Wetland Assessment for the proposed Tailings Reclamation Pipeline

Welkom, Free State

October 2021

CLIENT

Prepared by:

The Biodiversity Company

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany.com

Report Name	**Wetland Assessment for the proposed Tailings Reclamation Pipeline**	
Submitted to	**EIMS**	
Report Writing	**Ivan Baker**	

Ivan Baker is Cand. Sci Nat registered (119315) in environmental science and geological science. Ivan is a wetland and ecosystem service specialist, a hydropedologist and pedologist that has completed numerous specialist studies ranging from basic assessments to EIAs. Ivan has carried out various international studies following FC standards. Ivan completed training in Tools for Wetland Assessments with a certificate of competence and completed his MSc in environmental science and hydropedology at the North-West University of Potchefstroom.

Review	**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.

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.

Table of Contents

Tables

Figures

Declaration

I, Ivan Baker declare that:

- I act as the independent specialist in this study;
- 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 client;
- 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 study, 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.

Ivan Baker

Wetland Ecologist

The Biodiversity Company

October 2021

1 Introduction

The Biodiversity Company was commissioned to conduct a wetland assessment as part of the water use authorisation process for the proposed reclamation pipeline from the Harmony FSS6 Tailings Storage Facility (TSF) to the Brand A Pump Station located approximately 10 km south-east of Welkom, Free State. One site visit was conducted on the 7th of October 2021, which constitutes a wet season survey.

This assessment has been completed in accordance with the requirements of the published General Notice (GN) 509 by the Department of Water and Sanitation (DWS). This notice was published in the Government Gazette (no. 40229) under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, for a Water Use Licence (WUL) in terms of Section 21(c) & (i) water uses. The GN 509 process provides an allowance to apply for a WUL for Section 21(c) & (i) under a General Authorisation (GA), as opposed to a full Water Use Licence Application (WULA). A water use (or potential) qualifies for a GA under GN 509 when the proposed water use/activity is subjected to analysis using the DWS Risk Assessment Matrix (RAM). This assessment will implement the RAM and provide a specialist opinion on the appropriate water use authorisation.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed project and to provide an opinion on the whether any environmental authorisation process or licensing is required for the proposed activities.

1.1 Objectives

The aim of the assessment is to provide information to guide the proposed project with respect to the current state of the associated water resources in the regulated area. This was achieved through the following:

- Determining the present ecological status of the local watercourses:
  - The assessment of habitat quality; and
  - The assessment of biological responses.
- The delineation and assessment of watercourses within 500 m of the project area;
- To determine the hydropedological types for the relevant hillslope;
- To determine what the impact to the vadose zone properties will be;
- A risk assessment for the proposed pipeline; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Key Legislative Requirements

2.1 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).

2.2 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.

3 Project Area

The project area is located approximately 10 km south-east of Welkom with the R73 crossing through the western portion of the 500 m regulated area (see Figure 3-1). The local land use surrounding the proposed pipeline includes open areas, mining and industrial areas.

