Hydropedology Assessment - Proposed Kalabasfontein Coal Mining Project Extension

Mpumalanga Province, South Africa

October 2018

CLIENT

Prepared for:

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Report Name	**Hydropedology Assessment - Proposed Kalabasfontein Coal Mining Project Extension**	
Submitted to	**EIMS Environmental (Pty) Ltd**	
Report Reviewer	**Andrew Husted**	
	Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 12 years' experience in the environmental consulting field. Andrew has completed numerous wetland training courses, and is an accredited wetland practitioner, recognised by the DWS, and also the Mondi Wetlands programme as a competent wetland consultant.	
Report Writer (Wetlands)	**Wayne Jackson**	
	Wayne Jackson is a Soils Scientist & Hydrologist, and has 9 years' experience in the classification of soils and wetlands, both nationally and internationally. Wayne completed a B.Sc. degree (Soil Science and Hydrology) from the University of Kwa-Zulu Natal and has 8 years of consulting experience.	
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Ecological Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.	

EXECUTIVE SUMMARY

GNR 982	Appendix 6 (n): Specialist Opinion
The Underground mining poses a risk if subsidence occurs, however all efforts must be made to minimise the risk of subsidence as avoiding this impact is the most effective way to mitigate it. The preferred Ventilation Shaft is situated some distance from the wetlands and is considered low risk. The Powerlines are also considered low risk if they are constructed as close to the road reserve as possible. Considering the above-mentioned conclusions, it is the opinion of the specialist that the Kalabasfontein project area, with the current proposed infrastructures layout areas, may be favourably considered.	

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

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

Although interflow in soils and shallow bedrock dominates, indicating that a large part of rainfall serves terrestrial ecosystems, the wetlands in valley bottoms indicate that a significant amount of water is supplied during the rainy season and post seasonal, to the wetlands. It implies that the hills in most sites primarily partition the rainfall in shallow interflow, yet all leaks water to the deep fractured rock system, stores and release it slowly long after the rain, keeping wetlands wet. Wetland controls contribute well to keep water in the wetland longer. These flowpaths serving recharge/interflow/release of water to wetlands and storing it in the wetland, must be preserved.

The impact of underground mining is ‘low’. Shallow flow paths dominates the hillslopes, yet all have flow and storage mechanisms maintaining wetlands. Shallow interflow down to the midslope, feed terrestrial ecosystems and disturbance of these flowpaths will not significantly affect wetlands.

These recommendations may supplement the prescribed mitigation measures, but these recommendations must be investigated prior to the issuing of environmental authorisation. The following recommendations are applicable for this project:

1. The recommended buffer width is 25 m for the Ventilation shaft and 10 m for the Powerline implemented from the onset of the construction phase of the project and no activities or footprint area must be within these buffers.
2. In the event that wetland areas will be impacted, a wetland rehabilitation plan is required.

DOCUMENT GUIDE

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

GNR 982	Description	Section in the Report
Specialist Report		
Appendix 6 (a)	A specialist report prepared in terms of these Regulations must contain— details of— i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page ii
Appendix 6 (b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Page v
Appendix 6 (c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 3
Appendix 6 (cA)	An indication of the quality and age of base data used for the specialist report;	Section 7 & 8
Appendix 6 (cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
Appendix 6 (d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 8
Appendix 6 (e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 5
Appendix 6 (f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives;	Section 8
Appendix 6 (g)	An identification of any areas to be avoided, including buffers;	Section 8
Appendix 6 (h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 8
Appendix 6 (i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
Appendix 6 (j)	A description of the findings and potential implications of such findings on the impact of the proposed activities;	Section 9 & 10
Appendix 6 (k)	Any mitigation measures for inclusion in the EMPr;	Section 10
Appendix 6 (l)	Any conditions for inclusion in the environmental authorisation;	Section 10 & 11
Appendix 6 (m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	None
Appendix 6 (n)	A reasoned opinion— i. Whether the proposed activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activities; and ii. if the opinion is that the proposed activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 12.1
Appendix 6 (o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	None
Appendix 6 (p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
Appendix 6 (q)	Any other information requested by the competent authority.	None

DECLARATION

I, Wayne Jackson, 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.

Wayne Jackson

Wetland Specialist

The Biodiversity Company

23rd October 2018

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1. Introduction & Background

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

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

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

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

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

One wet-season wetland survey was conducted in September 2018/October 2018. The survey was conducted by specialists over a total period of six days.

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

This report, after taking into consideration the findings and recommendations provided by the specialist herein, 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 Project Area

The Kalabasfontein project area is situated in Mpumalanga, 20 kilometres north of Bethal and 20 kilometres (line of sight) east of Ga-Nala (Kriel). It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality, (Figure 1).

As part of the Kalabasfontein project, two alternative sites have been proposed for a new ventilation shaft, namely Portion 7 of the farm Uitgedacht 229 IS and Portion 22 of the farm Uitgedacht 229 IS. Land use in the considered catchments consists predominantly of grassland areas, wetlands, farmsteads and irrigated agriculture as well as the urban footprint of the town of Bethal.

The project area covers a total area of approximately 1 547.83 hectares in separate blocks over a number of properties and farm portions.

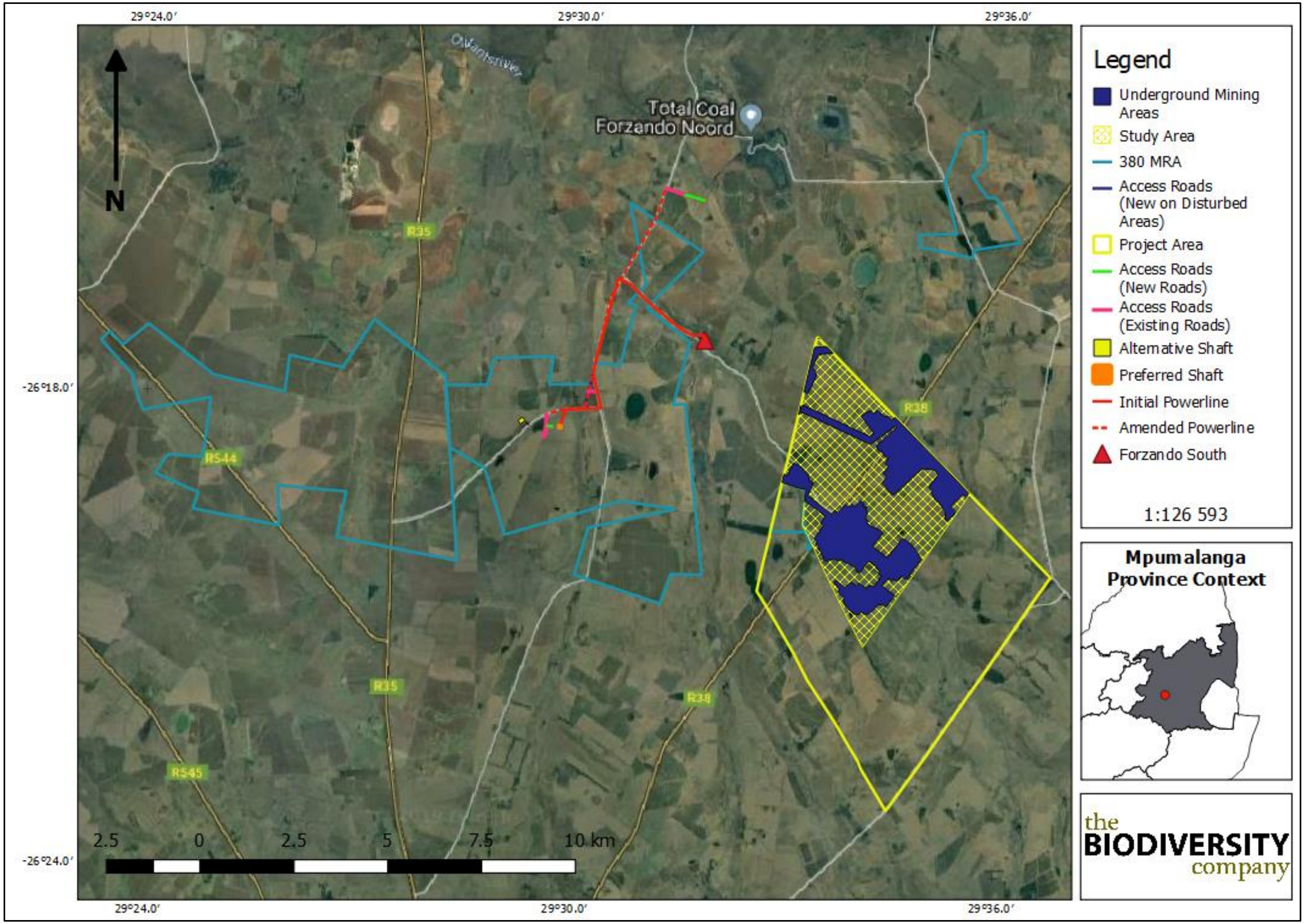

Figure 1: The proposed Kalabasfontein project area

2. Project Description

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

2.1 Mining Operations Overview

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

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

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

2.2 Current Authorisations

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

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

2.3 Infrastructure Requirements

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

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

Below are plant design parameters used:

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

2.4 Mining Method to be Employed: Underground Mining

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

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

2.5 Surface Infrastructure

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

2.6 Administration Buildings, Engineering Bays, Workshops and Other Buildings

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

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

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

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

3. Scope of Work

TBC was commissioned by EIMS to conduct a hydropedology baseline and impact assessment for the proposed Kalabasfontein project. The Terms of Reference (ToR) for this study included the following:

- Conduct a desktop assessment of the project area;
- Complete a site visit to understand the various flow paths both at surface and below surface;
- Identify, characterise, and delineate the local hydropedological systems;
- Consolidate the findings from the desktop assessment and the field assessments;

- Report on the various flow drivers, how they function, and how they will be affected;
- Once the baseline assessment has been completed and the infrastructural layout plans and drawings have been finalised the specialists will commence with the impact assessment;
- The significance of potential impacts on the above-mentioned attributes will be assessed using an agreed upon impact assessment matrix; and
- Suitable and practically implementable mitigation measures will be identified, and the significance of potential impacts will be reassessed post mitigation.

4. Limitations

The following aspects were considered as limitations;

- The GPS used for the hydropedological field assessment is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.
- The study has been supplemented by supporting wetland studies and geohydrological information which are considered to be true and accurate.

5. Methodologies

Hydropedology aims to address two fundamental questions (Lin, 2012):

1. How do soil architecture and the associated distribution of soils over the landscape exert a first-order control on hydrologic processes (and related biogeochemical dynamics and ecological functions)?
2. How do hydrologic processes (and the associated transport of energy and mass) influence soil genesis, evolution, variability, and function across space and time?

According to Lin (2012) the successful management and use of land, and also effective point scaling from point observations to landscape processes is an in situ understanding of flow and transport processes in natural soils. The focus of pedology has shifted from classification and inventory, to now understanding and quantifying variable processes upon which the water cycle and ecosystems depend (Lin et al., 2005, 2006b).

5.1 Hydropedology: linking soil morphology with hydrological processes

Hydropedology is the relatively new, interdisciplinary research field which focuses on the interactive relationship between soils and water (Figure 1). Soil physical properties, such as the hydraulic conductivity and porosity, have an important impact on the occurrence and rates of hydrological processes. In turn, hydrological processes play an important role on the formation of soil morphological properties such as colour, mottles, macropores and carbonate accumulations. Accurate mapping and the interpretation of these soil morphological properties can thus be used to conceptualise and characterise hydrological processes including water flowpaths, storage mechanisms and the connectivity between different flowpaths. Most of these hydrological mechanisms and processes are very difficult to observe in the field because they are dynamic in nature with strong temporal and spatial variation. Nevertheless, soil morphological properties are not dynamic in nature and their spatial variation is not random, making soil properties the ideal identifier for predicting and conceptualising hydrological processes. One of the major contributions of hydropedology is the ability to conceptualise hydrological processes spatially to understand the hydrological functioning of landscapes (catchments or hillslopes).

In general, hydropedological information assists with effective water resource management, as required by the National Water Act (1998), through improved understanding and characterisation of hydrological processes.

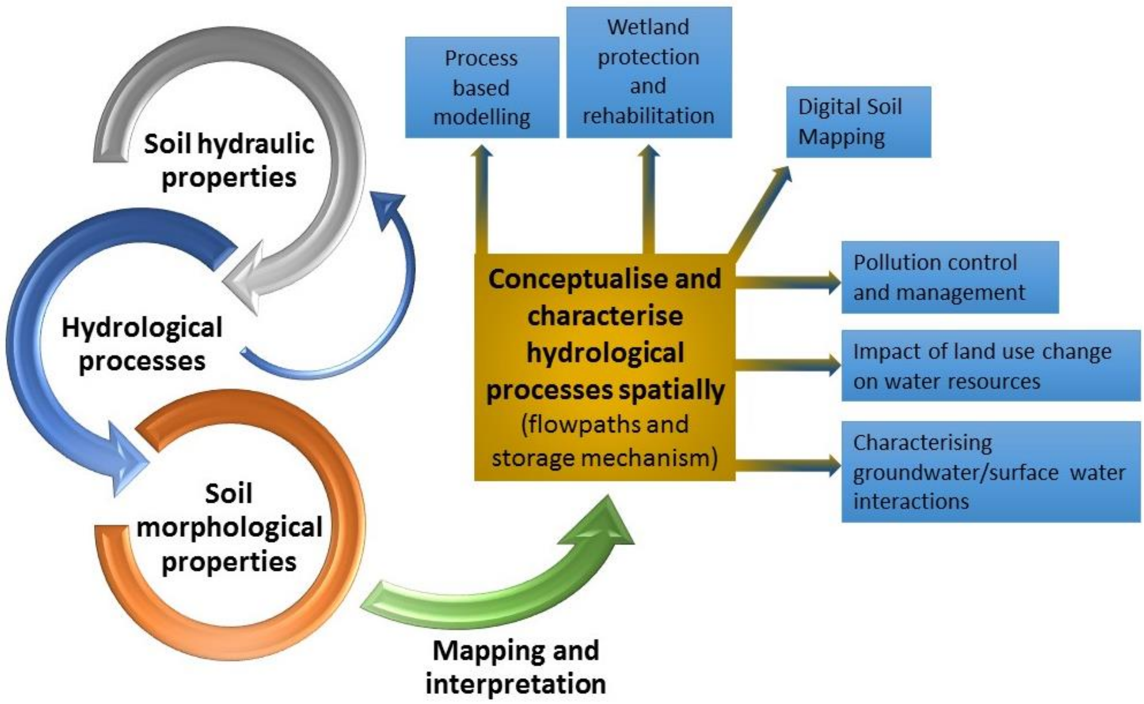

Figure 1: Illustration of the interconnection between hydropedology and its functions, van Tol et al., 2017.

