for the duration of the programme.

Table 35: Aquatic and Wetland Ecology Monitoring Plan

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



7 Conclusion

The results of the PES assessment derived largely modified (class D) conditions of the Leeufontein and Wilge River reaches assessed. The modified conditions were largely attributed to cumulative water quality and flow modifications within the Leeufontein system. Continued elevated dissolved solids stemming from upstream reaches within the Leeufontein system were observed. Furthermore, water quality conditions within the Blesbok system continued. Upstream management is required on the Blesbok and Leeufontein systems.

One (1) wetland type was identified within the 500m project assessment boundary, namely a depression, which comprised of two units. No other wetlands were identified within the larger 500m study area. The overall wetland health for the systems was determined to be that of a Largely Modified (D) system. The wetland type had overall Intermediate levels of service, with only some water quality enhancement services showing a moderately high level of benefit. The EIS and direct human importance for the wetlands was rated to be Low (D). The hydrological / functional importance was rated as Moderate (C).

The project is for the proposed expansion of the Vlakovarkfontein Coal Mine. The expansion of the mining area will result in the loss of the delineated wetlands. Alternatively, should the depressions be avoided, and the surrounding areas be mined, the removal of the stockpiles and subsequent change to the topographical features will remove a source for hydrological inputs which will result in the loss of the wetlands. Additionally, the wetlands are considered to be a result of the mining operation, and are not regarded as natural systems. It is apparent that the loss of these wetlands is unavoidable, and no buffer zone is suitable for either of the above-mentioned options.

The loss of these depressions is not regarded as a fatal flaw for this project. The DWS should be consulted in order to determine the need, if any, for a wetland offset strategy.

Owing to the fact that the Leeuspruit, Blesbok and Wilge systems are in excess of 500m from the proposed expansion area, the focus for the impact assessment were the delineated depressions. These systems are regarded as artificial systems and largely a result of the mining activities, but despite this, these systems do provide some level of ecological service, particularly with regards to water quality enhancement.

The most notable impact is the expectant loss of some water resources, the delineated depressions in particular. The significance of the loss is regarded as high, and the loss of wetlands is avoidable due to the nature of the project. It is worth mentioning that the loss of the wetlands is regarded as permissible for this project, owing to the fact that these wetlands are a result of the current mining operation, and are therefore classified as artificial systems. Thus there is no preference to assign a buffer to these areas and avoid disturbances to these systems, because as the landscape changes to accommodate the rest of the proposed expansion, the hydrological inputs to these wetlands will be lost as a result.

The expectant level of risk posed to the Leeuspruit, Blesboks and Wilge systems by the relevant aspects is low both without and with mitigation. These two watercourses are in excess of 500m from the proposed expansion, and the area between the project and water resources is buffered by the local land uses and access routes. As a result of this, the significance of any impact to these two systems is expected to be negligible, if any.



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This study has concluded that no significant risks are posed to the local water resources by the proposed expansion of the Vlakovarkfontein Coal Mine.



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