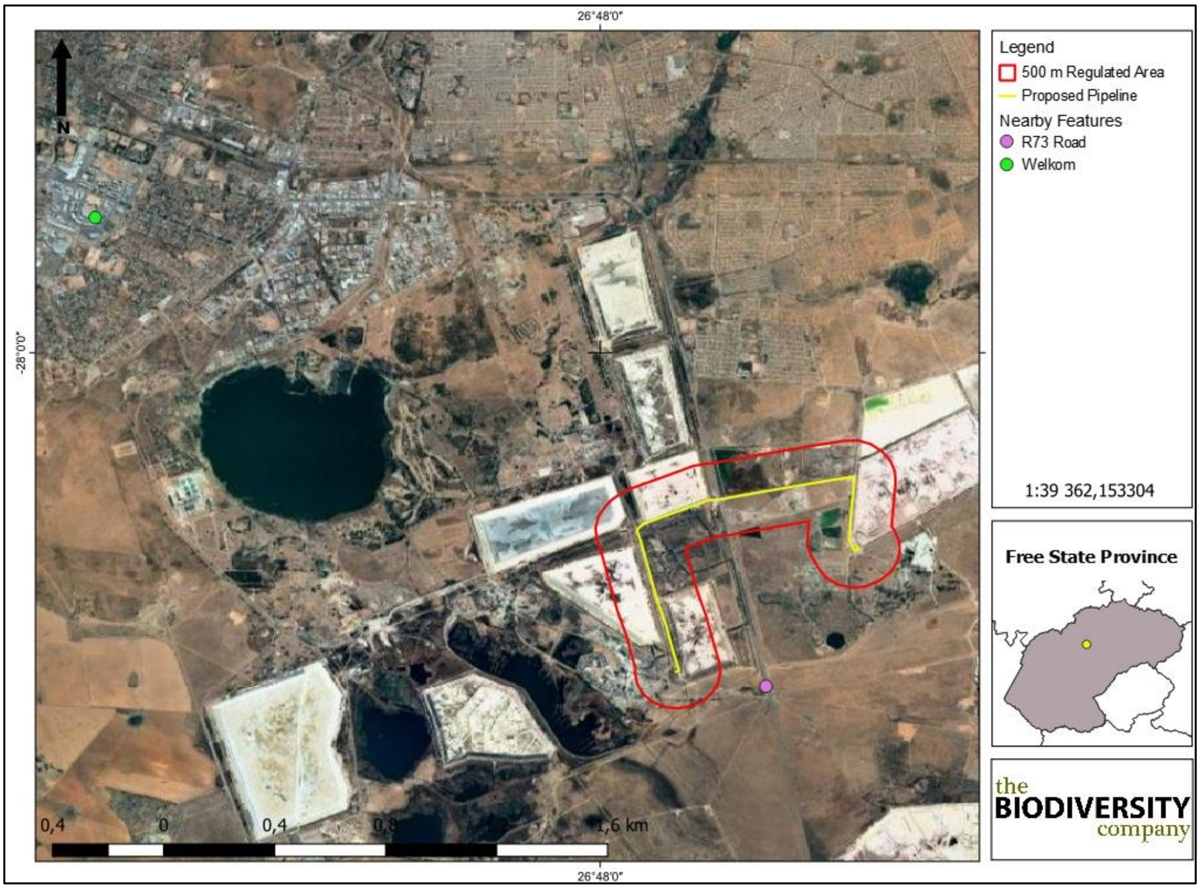

Figure 3-1 The regional layout of the project site

4 Methodology

4.1 Wetland Assessment

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

4.1.1 Desktop Assessment

The following information sources were considered for the desktop assessment:

- NASA Shuttle Radar Topography Mission Global 1 arc second digital elevation data
- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel et al., 2011);

- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer, H., et al., 2018); and
- Contour data (5 m).

4.1.2 Delineation

The wetland areas were delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 4-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

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

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

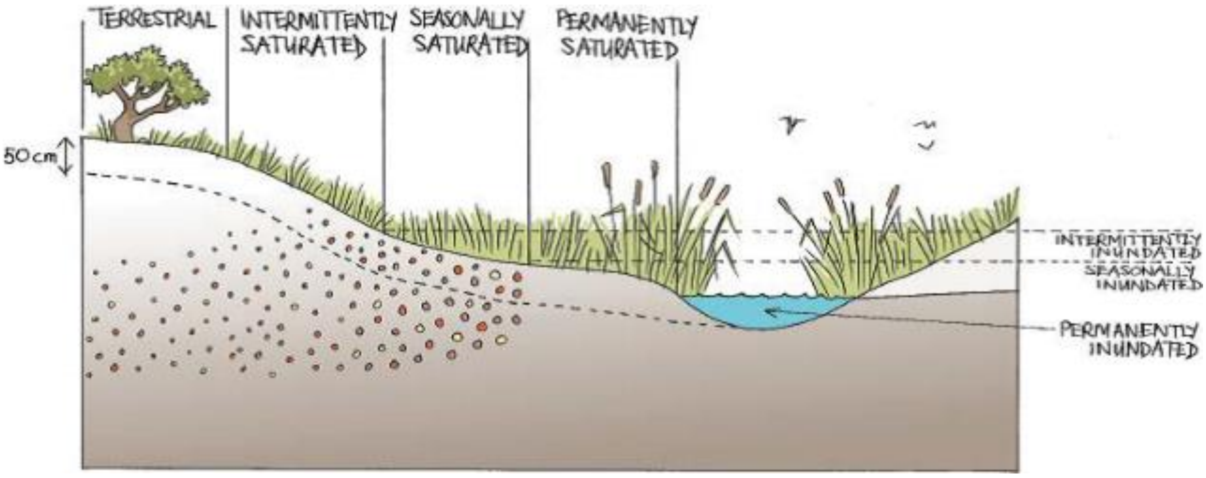

Figure 4-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al., 2013)

4.1.3 Present Ecological Status

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 4-1.