5.2 Hydropedology of hillslopes

For effective water resource management, it is important to gain a holistic understanding of hydrological processes. Figure 2 presents a typical example of the hydropedological response of a hillslope. In the recharge zone, the dominant flow direction is vertical through the soil and into the fractured rock, from where it can recharge groundwater levels or downslope positions in the hillslope soils. Lateral flow at the A/B horizon interface or soil/bedrock interface dominate in the interflow zone. The responsive zone is fed by lateral flowing water from the interflow zone as well as via the bedrock from the recharge zone.

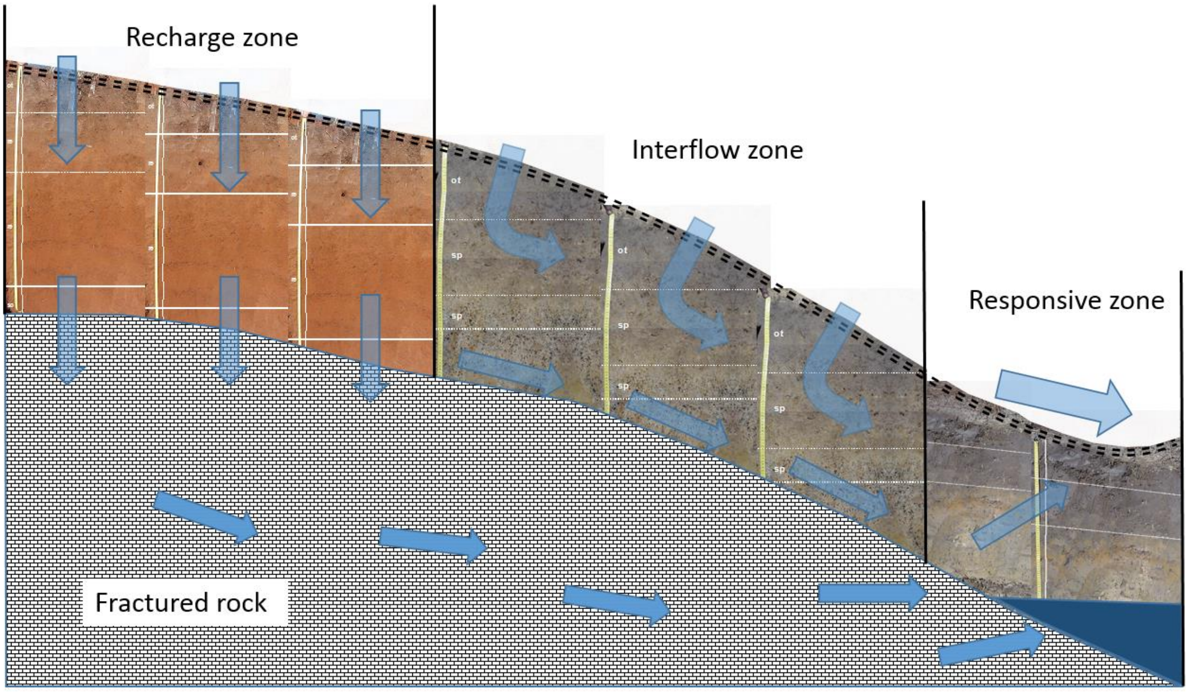

Figure 2: Typical example of hydrological flowpaths on different hydropedological soil types- hillslope hydropedological behaviour, van Tol et al., 2017

Although Figure 2 represents an oversimplification of a fraction of the complex hydrological cycle, the application of this information can make important contributions to effective management. Four scenarios are presented to support this statement.

1 **Pollution:** The fate of pollution will differ depending on whether it was spilled on recharge, interflow or responsive soils. A spill on recharge soils is likely to end up in the groundwater or might arrive in the stream several months after the spill via flow through the fractured rock. Pollutants spilled on interflow zones will migrate downslope through the soil.

2 **Conserving wetlands:** Hydropedological information can aid in identifying the sources of water in order to preserve wetlands. If the recharge zone is the major source of water to the wetland i.e. the recharge zone is the hydrological driver of the wetland, care should be taken to restrict surface sealing (paving) of the recharge zone. If the wetland's water comes from an interflow zone, care should be taken to prevent obstruction of subsurface lateral flowpaths.

3 **Hydrological modelling:** Hydropedological information can assist in the correct configuration of distributed hydrological models. In many landscapes different landscape elements (or Hydrological Response Units – HRU's) are not connected in a simple cascading downslope way to one another. There might be areas which are disconnected from the stream or groundwater stores. In addition, deep infiltration from recharge soils at the crest of a hillslope, may re-appear as lateral flow water further down the slope. Hydropedological information can thus be used to ensure that the model configuration properly reflects the hydrological processes. This can be critical in simulating low flows, where vegetation may have access to near-surface water and thus limit contributions to streamflow.

4 **Land-use change:** Hydropedological information can support the understanding of the impact of land-use change on water resources. If, for example, the interflow zone is urbanised it may result in a build-up of water against foundations and the generation of return flow to the surface and overland flow which may cause erosion. Open cast mining close to responsive zones are likely to result in a draw-down of water levels and drying of wetlands. If such an open cast section intersects lateral flowpaths it will break the connectivity of flowpaths and cut the source of water to wetlands. Although the impact of land-use change cannot always be avoided, hydropedological information might aid in managing and protecting the hydrologic drivers of the ecosystem and thereby minimise negative impacts.

5.3 Hydropedological surveys

A hydropedological survey (in the context discussed above) is different from a conventional soil survey in the following aspects:

- Observation depth: the depth of observation in a conventional survey is 1.5 m, whereas the observation depth for the hydropedological survey is the depth to the soil bedrock interface.
- Classification: conventional soil surveys aim to classify soils in accordance with a specific classification system. In hydropedological surveys all morphological properties and all soil horizons are described, recorded and interpreted, with particular emphasis on the ambient and connected soil water environment. This include saprolitic (weathering rock) horizons and horizons which are not necessarily included in the hierarchy of the classification system.
- Observation density: Conventional soil surveys aim to capture the distribution of different soils in a particular landscape. Hydropedological surveys focus on the hydrological response of dominant hillslopes/transects.

Important to note is that hydropedological surveys cannot be used as a surrogate for mapping the agricultural potential (as required during most EIA's) of an area. Conventional soil surveys (or other existing soil information) can also not always be used to infer the hydropedological response of an area, due to the differences between conventional and hydropedological surveys highlighted above.

Hydropedological surveys do not replace detailed soil physical or hydrometric measurements but rather serves as a vehicle to identify representative sites for such measurements and to extrapolate these measurements to larger areas. Hydropedological surveys are also not a surrogate for hydrological modelling, but can contribute to the efficiency and accuracy of modelling exercises. Hydropedological surveys and the interpretation and application of hydropedological information can be a cost -and time effective approach to conceptualise and characterise hydrological behaviour of landscapes.

6. Key Legislative Requirements

National Water Act (Act No. 36 of 1998)

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

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

A watercourse means:

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

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS.

For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998): “Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”.

Wetlands have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

National Environmental Management Act (Act No. 107 of 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in April 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

7. Project Area

Kalabasfontein project area is situated in Mpumalanga, 20 kilometres north of Bethal and 20 kilometres (line of sight) east of Ga-Nala (Kriel). It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality. The project area comprises two prospecting rights, 1035PR & 1170PR, which covers a total of approximately 1 547.83 ha over portions 7, 8, RE, 11 and 13 of the farm Kalabasfontein 232 IS. A new ventilation shaft will be located either on Portion 7 of the farm Uitgedacht 229 IS or on Portion 22 of the farm Uitgedacht 229 IS as part of the Kalabasfontein project.

7.1 Desktop Assessment -Terrain

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. The following processes have been considered for the desktop assessment:

- **The relief map** (Figure 4): The project area is non-uniform with an elevation range from approximately 1580 meter above sea level (masl) to 1700 masl. The lower laying regions are characterised by various signs of wetness including hydrophytes, wetland soils, historic signs of wetness and current signs of wetness.
- **The slope map** (Figure 5): The project area is non-uniform with slopes between 0% and 30% with some major height changes throughout the project boundaries which represents cliffs.
- **The aspect map** (Figure 6): The map shows that the entire project area is non-uniform and with an aspect facing towards north, south, east and west.

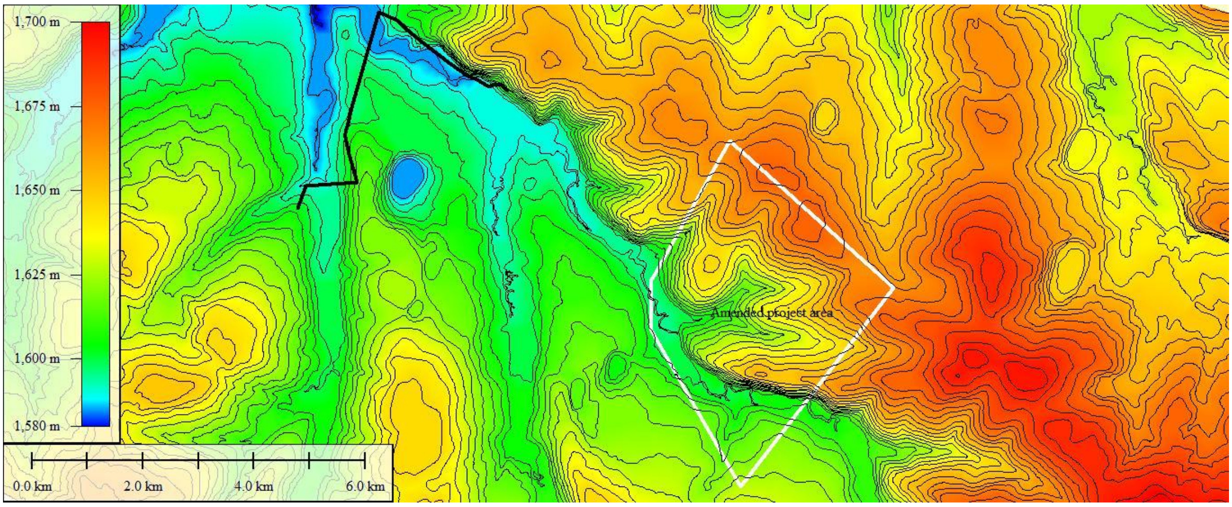

Figure 4: The relief map for the project area

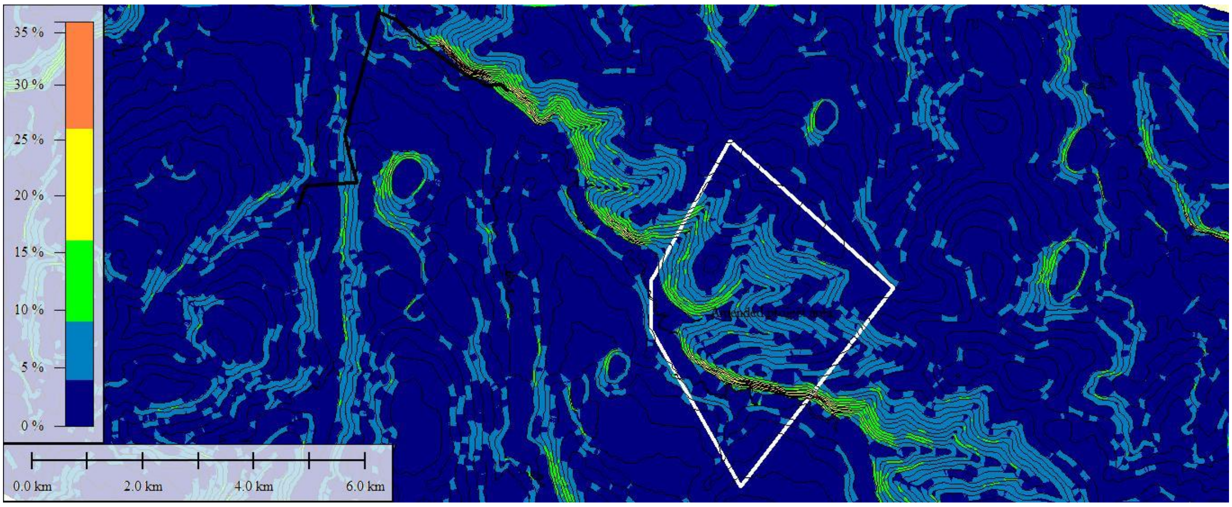

Figure 5: The Slope Percentage map for project area

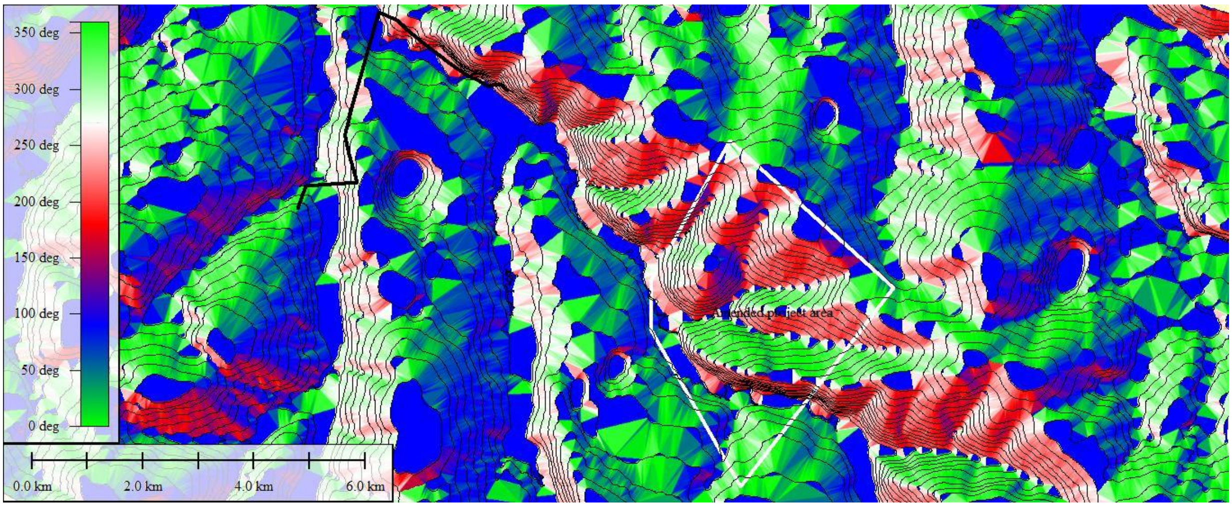

Figure 6: The Slope Aspect map for project area

7.2 General Land Use

The dominant land use of the surrounding area is cultivated land/agriculture, predominately maize and to a lesser extent other crop plants such as Soya. Natural vegetation is utilized for livestock grazing, predominately by cattle. Subsistence farming also occurs on site, with cattle grazing across various portions of the project area, including wetland areas. Other land uses nearby include other coal mining operations as well as the urban footprint of the town of Bethal. The following infrastructure exists in the project area and surrounds:

- Agricultural properties and cultivated fields;
- Various secondary farm roads, minor tar roads (R35 and R38), and a national highway (N17) south of the project area;
- Many farm dams and at least three notably large man-made dams;
- Wetland areas;

- Rocky ridges and caves;
- Power lines – especially large Eskom powerlines transecting multiple farm portions;
- Telephone lines;
- Agricultural homesteads and fields; and
- Urban dwellings.

7.3 Climate

According to Mucina & Rutherford (2006), this region is characterised by a strongly seasonal rainfall, dry winters and a mean annual precipitation of approximately 726mm and is relatively uniform across the distribution of the Gm 12 vegetation type. Incidence of frost ranges between 13 to 42 days a year and occurs more at higher elevations, see Figure 2.

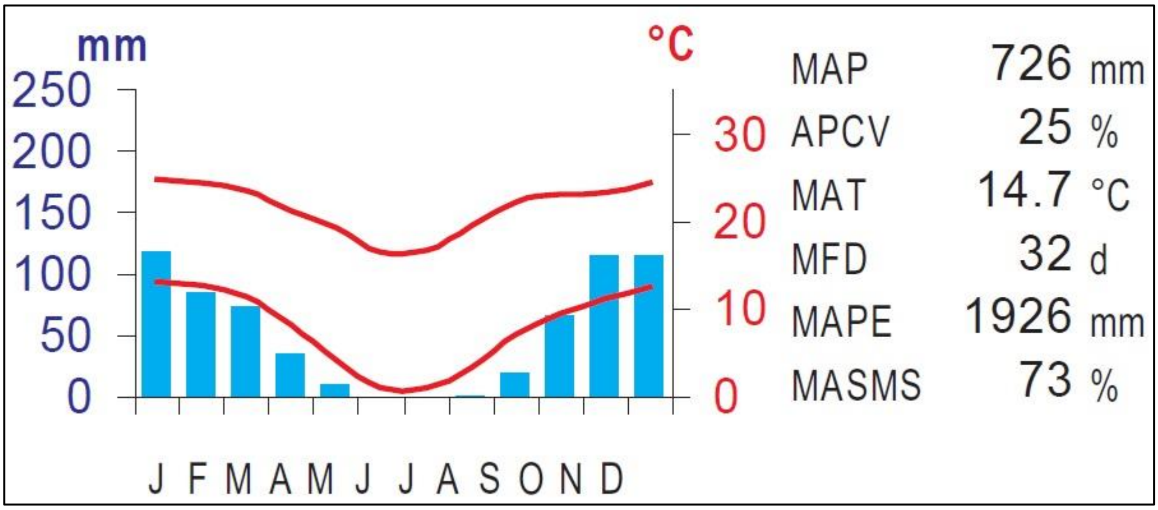

Figure 2: Climate for the project area, Mucina & Rutherford (2006),

7.4 Vegetation Types

The grassland biome comprises many different vegetation types. The project area is situated within one vegetation type; namely the Eastern Highveld Grassland (GM12) according to Mucina & Rutherford (2006) (Figure 3).

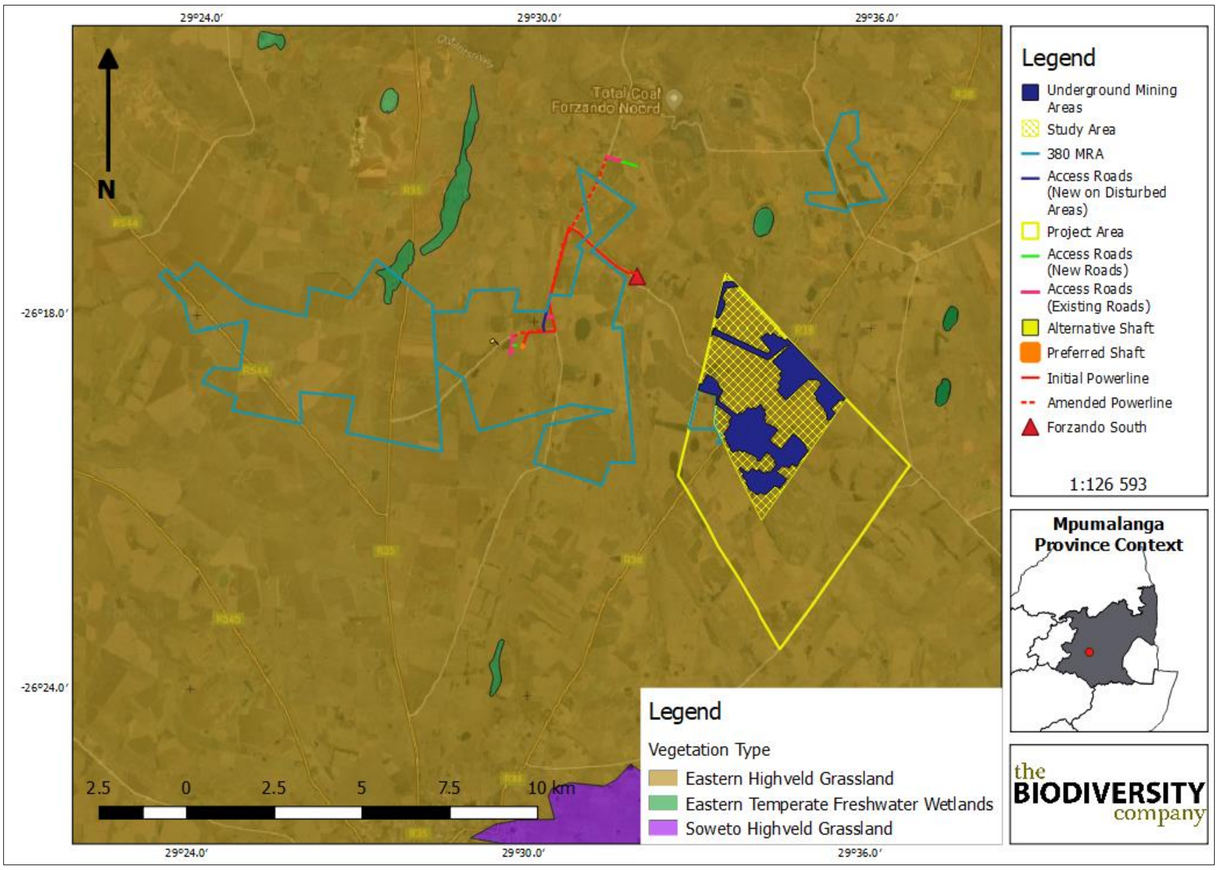

Figure 3: The project area showing the vegetation types based on the Vegetation Map of South Africa, Lesotho & Swaziland (BGIS,2017)

7.5 Eastern Highveld Grassland

This vegetation type occurs on slightly to moderately undulating planes, including some low hills and pan depressions. The vegetation is a short dense grass land dominated by the usual highveld grass composition (Aristida, Digitaria, Eragrostis, Themeda, Tristachya etc.) with small scattered rocky outcrops with, wiry sour grasses and some woody species. Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. No serious alien invasions are reported (Mucina & Rutherford, 2006).

7.6 Geology & Soils

The geology of the area is shale, sandstone, clay and conglomerate of the Ecca Group, Karoo Sequence; dolerite; occasional felsitic lava of the Rooiberg Group, Transvaal Sequence.

According to the land type database (Land Type Survey Staff, 1972 - 2006) the project falls within the Bb4 land type. It is expected that, the dominant soils in the crest and midslope positions will be soils of the Avalon and Hutton forms. The soils that dominate the footslopes and the valley bottoms are Escourt, Katspruit, and Rensburg soil forms.

7.7 The MBSP Freshwater Assessment

The MBSP Freshwater Assessment outlines priority areas for freshwater biodiversity in Mpumalanga. The resulting features are predominantly derived from the NFEPA products, layers include CBA Rivers (based on FEPA and free-flowing rivers), CBA Wetlands (based on

FEPA wetlands), CBA Aquatic species (Odonata & crab taxa of conservation concern only), ESA Wetland Clusters (FEPA wetland clusters), and ESA Wetlands (all other non-FEPA wetlands). The MTPA created an updated land-cover using SPOT 2010 imagery. This data, together with high-resolution aerial imagery, was used to update and clean some of the features (MTPA et al., Freshwater Assessment, 2011).

The Kalabasfontein project area in relation to the MBSP Freshwater Assessment overlaps with the following areas: Ecological Support Areas (ESAs), Heavily Modified Areas (HMAs) and Other Natural Areas (ONAs) (Figure 4).

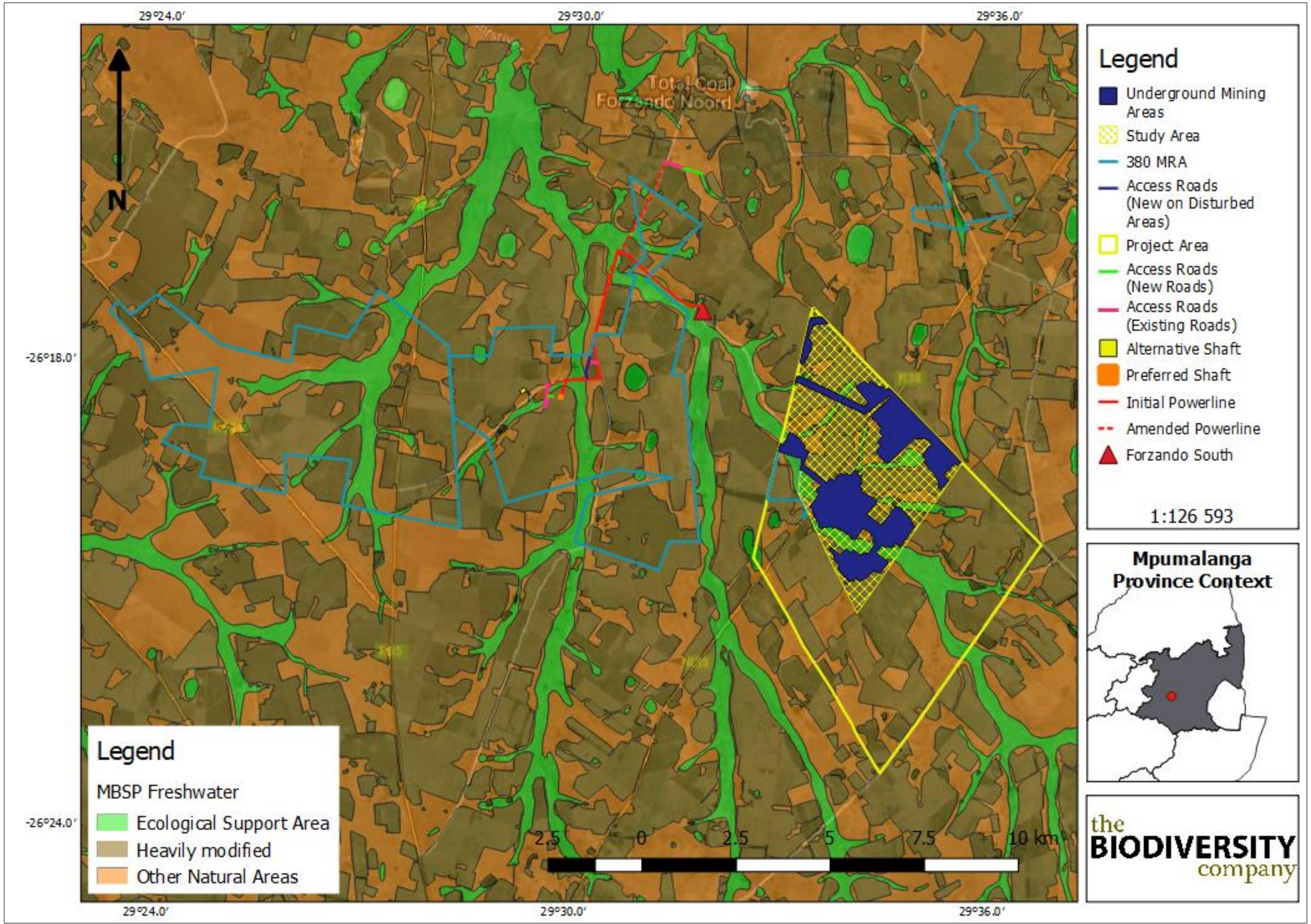

Figure 4: The Kalabasfontein project area in relation to the MBSP Freshwater Assessment

7.8 Mpumalanga Highveld Wetlands and NFEPA

The National Freshwater Ecosystem Priority Areas (Nel *et al*., 2011) where used to determine the presence of NFEPA wetlands.