Table 4-1 Summary of the Present Ecological State categories (Macfarlane, et al., 2009)

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

4.1.4 Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze *et al*., 2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 4-2).

Table 4-2 Classes for determining the likely extent to which a benefit is being supplied (Kotze et al., 2009)

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

4.1.5 Importance and Sensitivity

The importance and sensitivity of water resources is determined in order establish resources that provide higher than average ecosystem services, biodiversity support functions or are particularly sensitive to impacts. The mean of the determinants is used to assign the Importance and Sensitivity (IS) category as listed in Table 4-3.

Table 4-3 Description of Importance and Sensitivity categories

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

4.1.6 Ecological Classification and Description

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

4.1.7 Buffer Determination

The "*Buffer zone guidelines for wetlands, rivers and estuaries*" (Macfarlane *et al.,* 2014) was used to determine the appropriate wetland buffer zone for the proposed activity (in this case the category transportation infrastructure, paved roads).

4.1.8 Identification of Soil Types and Hydrological Soil Types

Soil types have been identified according to the South African soil classification (Soil Classification Working Group, 1991) after which the link between soil forms and hydropedological response were established (van Tol & Le Roux, 2019), and the soils regrouped into various hydropedological soil types as shown in Table 4-4.

Table 4-4 Hydrological soil types of the studied hillslopes (van Tol et al., 2019).

Hydrological Soil Type	Description	Subgroup	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out the profile into the underlying bedrock is the dominant flow direction. These soils can either be shallow on fractured rock with limited contribution to evapotranspiration or deep freely drained soils with significant contribution to evapotranspiration.	Shallow	
		Deep	
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates build-up of water in the topsoil. Duration of drainable water depends on rate of ET, position in the hillslope (lateral addition/release) and slope (discharge in a predominantly lateral direction).	A/B	
Interflow (Soil/Bedrock)	Soils overlying relatively impermeable bedrock. Hydromorphic properties signify temporal build of water on the soil/bedrock interface and slow discharge in a predominantly lateral direction.	Soil/Bedrock	
Responsive (Shallow)	Shallow soils overlying relatively impermeable bedrock. Limited storage capacity results in the generation of overland flow after rain events.	Shallow	
Responsive (Saturated)	Soils with morphological evidence of long periods of saturation. These soils are close to saturation during rainy seasons and promote the generation of overland flow due to saturation excess.	Saturated	
Stagnating	In these soils outflow of water is limited or restricted. The A and/or B horizons are permeable but morphological indicators suggest that recharge and interflow are not dominant. These includes soils with carbonate accumulations in the subsoil, accumulation and cementation by silica, and precipitation of iron as concretions and layers. These soils are frequently observed in climate regions with a very high evapotranspiration demand. Although infiltration occurs readily, the dominant hydrological flowpath in the soil is upward, driven by evapotranspiration.		

4.2 Risk Assessment

The risk assessment will be completed in accordance with the requirements of the DHSWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). The significance of the impact is calculated according to Table 4-5.

Table 4-5 Summary of the significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

5 Limitations

The following aspects were considered as limitations of the assessment:

- Only wetlands that were likely to be impacted by proposed development activities were assessed in the field. Wetlands located within a 500 m radius of the sites but not in a position within the landscape to be measurably affected by the developments were not considered as part of this assessment;
- A portion south of the pipeline was inaccessible during the site survey due to the fact that this area is fenced off as private property (see Figure 5-1). This area could therefore only be assessed by means of desktop and visual assessments;
- Considerable artificial inputs from various sources have led to the formation of wetlands, these systems are all deemed to be artificial. The full extent of artificial wetlands is difficult to determine due to the anthropogenic nature of these systems. Therefore, only natural wetlands were focussed on with not all artificial systems delineated; and
- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.