The purpose of the Mpumalanga Highveld Wetlands project was to:

- Ground-truth and refine the current data layers of the extent, distribution, condition and type of freshwater ecosystems in the Mpumalanga Highveld coal belt, to support informed and consistent decision-making by regulators in relation to the water-biodiversity-energy nexus;
- To incorporate these revised data layers into the atlas of high-risk freshwater ecosystems and guidelines for wetland offsets, currently being developed by SANBI, to improve the scientific robustness of these tools; and
- To support the uptake, and development of the necessary capacity to apply the data, atlas and guidelines by regulators and the coal mining industry in their planning and decision-making processes'' (SANBI, 2012).

The Mpumalanga Highveld Wetlands data also classifies NFEPA land cover based on the defined condition of each area. These are known as the NFEPA wetland conditions categories. The categories are listed in Figure 5 and are represented in relation to the project area in Figure 6.

Description of NFEPA wetland conditions categories.
PES equivalent provides a description of the condition category that is broadly equivalent to that used by the Department of Water Affairs to describe Present Ecological State. Percentage of total area in each condition category is also provided.

PES equivalent	NFEPA condition	Description	% of total wetland area*
Natural or Good	AB	Percentage natural land cover ≥ 75%	47
Moderately modified	C	Percentage natural land cover 25-75%	18
Heavily to critically modified	DEF	Riverine wetland associated with a D, E, F or Z ecological category river	2
	Z1	Wetland overlaps with a 1:50,000 "artificial" inland water body from the Department of Land Affairs: Chief Directorate of Surveys and Mapping (2005-2007)	7
	Z2	Majority of the wetland unit is classified as "artificial" in the wetland delineation GIS layer	4
	Z3	Percentage natural land cover < 25%	20

** This percentage excludes the unmapped wetlands that have been irreversibly lost due to draining, ploughing and concreting*

Figure 5: A breakdown of the NFEPA wetland condition categories

Figure 6 shows the project area in relation to the Mpumalanga Highveld Wetlands data as provided by SANBI. The Kalabasfontein project area intersects with wetland areas classified as FEPA wetlands. The majority of these wetlands are classified as Class D wetlands (Figure 7). This means that these areas have been classified as heavily to critically modified.

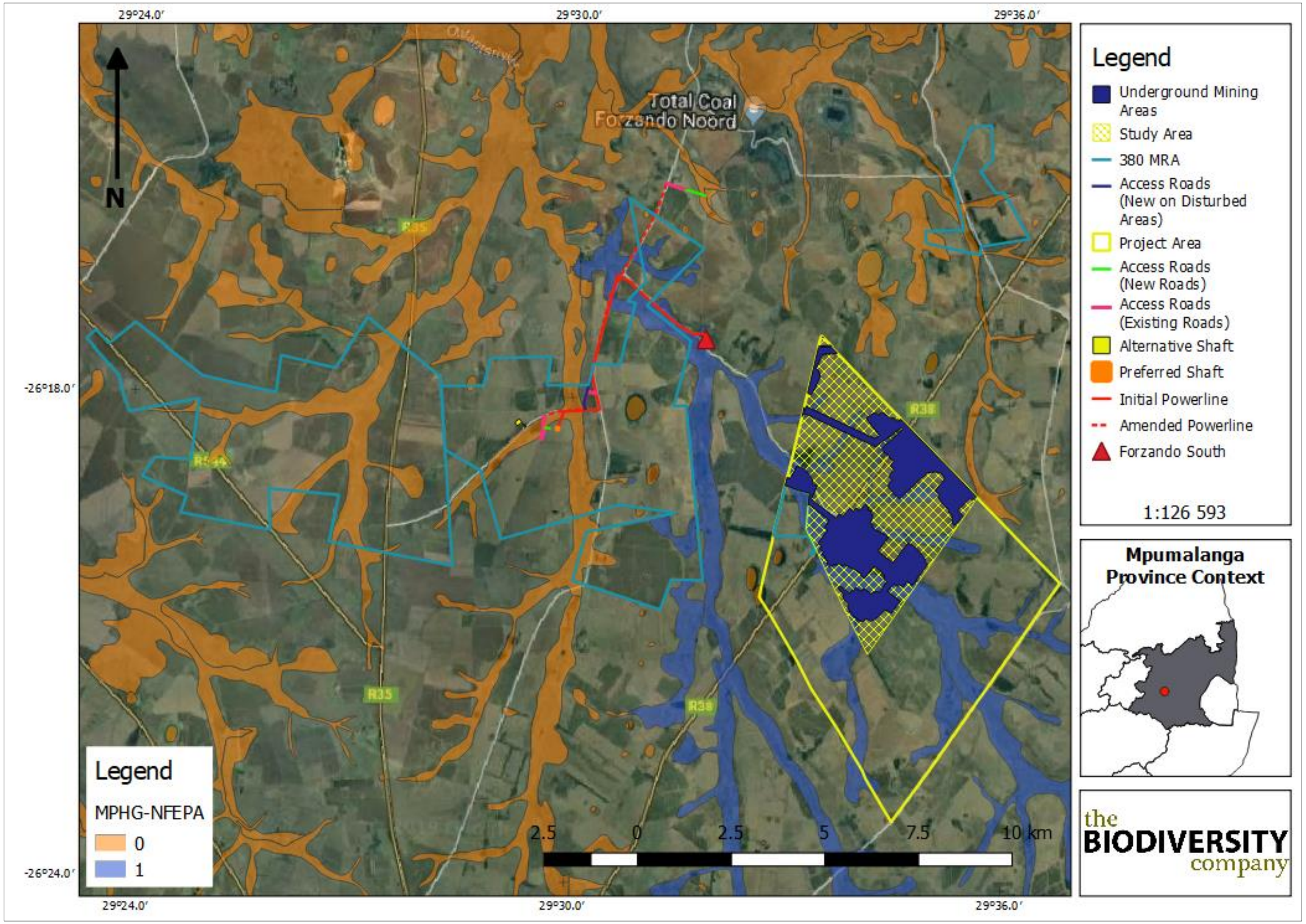

Figure 6: Shows the overall project area in relation to the Mpumalanga Highveld Wetlands (SANBI, 2012)

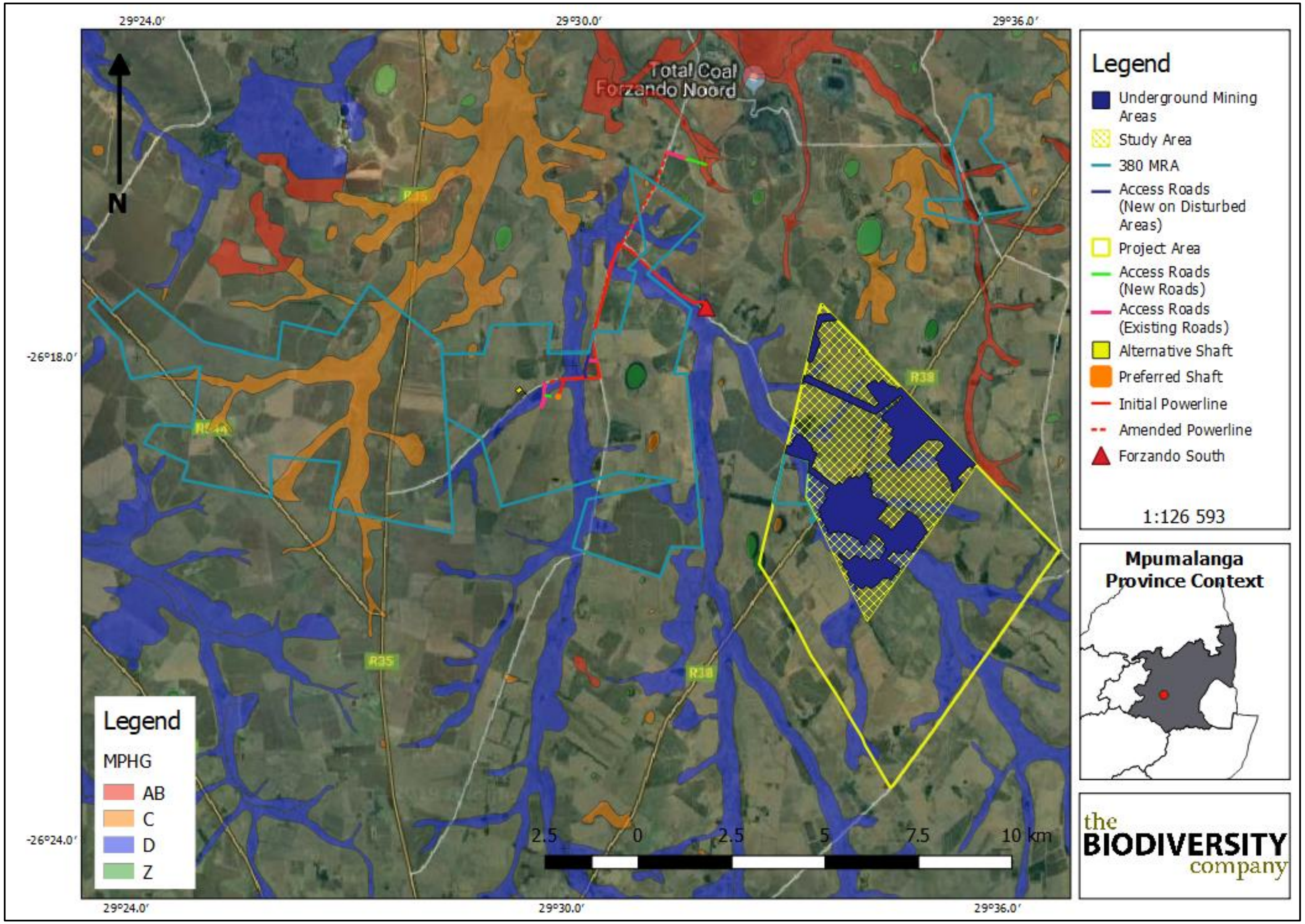

Figure 7: Shows the overall project area in relation to the Mpumalanga Highveld Wetlands in relation the wetland conditions

7.9 Wetlands Report

A wetland assessment was completed (TBC, 2018) and the results below reflect the findings. The wetland delineation is shown in Figure 8. Table 1 shows the wetland classification as per SANBI guidelines (Ollis *et al*. 2013). Seven wetland types were identified within the two project areas, and these were categorised into nine (9) HGM units, namely;

- Floodplain (HGM 1 and HGM 2);
- Unchannelled valley bottom (HGM 3);
- Channelled valley bottom (HGM 4);
- Hillslope seep (HGM 5);
- Flat (HGM 6);
- Depression (HGM 7 and HGM 8); and
- Artificial dams (HGM 9).

Table 1: Wetland classification as per SANBI guideline (Ollis et al. 2013).

Wetland Name	Level 1	Level 2		Level 3	Level 4		
	System	DWS Ecoregion	NFEPA Wet Veg Group	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	Highveld	Mesic Highveld grassland group 4	Valley Floor	Floodplain	Flat	N/A
HGM 2				Valley Floor	Floodplain	Flat	N/A
HGM 3				Valley Floor	Unchannelled valley bottom	N/A	N/A
HGM 4				Valley Floor	Channelled valley bottom	N/A	N/A
HGM 5				Slope	Hillslope seep	With channelled outflow	N/A
HGM 6				Bench	Flat	N/A	N/A
HGM 7				Bench	Depression	Exorheic	Without channelled outflow
HGM 8				Bench	Depression	Exorheic	Without channelled outflow
HGM 9				Valley Floor	Depression	Dammed	With channelled outflow

The overall wetland health for HGM 1 was determined to be Largely Modified (D), with the remaining HGM units determined to be Moderately Modified (C).

All HGM units exhibited a moderately high benefit for indirect benefits such as; sediment trapping, and phosphate/nitrate/toxicant assimilation. HGM 7, 8, and 9 had a moderately high benefit for flood attenuation. The floodplains HGM 1 and HGM 2 exhibited a moderately high benefit for biodiversity maintenance providing suitable habitat for fauna and flora. HGM 3 and

HGM 8 had a moderately high benefit for erosion control. The remaining benefits were rated as intermediate or lower.

The EIS was calculated to have a Very High (A) importance for HGM 1. This rating can be attributed to the ecological importance of the floodplain from an NFEPA perspective as well as the national ecosystem classifications (see section 7.5) rating this area as vulnerable. HGM 2, 3, 4, 8, and 9 were rated as High (B) importance. HGM 5, 6, and 7 were rated as Moderate (C) importance.

A conservative buffer zone was suggested of 25 m for the ventilation shafts and 10 m for the associated powerline, this buffer is calculated assuming mitigation measures are applied. This would typically include a commitment to rehabilitate and manage buffer zones to ensure that these areas function optimally. No buffer was calculated for the underground mining areas as a buffer would not address any impacts associated with that type of mining.