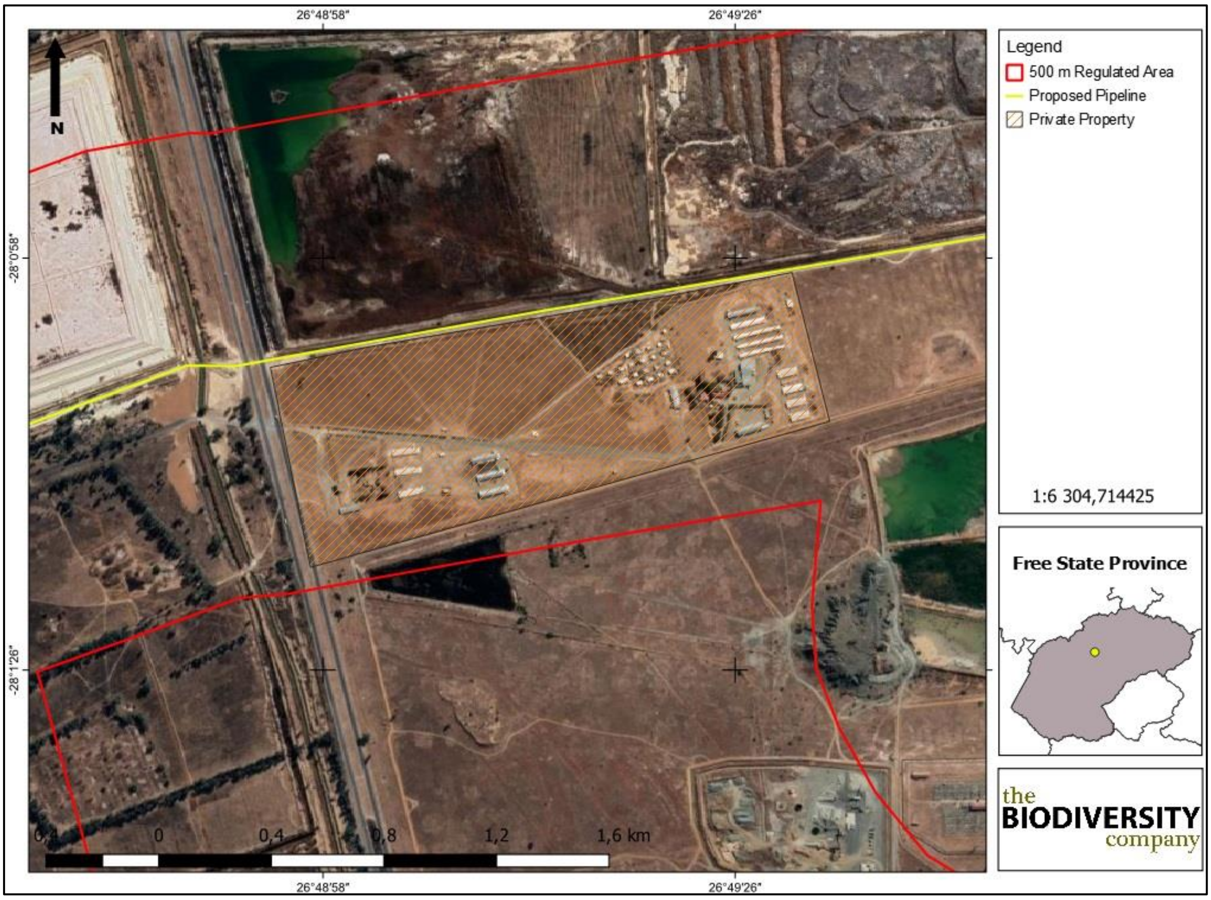

Figure 5-1 Private property

6 Desktop Assessment

6.1 Vegetation Type

The project area falls within the Vaal-Vet Sandy Grassland (Gh10) vegetation type. This vegetation type is distributed throughout North-West and Free State and stretches from south of Lichtenburg to Klerksdorp, Bothaville, Leeudoringstad as well as Brandfort. The latitude suited for this vegetation type is between 1 260 meters above sea level to 1 360 meters above sea level (Mucina & Rutherford, 2006).

This vegetation type features in areas dominated by plains with scattered and undulating hills. These areas mainly comprise of low-tussock grasslands with Themeda triandra being one of the most important features of this vegetation type. Overgrazing and erratic rainfall have however ensured that Themeda triandra is often replaced with *Elionurus muticus, Aristida congesta* and *Cymbopogon pospischilii* (Mucina & Rutherford, 2006).

The conservation status of this vegetation type is endangered with only 0.3% of it being protected within the Bloemhof Dam, Sandveld, Schoonspruit, Wolwespruit, Soetdoring and Faan Meintjes nature reserves (Mucina & Rutherford, 2006).

6.2 Geology

The geology of this area is characterised by aeolian and colluvial sand which overlies mudstone, sandstone and shale of the Karoo Supergroup. Older Ventersdorp Supergroup basement gneiss and andesite is located to the north. Soil forms associated with the project area includes the Bd, Bc, Ae and Ba land types, which correlates with the findings from the land type database (Mucina and Rutherford, 2006).

6.3 Climate

This region is characterised by a warm-temperate summer rainfall climate with the average annual precipitation being approximately 530 mm (see Figure 6-1). High summer temperatures are common for this region with severe frost occurring throughout the winter (on average 37 days per year) (Mucina & Rutherford, 2006).

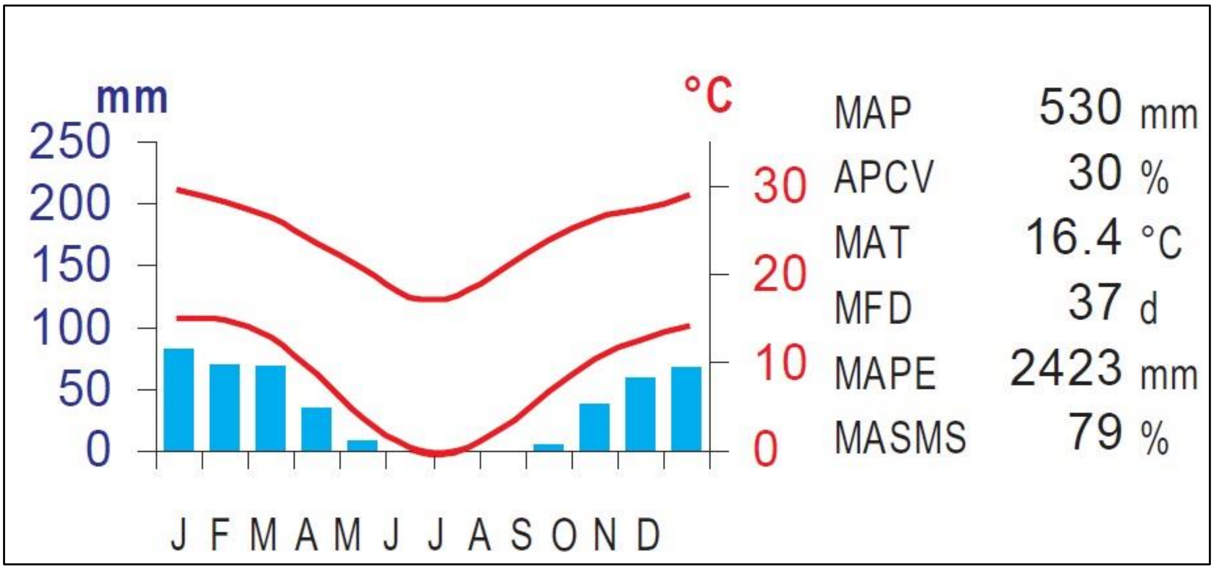

Figure 6-1 Climate for the Vaal-Vet Sandy Grassland (Mucina & Rutherford, 2006)

6.4 National Wetland Map 5

This spatial dataset is part of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) which was released as part of the National Biodiversity Assessment (NBA) 2018. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other datasets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE, 2018).

One wetland type was identified by means of this dataset, namely a depression wetland (see Figure 6-2). This system is however located within a tailings facility, ultimately rendering the system artificial.

6.5 NFEPA Wetlands

Various NFEPA wetlands were identified, of which the majority of systems have been classified as being artificial. Both natural NFEPA systems are classified as being wetland flats (see Figure 6-2).