It must be noted that the alternative ventilation shaft is within the wetland buffer and it is recommended that the preferred shaft location be used. The powerline will traverse many wetland areas and it is recommended that the powerline route be situated on the existing servitude and that spans are planned to cross wetland areas and their associated buffer zones.

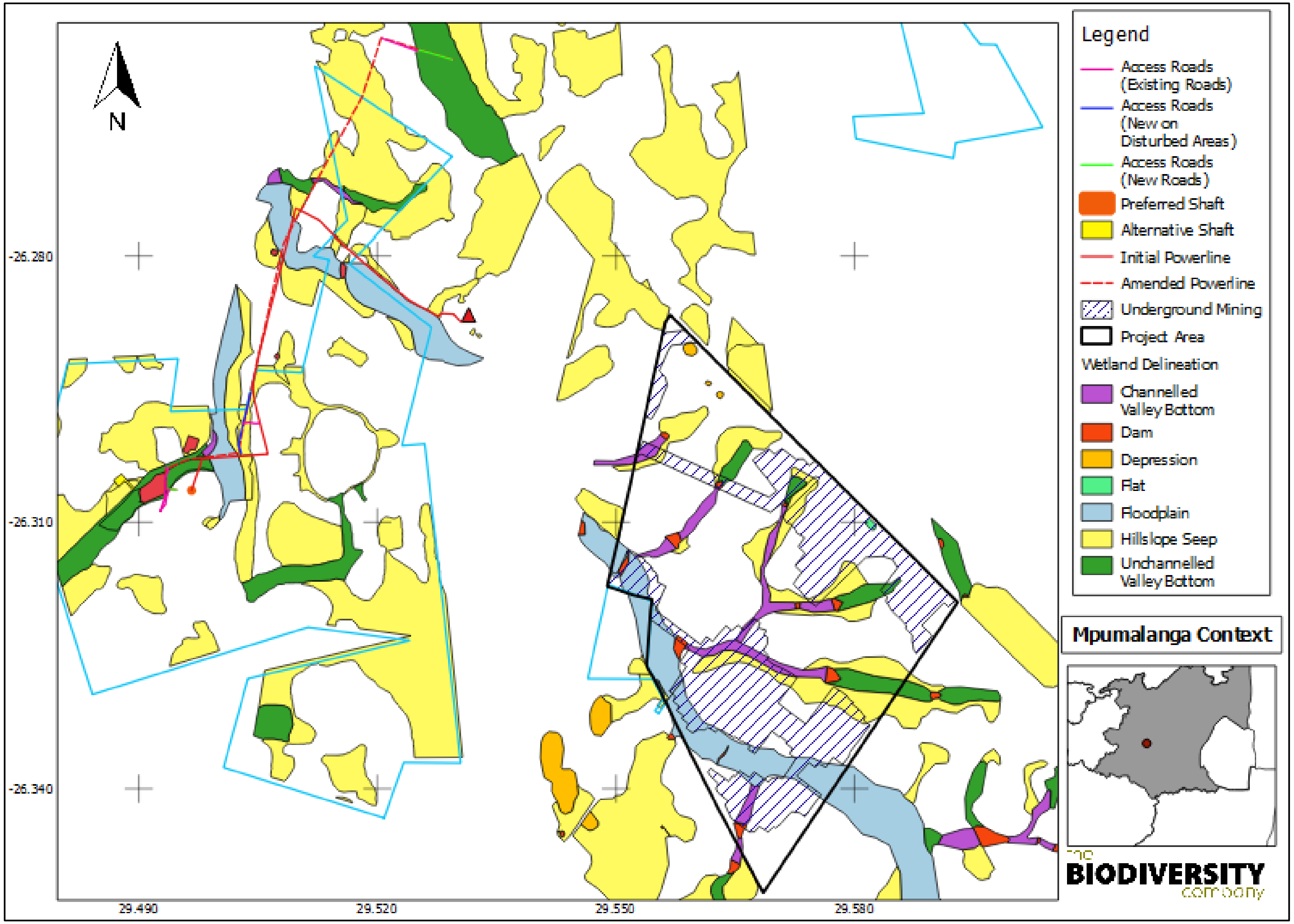

Figure 8: Kalabasfontein project wetland delineation

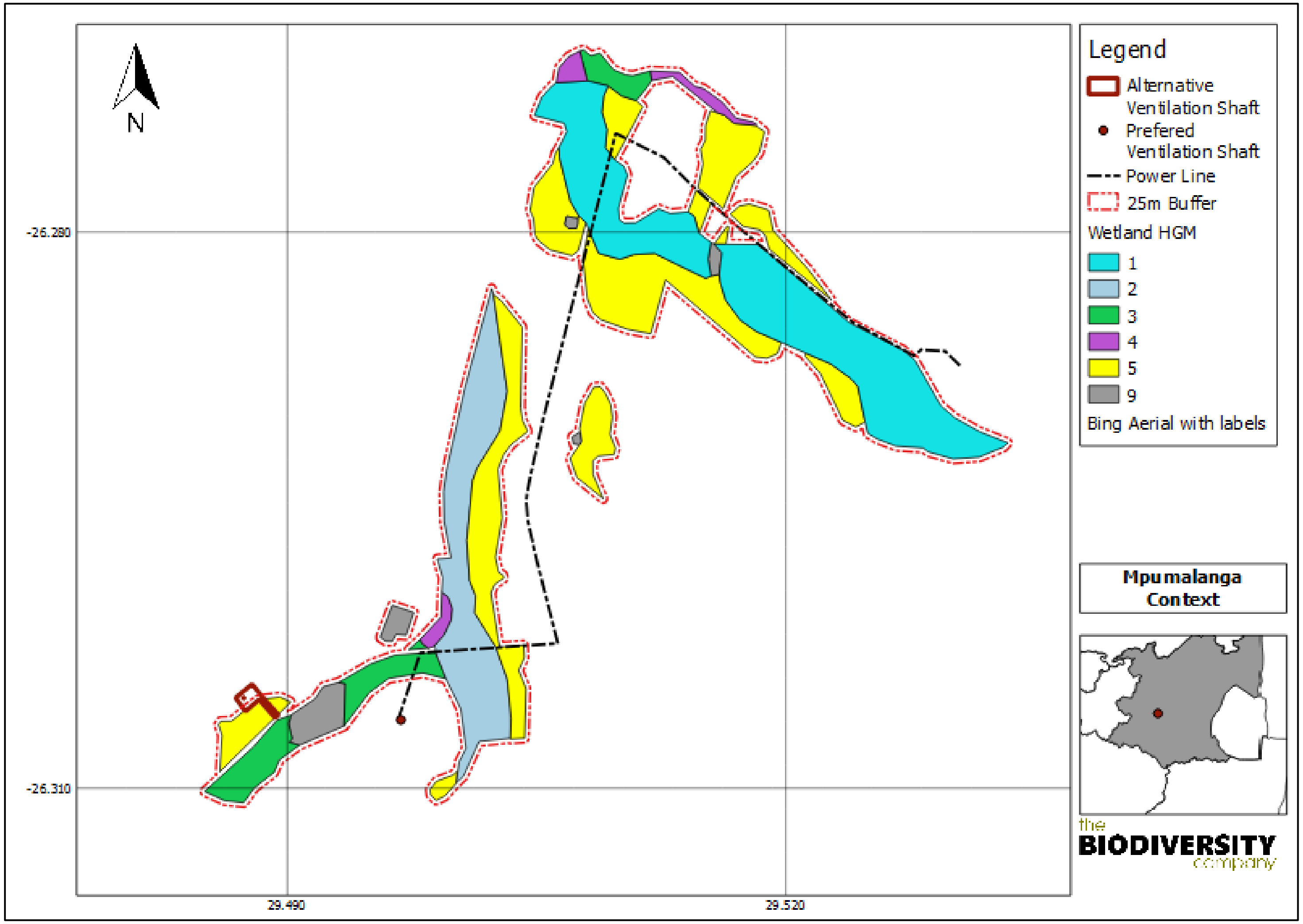

Figure 9: The buffer zones for the wetlands in the Kalabasfontein project

7.10 Groundwater and Geotechnical Reports

7.10.1 Aquifer Characterisation

According to the hydrogeological assessment conducted by GCS in 2018, two distinct superimposed groundwater systems are present within the Olifants River Catchment. They can be classified as:

- The upper weathered Ecca aquifer (shallow aquifer formed in the weathered zone of the Karoo sediments and which is locally perched on the fresh bedrock), the ground water level for this aquifer is within 5 m of the surface; and
- The aquifer below the Ecca sediments (deeper aquifer formed by fracturing of the Karoo sediments and dolerite intrusions (Hodgson & Krantz, 1998 and WRC report 291/1/98).

These types of groundwater systems are common to the groundwater regime that characterises a Karoo environment. The systems do not necessarily occur in isolation of one another, more often than not forming a composite groundwater regime that is comprised of one, some or all of the systems. Good hydraulic connectivity often exists between the two top aquifers and they have consequently been treated as a single unit in the modelling of groundwater flow.

7.10.2 Shallow Weathered Aquifer

The Ecca sediments are weathered to depths between 5 m to 12 m below surface throughout the Olifants Catchment. The upper aquifer is associated with this weathered zone and water is often found within a few meters below surface. This aquifer is recharged by rainfall.

Rainfall that infiltrates the weathered rock soon reaches an impermeable layer of shale underlying the weathered zone. The movement of groundwater on top of this shale is lateral and in the direction of the surface slope. This water reappears on surface at fountains where the flow paths are obstructed by a barrier, such as a dolerite dyke, paleo-topographic highs in the bedrock, or where the surface topography cuts into the groundwater level at streams. It is suggested that less than 60% of the water recharged to the weathered zone eventually emanates in streams.

The aquifer within the weathered zone is generally low-yielding (range 100 – 2 000 l/h). Few farmers therefore tap this aquifer by borehole. Wells or trenches, dug into the upper aquifer, are often sufficient to secure a constant water supply of excellent quality.

It is likely that no significant stream flow reduction will occur within the Viskuile Spruit and/or the Olifants River due to the aquifer drawdown in the area. The numerical model indicated a short period of maximum drawdown and restricted to the area around the Forzando South Adit area. Baseflow may be slightly reduced in this area and this will only be evident during the dry winter months.

It is proposed that shallow groundwater monitoring sites be installed during the operational phase to determine the impact on shallow groundwater flow conditions by monitoring the shallow aquifer characteristics within the Forzando South and Kalabasfontein Project Area (Figure 10).

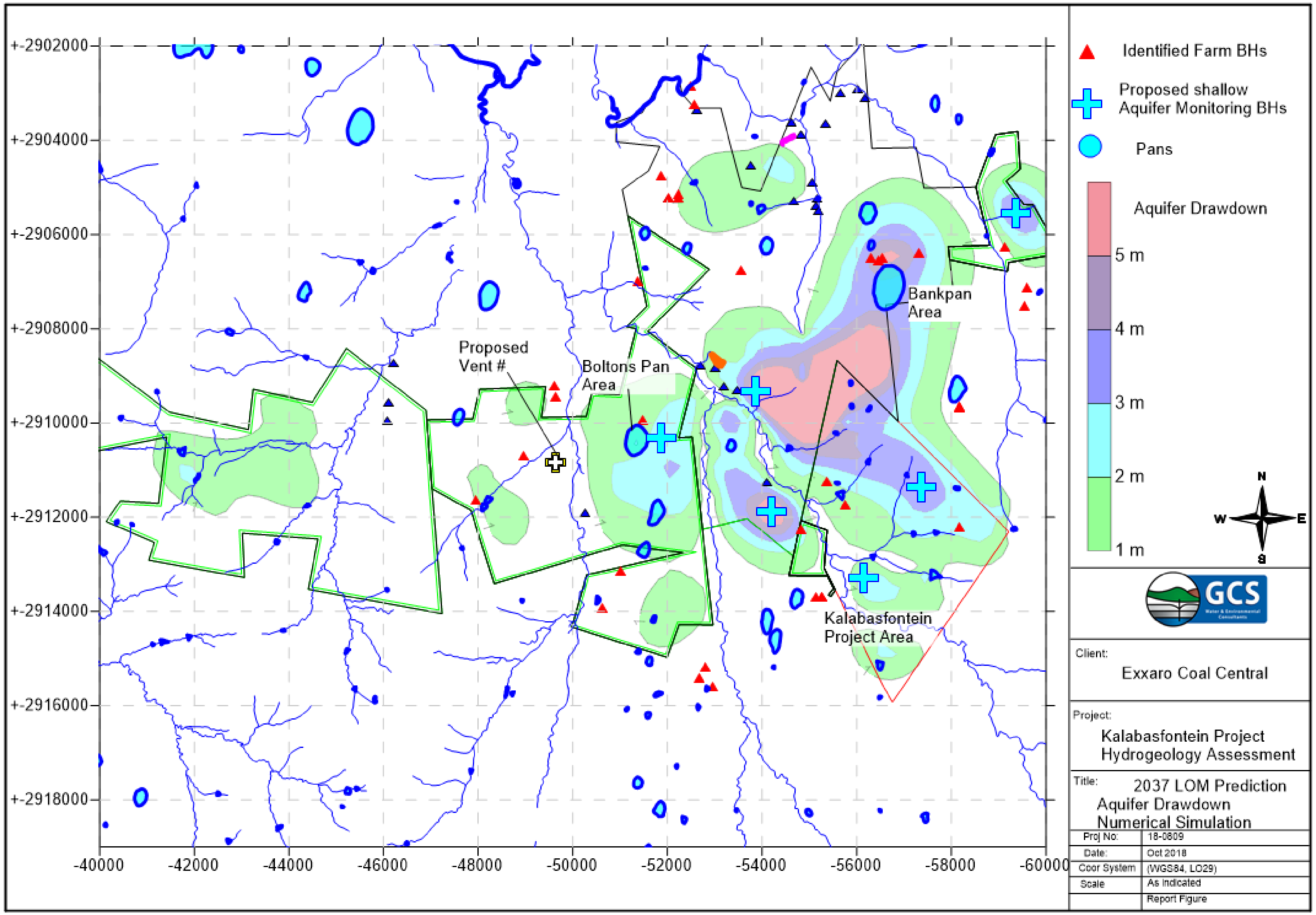

Figure 10: Forzando North and South regional groundwater dewatering contours in meter [m] – LOM prediction (GCS, 2018)

7.10.3 The Fractured Karoo Rock Aquifers

The pores within the Ecca sediments are too well cemented to allow any significant permeation of water. All groundwater movement is therefore along secondary structures, such as fractures, cracks and joints in the sediments. These structures are better developed in competent rocks such as sandstone, hence the better water-yielding properties of the latter rock type.