6.6 Water Source Points

Water source points, even though anthropogenic in nature, potentially indicate areas that might be characterised by signs of wetness due to faulty equipment causing leaks. Two water source types were identified within the 500 m regulated area, including reservoirs and windpumps (see Figure 6-2).

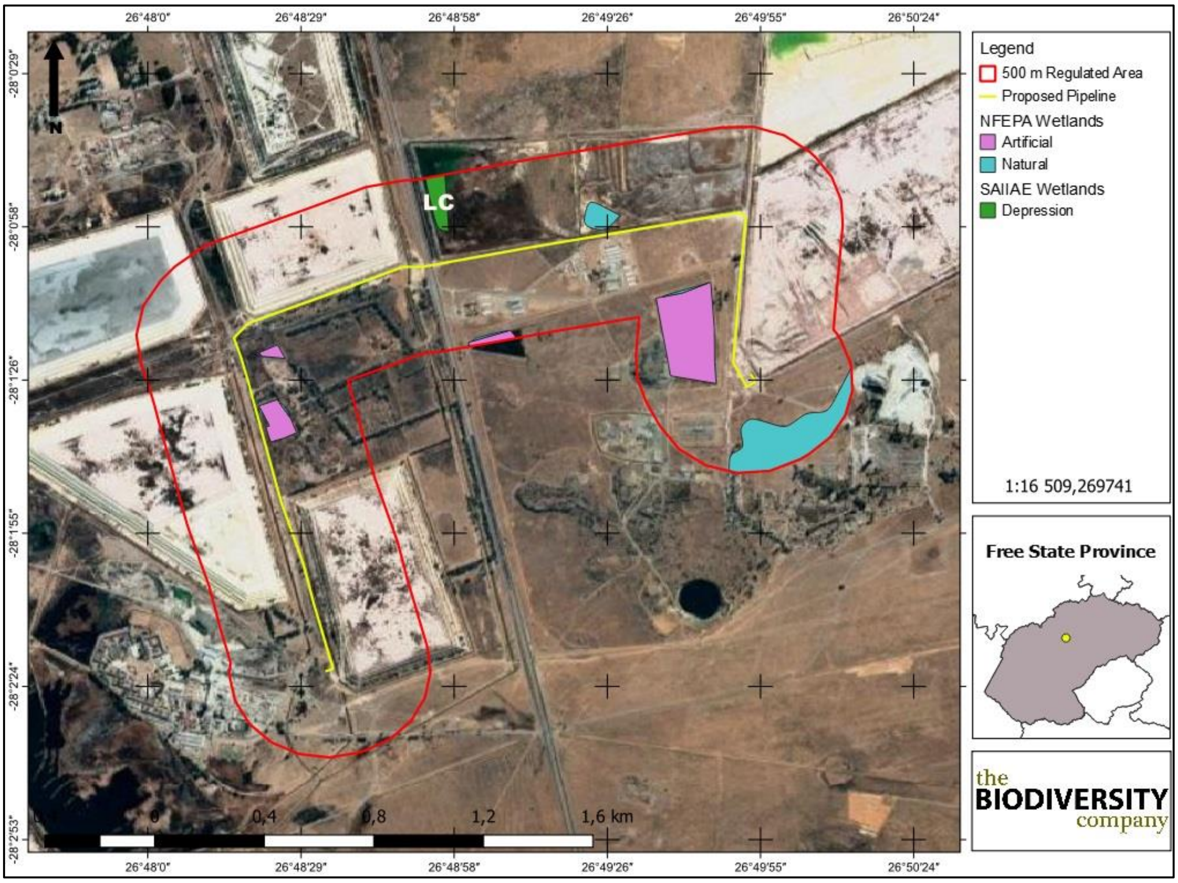

Figure 6-2 NFEPA and SAIIAE wetlands located within the 500 m regulated area

6.7 Terrain

The terrain of the 500 m regulated area has been analysed to determine potential areas where wetlands are more likely to accumulate (due to convex topographical features, preferential pathways or more gentle slopes). Hydropedologically, this data is crucial in understanding the dynamics of the hillslopes associated with the area.