7.10.4 Aquifer Characteristics Specific to Kalabasfontein Project Area

The aquifer characteristics for Forzando South can be summarised as follows:

- Transmissivity values decreased with depth;
- The sandstone between the No 4 upper and No 4 lower coal seam has a permeability significantly lower than that of fractures within the Vryheid Formation sediments;
- The No 4 coal seam is not highly permeable. Some seepage of water from the coal can be expected during mining;
- The average hydraulic conductivity is around 0.1m/day for the upper Karoo formation;
- Shales and sandstone at depths exceeding 15m has a hydraulic conductivity between 0.004 and 0.02m/day;
- The shallow boreholes close to the streams at the Forzando South box-cut exhibit hydraulic conductivities an order of magnitude higher, ranging from 0.3 m/day to in excess of 1m/day. It is fair to assume that the alluvial sands along the streams having higher permeability values; and
- The geotechnical report completed by Rock Engineering Department, 2018. Discusses the subsidence and sinkhole risks below:

Pillar Stability

No potential pillar instability is anticipated if the Reserves are mined with pillars laid-out on minimum 15.0m x 15.0 m center and maximum 18.0 m x 18.0 m center layout with 7.2 m bords. Pillar size variation will be a function of bord width, mining depth and mining height. Pillar sizes generally increase with increasing mining depth, mining height and bord widths. All the pillars were found to have a probability of survival more than 99.995% which is recommended for the highly sensitive surface structures. This therefore implies a probability of failure of < 0.005%.

Pillar life index calculation shows that all pillars will have a life index of at least 11 046 years before a 50% probability of failure is reached. This is far more than the recommended 2000 years for highly sensitive structures.

Sinkhole

A maximum caving height of 14.0 m was calculated for all areas should roof failure occur. No sinkhole is therefore expected in the reserve area as the maximum caving height does not progress to / intersect the weathered zone in any of the boreholes.

Cognisance must also be given to the fact that the overburden is comprised of at least 39% competent sandstone layers. Competent means any lithological units with a thickness of at least 1.0 m and a composition of at least 80% sandstone.

A minimum sandstone thickness of 15 m in the overburden was found during the investigation. This layer has an unsupported stable span of at least 20 m when jointed and 49 m when unjointed. Thus, pillar failure must occur before the overburden can fail. This means that sinkhole hole probabilities are low in the area.

Subsidence

The magnitude of maximum subsidence in a bord and pillar layout is dependent on the unlikely event that panel's pillar system fails. Cognisance must be taken to the fact that the calculated pillar life index and probability of survival are far greater than the recommended minimums, indicating a stable pillar system.

The investigation shows that a Class C, D & E subsidence profile will occur in the area in the unlikely event that pillar fails. The subsidence profile will have the following characteristics:

- Class C: Noticeable in flat terrain, smooth, cracks 2 to 10 cm wide, compression ridges 1 to 5 cm high.
- Class D: Noticeable in most terrains, visible vertical displacements across cracks, cracks 10 to 50 cm wide, compression ridges 5 to 50 cm high.
- Class E: Severe profile, almost vertical sides, cracks wider than 50 cm, compression ridges higher than 50 cm.

8. Results & Discussion

The survey was conducted to understand the soils present at the site as well as the hillslope hydrology which drive the wetlands in the area if any are present.

The survey was conducted by using a transect method, with the crest being the starting point and the valley bottom the end. The purpose of the maps is to indicate the hydrological hillslope classes in order to illustrate the dominant flow paths from the crest of a slope to the valley bottom.

The scope of work required that the hydropedological impacts for the two proposed ventilation shafts, the powerline and the underground portions be assessed. The assessment only focused on the ventilation shaft locations and the underground workings. The powerline infrastructure will not impact on the hydropedological functioning as the layout will be in existing servitudes where possible.

It was decided that one (1) hillslope transects would describe the dominating hillslope hydrology of the proposed ventilation shaft and underground mining areas. This is discussed in subsequent sections in more detail.

8.1 Soils & Hydrological Hillslope Classes

During the site assessment, various soil forms were identified. These soil forms have been delineated and illustrated in Figure 11 and the hydropedological soil units in Figure 12 according to soil type and hydrological soil units (TBC, 2018).

All of the hydromorphic soils identified have similar properties and depths and has therefore been labelled as “hydromorphic soils” rather than individual soil forms.

Table 2: Summary of soils identified within the project area

Soil Forms	Hydrological Soil Unit
Dresden	**Interflow (Soil/ Bedrock)**
Mispah	**Responsive Shallow**
Westleigh	**Responsive (Saturated)**
Shortlands "A"	**Recharge**
Shortlands "B"	**Recharge**
Clovelly	**Recharge**
Hutton	**Recharge**
Inhoek	**Responsive (Saturated)**
Longlands	**Interflow (Soil/ Bedrock)**
Hydromorphic soils	**Responsive (Saturated)**
Tukulu	**Interflow (Soil/ Bedrock)**
Fernwood	**Interflow (Soil/ Bedrock)**
Bainsvlei	**Interflow (Soil/ Bedrock)**
Avalon	**Interflow (Soil/ Bedrock)**
Oakleaf	**Recharge**

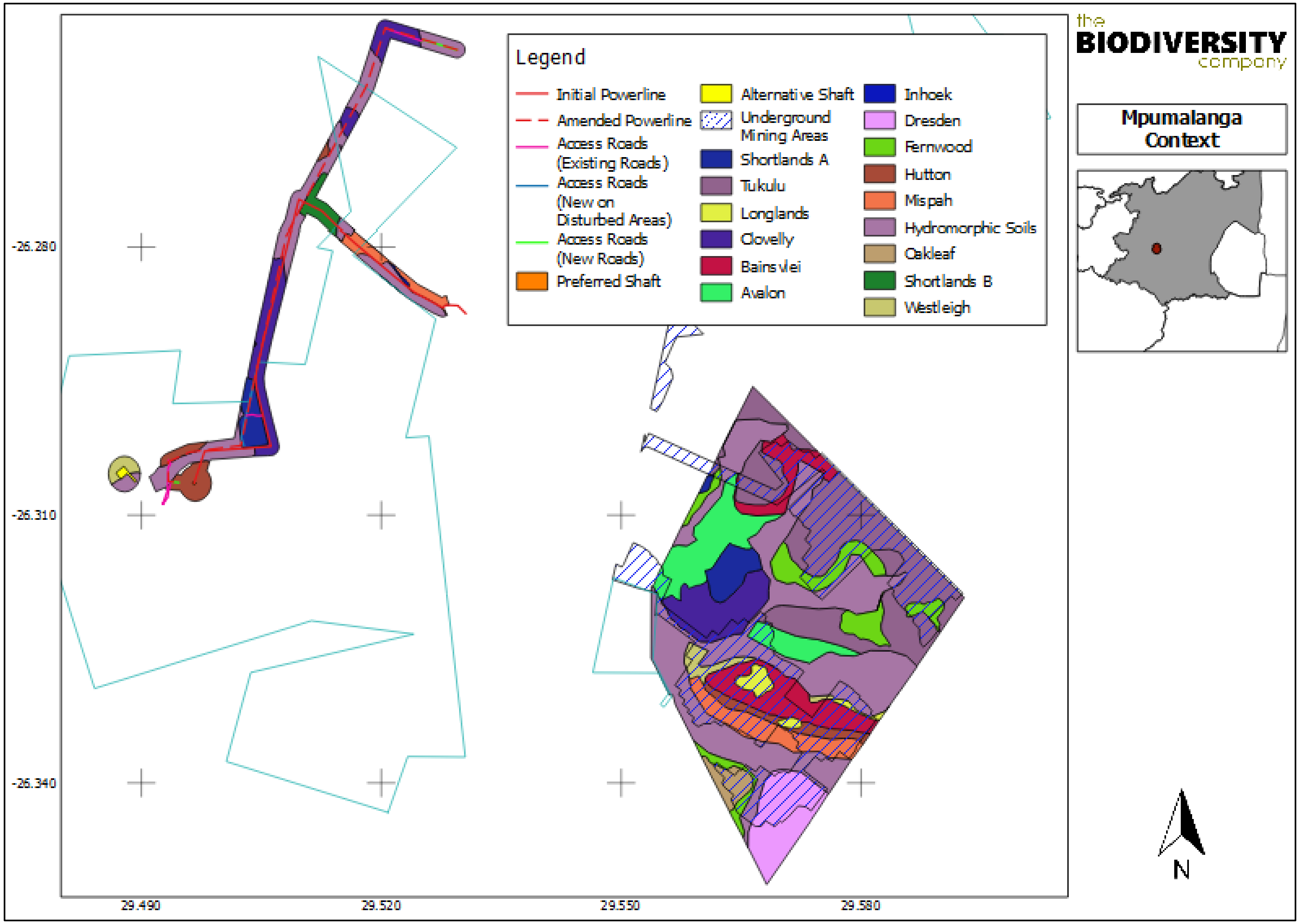

Figure 11: Soil delineations within the project area

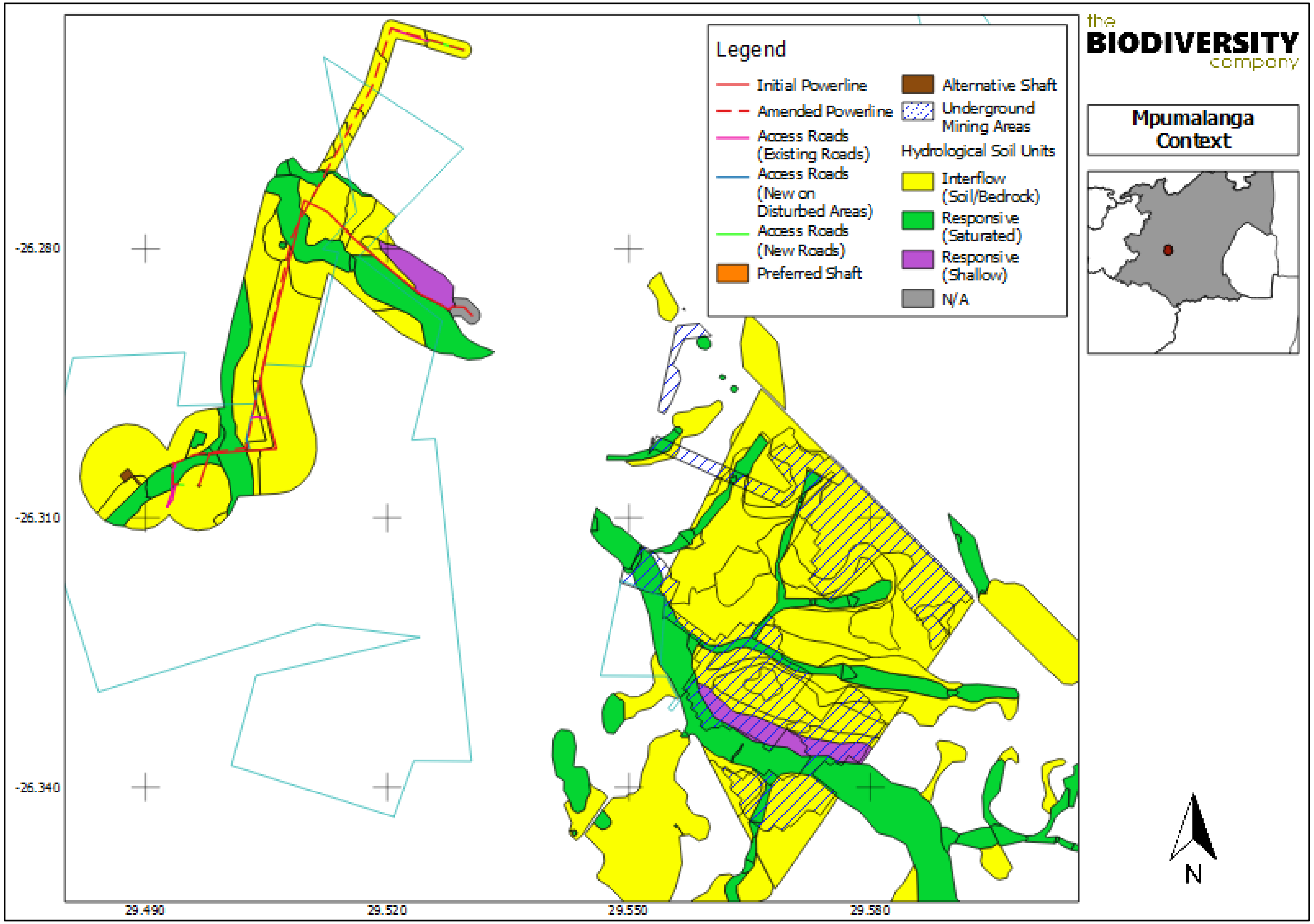

Figure 12: Hydropedological soil units within the project area

The hydropedological behaviour of the dominant hillslopes is presented in Figure 13:

- Shallow soils are dominant on the convex areas of crest and midslope positions – responsive (shallow). The combination of relatively impermeable bedrock and shallow soil depth implies that these soils have a low storage capacity. They will saturate quickly following a rain event and contribute to the generation of overland flow.
- Concave and linear areas of the crest and upper midslope positions are dominated by soils with evidence of periodic saturation at the soil/bedrock interface – Interflow (soil/bedrock). The plinthic horizons (mostly in Avalon, Bainsvlei soil forms) are indicative that the underlying bedrock is slowly permeable, and saturation is likely, which may lead to lateral flow at the soil bedrock interface.
- Although the plinthic layers are indicative of slowly permeable bedrock there might be infiltration into fractures in the bedrock. This water can either recharge groundwater or return to the soils in the valley bottom position.
- The accumulation of lateral discharging water from upslope positions cause long periods of saturation in the valley bottom. Responsive (Saturated) soils of the Katspruit, Rensburg, and Westleigh forms dominate on these positions. The gleyic and plinthic horizons occurring close to the surface are indicators that water levels are shallow and that additional precipitation will likely result in overland flow towards the stream.

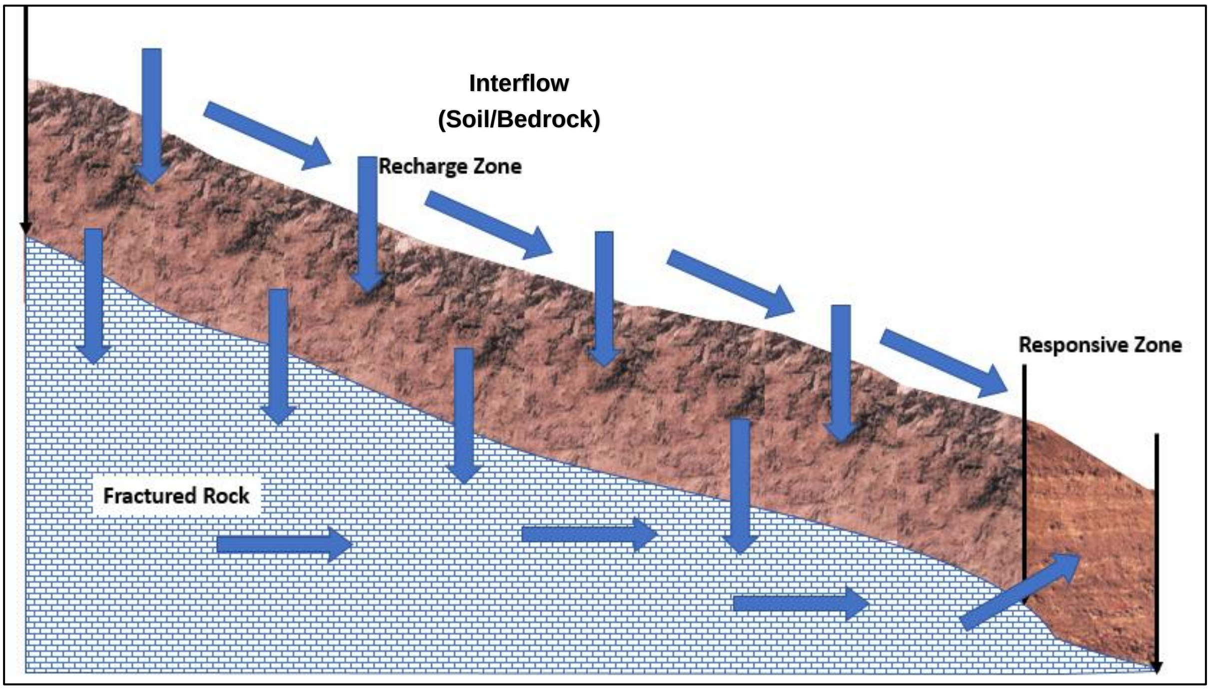

Figure 13: The hydrological flow paths in the project area

9. Impact Assessment

This section includes the impact assessment relevant to the proposed underground mining operations, the two alternative shaft areas, the access roads and the power line.

The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) will be considered for this component of the study, (Figure 14). In accordance with the mitigation hierarchy, the preferred mitigatory measure is to avoid impacts by considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts.

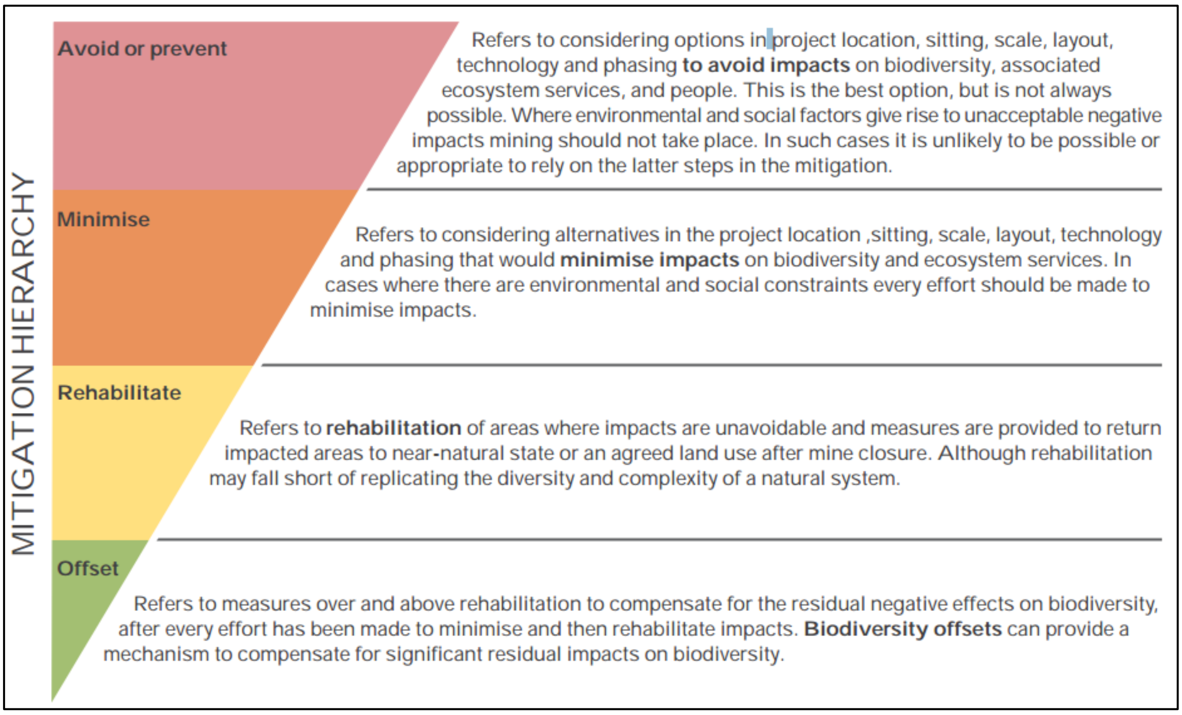

Figure 14: The mitigation hierarchy as described by the DEA (2013)

9.1 Methodology

The impact assessment methodology was provided by EIMS and is guided by the requirements of The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in April 2017. The broad approach to the significance rating methodology is to determine the environmental risk (pre-and post-mitigation) by considering the consequence of each impact (nature of impact, extent, duration, magnitude, reversibility and probability). This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor which is applied to the environmental risk to determine the overall significance.

9.2 Current Impacts

The impacts currently affecting the wetland health are shown in Figure 35.

- Commercial crop production and plantations;
- Fences;

- Overgrazing and trampling of natural vegetation and wetlands by livestock;
- Farm roads and highways;
- Artificial impoundments;
- Artificial drainage in agricultural fields;
- Erosion;
- Alien and/or Invasive Plants (AIP);
- Water contamination; and
- Vegetation removal.

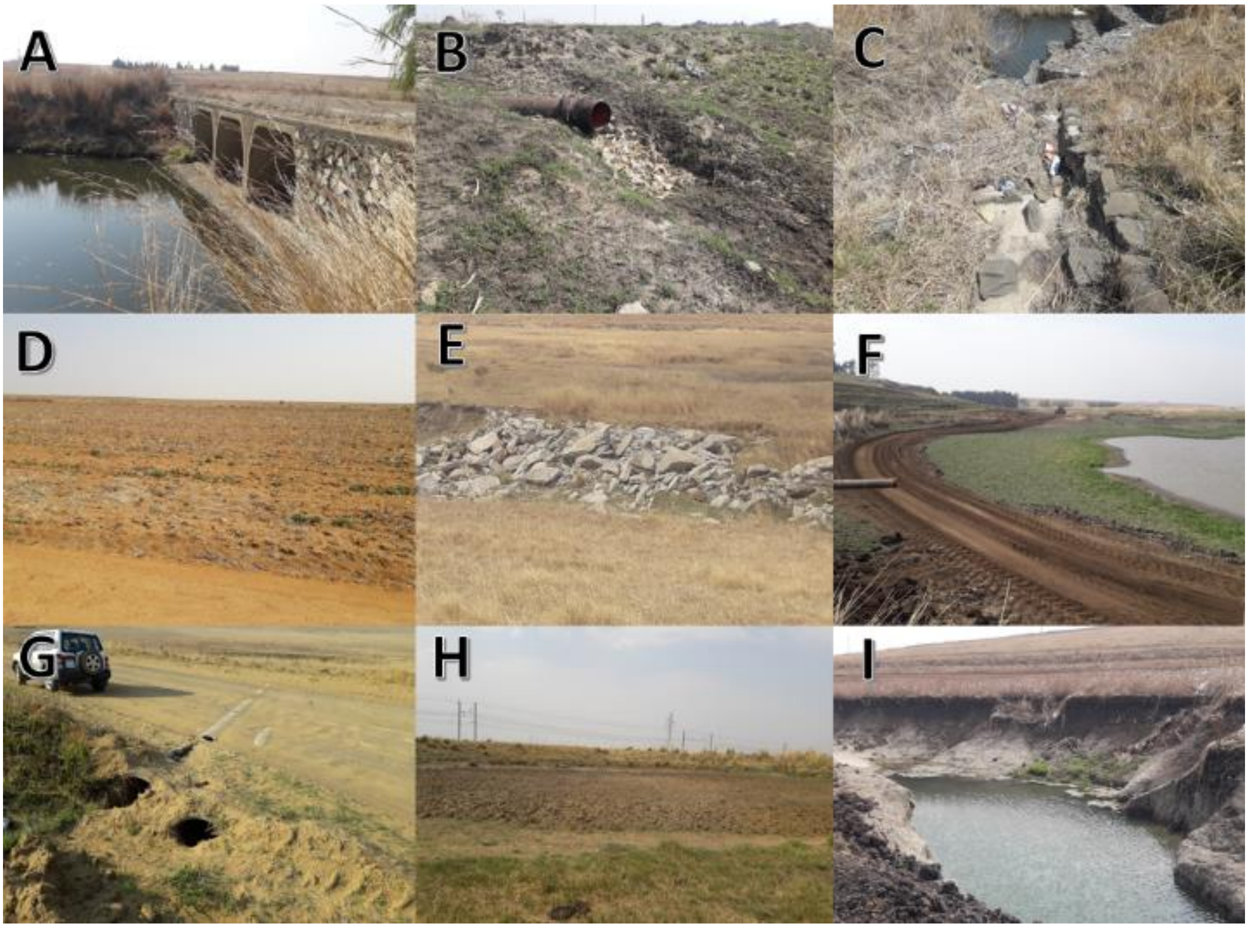

Figure 15: The current impacts on the wetland systems, A) Crossing infrastructure altering flow dynamics , B) Additional water inputs, C) Stormwater inputs from roads, D) Commercial agriculture, bare areas, and sediment sources, E) Incorrect erosion control, F) Dams within floodplains, G) Dirt roads with limited through flow for seeps, H) Depressions and flats used as watering holes, I) Deeply eroded channels

9.3 Anticipated Impact Framework

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. Alterations in hydrological regime (flow of surface and sub-surface water)
    a. Project activities that can cause alterations in hydrological regime
        i. Excavations and infrastructure development
        ii. Road network creation
        iii. Alterations to surface topography (due to voids and surface structures)
        iv. Dewatering of underground mine area
    b. Secondary impacts associated with alterations in hydrological 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
        vi. Loss of soil fertility and topsoil recharge through interruption of seasonal recharge and natural flow, including natural sedimentation

9.4 Potential Impacts

The proposed project will not result in the loss of wetlands but the hydropedological drivers to wetlands downstream could be affected. The following list provides a framework for the anticipated impacts associated with the project.

The potential impact of the ventilation shaft locations will result in:

1. Infiltration of water into the fractured rock will still be dominant on midslope positions.

2. This infiltrated water can still flow through fractures in the bedrock and return to the stream via bedrock flowpaths.

3. It is expected that the 'average/long-term' supply of water to the stream via bedrock flowpaths will not be altered drastically.

Based on the conceptual hydropedological understanding it is clear that this is a very responsive landscape; with overland flow dominating. The longer-term water regimes of soils below the ventilation shaft locations that will be affected moderately and there would be a slight drop in the PES from a hydrological input's perspective.

The potential impact of underground mining activities are unlikely to have a significant effect on the hydrological behaviour of this site. Due to the relative impermeability of the bedrock, infiltration into fractures are only sub-dominant. The contribution of bedrock flowpaths to valley bottom wetlands and streams are less than 40 % as per the groundwater assessment. There is a chance that the hydrological inputs to wetlands utilising lateral inputs will be reduced during the drawdown of the upper aquifer and therefor reduce the overall PES slightly.

The impact of underground mining is 'low'. Shallow flow paths dominate the hillslopes, yet all have flow and storage mechanisms maintaining wetlands. Shallow interflow down to the midslope, feed terrestrial ecosystems and disturbance of these flowpaths will not significantly affect wetlands. A lack of shallow flow paths in this area, however, indicates deep flowpaths. All flowpaths may meet in the valley bottom. These flowpaths feed wetlands and should be protected. Water stored for the wetlands are typical in the deep rock fractures.

9.5 Assessment of Significance

The summary tables below show the significance of the various impacts, which range from moderate to low before mitigation for the construction phase of the underground mining portion of the project. The significance of the impact's changes to a significance of moderate or low for all listed activities following the implementation of mitigation measures and recommendations.

Overall, the impacts of the underground mining have much lower significance and impact than those for opencast mining operations. Nonetheless, underground mining also requires some surface infrastructure (and ventilation shafts in the case of this project), and the significance of these impacts cannot be overlooked or underestimated. However, for this particular project existing infrastructure will be used and as such there is a lower impact rating overall.

9.5.1 Planning Phase

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

The tables below Table 3 and Table 4 show the significance of potential impacts in the planning phase impacts on hydropedological drivers to wetlands before and after implementation of mitigation measures.

These impacts occur from poor identification of wetlands and planning to avoid or mitigate these areas. Even though there will be no initial impact or mitigatable measures the impacts are considered in the construction and operational phase and the impact table shows a Low negative rating which could be a Low positive if all planning is done properly.

Table 3: Impact significance of the loss of hydropedological drivers for the ventilation shafts during the planning phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Vent Shafts**				
Phase	**Planning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	1	1
Extent of Impact	1	1	Reversibility of Impact	1	1
Duration of Impact	1	1	Probability	1	1
Environmental Risk (Pre-mitigation)					-1.00
Mitigation Measures					
Following the correct environmental procedures and ensuring the hydropedology has been assessed by specialists so that planning can take these systems into consideration to avoid and mitigate impacts were possible.					
Environmental Risk (Post-mitigation)					1.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					

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

Table 4: Impact significance of the loss of hydropedological drivers for the underground mining during the planning phase

Impact Name	**Loss / degradation of wetland habitat**				
Alternative	**Underground Mining**				
Phase	**Planning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	3	1
Extent of Impact	2	1	Reversibility of Impact	3	2
Duration of Impact	2	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-7.50
Mitigation Measures					
Following the correct environmental procedures and ensuring the hydropedology has been assessed by specialists so that planning can take these systems into consideration to avoid and mitigate impacts were possible.					
Environmental Risk (Post-mitigation)					2.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.17
Final Significance					2.92

9.5.2 Construction Phase

The construction phase activities have the potential to degrade hydropedological drivers to wetlands through altered or removed sub-surface flow paths.

Hydrological or flow dynamic impacts are likely to include reduced water volumes, bed, channel and flow modification, as well as the loss of wetland habitat through secondary alteration of water sources to the wetlands.

Table 5 shows the significance of potential construction phase impacts on hydropedological drivers to wetlands before and after implementation of mitigation measures. The underground mining will not have a construction phases as the underground mining area will be accessed from an existing adit.

Table 5: Impact significance of the loss of hydropedological drivers for the ventilation shafts during the construction phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Ventilation Shafts**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	3	2	Probability	4	3
Environmental Risk (Pre-mitigation)					-9.00
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. *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)					-6.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-6.00

9.5.3 Operational Phase

During the operational phase altered flow dynamics both at surface and subsurface could impact on the hydropedological drivers to the wetlands. The underground mining has a slight risk of subsidence and this would alter the hydropedological drivers as well as the wetlands.

The Underground mining poses a risk if subsidence of less than 0.0005% (GCS, 2018), however all efforts must be made to minimise the risk of subsidence as avoiding this impact is the most effective way to mitigate it.

It is likely that no significant stream flow reduction will occur within the Viskuile Spruit and/or the Olifants River due to the aquifer drawdown in the area. The numerical model indicated a short period of maximum drawdown and restricted to the area around the Forzando South Adit area. Baseflow may be slightly reduced in this area and this will only be evident during the dry winter months (GCS, 2018).

It is proposed that shallow groundwater monitoring sites be installed during the operational phase to determine the impact on shallow groundwater flow conditions by monitoring the shallow aquifer characteristics within the Forzando South and Kalabasfontein Project Area (GCS, 2018).

The tables Table 6 and Table 7 show the significance of potential operation phase impacts on wetland systems before and after implementation of mitigation measures. No impacts are anticipated during the operational phase of the powerline.

Table 6: Impact significance of the loss of hydropedological drivers for the ventilation shafts during the operational phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Ventilation Shafts**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	2	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	3	2	Probability	4	3
Environmental Risk (Pre-mitigation)					-9.00
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. *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)					-6.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					

Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
The impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-6.00

Table 7: Impact significance of the loss of hydropedological drivers for the underground mining during the operational phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Underground Mining**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	1
Extent of Impact	2	1	Reversibility of Impact	3	2
Duration of Impact	2	1	Probability	2	2
Environmental Risk (Pre-mitigation)					-5.00
Mitigation Measures					
Underground workings must adhere to a safety factor that will not allow for subsidence. *Any loss/alteration of flow dynamics must be quantified, and mitigation options to re-introduce water in a safe and environmentally friendly way must be assessed.* *Construct diversion berms and drains around working areas.* *Incorporate green /soft engineering storm water measures. Avoid unnecessary vegetation clearing and avoid preferential surface flow paths.*					
Environmental Risk (Post-mitigation)					-2.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-2.50

9.5.4 Rehabilitation Phase

The removal of infrastructure and rehabilitation activities will be a large-scale operation and thus has the potential to alter flow dynamics. The tables below Table 8 and Table 9 show the significance of potential rehabilitation phase impacts on the hydropedological drivers to wetlands.

Table 8: Impact significance of the loss of hydropedological drivers for the ventilation shafts during the rehabilitation phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Ventilation Shafts**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	1
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
Rehabilitation of the vent shafts as per an approved rehabilitation plan					
Environmental Risk (Post-mitigation)					2.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					2.50

Table 9: Impact significance of the loss of hydropedological drivers for the underground mining during the rehabilitation phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Underground Mining**				
Phase	**Rehab and closure**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	2
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	2	1
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
Monitoring of subsidence and mining according to the recommended safety factors. *Rehabilitation if subsidence has occurred*					
Environmental Risk (Post-mitigation)					1.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					1.50

9.5.5 Closure and Decommissioning Phase

Typically, following the cessation of underground mining activities groundwater returns to the voids created by the mining process. This process results in the alteration of the groundwater resources as well as possible subsidence.

In addition, in line with the precautionary principle, it is anticipated that the undermining of wetlands systems and the hillslopes that feed them could result in the subsidence of the surface. The resultant potential impacts include serious changes to surface hydrology resulting in the significant alteration of catchment areas and subsequent habitat levels impacts.

The tables below Table 10 and Table 11 show the significance of potential closure and decommissioning phase impacts on hydropedological drivers to wetlands before and after implementation of mitigation measures.

Table 10: Impact significance of the loss of hydropedological drivers for the ventilation shafts during the closure and decommissioning phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Ventilation Shafts**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
Monitor and assess rehabilitation success					
Environmental Risk (Post-mitigation)					4.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					4.00

Table 11: Impact significance of the loss of hydropedological drivers for the underground mining during the closure and decommissioning phase

Impact Name	**Loss / degradation of hydropedological drivers to wetlands**				
Alternative	**Underground Mining**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	2
Extent of Impact	2	1	Reversibility of Impact	2	2
Duration of Impact	2	1	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
Monitoring of subsidence and mining according to the recommended safety factors *Rehabilitation if subsidence has occurred*					
Environmental Risk (Post-mitigation)					3.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					3.00

10. Mitigation Measures

The mitigation actions provided below are important to consider in conjunction with other specialist assessments which include but are not limited to the following specialist studies: Groundwater, Surface Water and Wetlands. These mitigation measures should be implemented in the Environmental Management Plan (EMP) should the project go-ahead.

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

Table 12 presents the recommended mitigation measures and the respective timeframes, targets and performance indicators.

Table 12: Mitigation measures including requirements for timeframes, roles and responsibilities

Mitigation Measures	Phase	Timeframe	Responsible Party for Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)
• Underground workings must adhere to a safety factor that will not allow for subsidence. • Any loss/alteration of flow dynamics must be quantified, and mitigation options to re-introduce water in a safe and environmentally friendly way must be assessed.	Operation Closure	Permanent	Applicant / Contractor	Monthly surface and groundwater quantity and quality	Avoid or minimise the loss of water input, and impaired water quality	Water quality guidelines (DWS,1996)
• Construct diversion berms and drains around working areas. • Incorporate green /soft engineering storm water measures. Avoid unnecessary vegetation clearing and avoid preferential surface flow paths. • All released water must be within DWAF (1996) water quality standards for aquatic ecosystems, and discharge must be managed to avoid scouring and erosion of the receiving systems. • Clean and dirty water must be separated. This water could be looked at for treatment and then re-introduced to mitigate losses to the catchment water hydro-dynamics. • Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area.	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)

• 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.	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)
• Separate clean and dirty water continue with surface water and biomonitoring programmes. • Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area. • All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported.	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)
• All surface infrastructure must be removed from the site. • Compacted areas must be ripped (perpendicularly) to a depth of 300mm. • A seed mix must be applied to rehabilitated and bare areas.	Closure	Ongoing	Applicant	Biomonitoring (bi-annual)	Maintain drinking water quality standards	Water quality guidelines (DWS,1996)

• Any gullies or dongas must also be backfilled. • The area must be shaped to a natural topography. • Trees (or vegetation stands) removed must be replaced. • No grazing must be permitted to allow for the recovery of the area. • Attenuation ponds may be created in channels to retain water in the catchment.				Wetland monitoring (bi-annual) Water quality monitoring, frequency to be advised by hydrology specialist		
• Rehabilitation of the area and shaping of the topography must minimise the ingress of water into the mining area. • Additionally, measures must also be considered to implement constructed wetlands at likely decant areas, and the planting of tree reduce groundwater recharge. • Decommission cut-off berms and drains last. • Debris must be placed in preferential flow paths. • Compacted areas must be ripped (perpendicularly) to a depth of 300mm. • A seed mix must be applied to rehabilitated and bare areas. • Any gullies or dongas must also be backfilled. • The area must be shaped to a natural topography.	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)

11. Recommendations & Conclusions

Although interflow in soils and shallow bedrock dominates, indicating that a large part of rainfall serves terrestrial ecosystems, the wetlands in valley bottoms indicate that a significant amount of water is supplied during the rainy season and post seasonal, to the wetlands. It implies that the hills in most sites (as indicated) primarily partition the rainfall in shallow interflow, yet all leaks water to the deep fractured rock system, stores and release it slowly long after the rain, keeping wetlands wet. Wetland controls contribute well to keep water in the wetland longer. These flowpaths serving recharge/interflow/release of water to wetlands and storing it in the wetland, must be preserved.

The impact of underground mining is ‘low’. Shallow flow paths dominates the hillslopes, yet all have flow and storage mechanisms maintaining wetlands. Shallow interflow down to the midslope, feed terrestrial ecosystems and disturbance of these flowpaths will not significantly affect wetlands.

These recommendations may supplement the prescribed mitigation measures, but these recommendations must be investigated prior to the issuing of environmental authorisation. These recommendations must be investigated for the feasibility to realistically achieve what is intended for this project. The following recommendations are applicable for this project:

1. The recommended buffer width is 25 m for the Ventilation shaft and 10 m for the Powerline implemented from the onset of the construction phase of the project and no activities or footprint area must be within these buffers.
2. In the event that wetland areas will be impacted, a wetland rehabilitation plan is required.

Impact Statement

The Underground mining poses a risk if subsidence of less than 0.0005% (GCS, 2018), however all efforts must be made to minimise the risk of subsidence as avoiding this impact is the most effective way to mitigate it.

The preferred Ventilation Shaft is situated some distance from the wetlands and is considered low risk. The Powerlines are also considered low risk if they are constructed as close to the road reserve as possible.

Considering the above-mentioned conclusions, it is the opinion of the specialist that the Kalabasfontein project area, with the current proposed infrastructures layout areas, may be favourably considered.

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Appendix A- Impact Assessment Results

Table 13: Impact assessment results

IMPACT DESCRIPTION			PRE - MITIGATION							POST - MITIGATION								IMPACT PRIORITISATION				
Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Public response	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score
Loss / degradation of hydropedological drivers to wetlands	Ventilation Shafts	Planning	-1	2	2	3	3	3	-7.5	1	1	1	1	2	2	2.5	High	1	1	1	1.00	2.50
Loss / degradation of hydropedological drivers to wetlands	Ventilation Shafts	Construction	-1	2	3	2	2	4	-9	-1	2	2	2	2	3	-6	High	1	1	1	1.00	-6.00
Loss / degradation of hydropedological drivers to wetlands	Ventilation Shafts	Operation	-1	2	3	2	2	4	-9	-1	2	2	2	2	3	-6	High	1	1	1	1.00	-6.00
Loss / degradation of hydropedological drivers to wetlands	Ventilation Shafts	Decommissioning	-1	2	2	2	2	2	-4	1	2	2	2	2	2	4	High	1	1	1	1.00	4.00
Loss / degradation of hydropedological drivers to wetlands	Ventilation Shafts	Rehab and closure	-1	2	2	2	2	2	-4	1	1	1	1	2	2	2.5	High	1	1	1	1.00	2.50

Loss / degradation of hydropedological drivers to wetlands	Underground Mining	Operation	-1	2	2	3	3	2	-5	-1	1	1	1	2	2	-2.5	High	1	1	1	1.00	- 2.50
Loss / degradation of hydropedological drivers to wetlands	Underground Mining	Decommissioning	-1	2	2	2	2	2	-4	1	1	1	2	2	2	3	High	1	1	1	1.00	3.00
Loss / degradation of hydropedological drivers to wetlands	Underground Mining	Rehab and closure	-1	2	2	2	2	2	-4	1	1	1	2	2	1	1.5	High	1	1	1	1.00	1.50