6.7.1 Digital Elevation Model

A Digital Elevation Model (DEM) has been created to identify lower laying regions as well as potential convex topographical features which could point towards preferential flow paths. The 500 m regulated area ranges from 1 340 to 1 411 Metres Above Sea Level (MASL). The lower laying areas (generally represented in dark blue) represent area that will have the highest potential to be characterised as wetlands (see Figure 6-3).

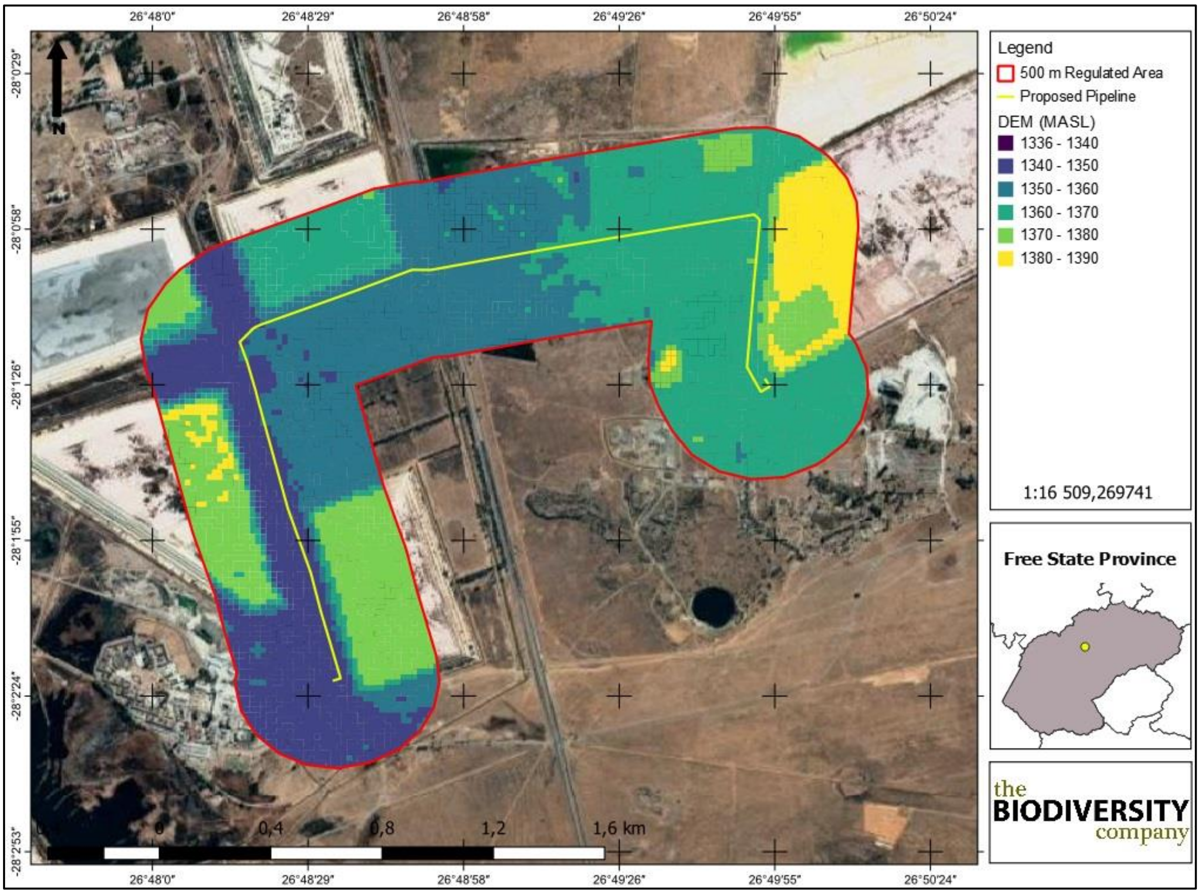

Figure 6-3 Digital Elevation Model of the 500 m regulated area

6.7.2 Slope Percentage

The slope percentage of the 500 m regulated area is illustrated in Figure 6-4. The slope percentage ranges from 0 to 62%, with majority of the 500 m regulated area being characterised by a gentler slope (between 0 and 2%). This indicates the presence of steep tailings throughout the 500 m regulated area, with the proposed pipeline located on a gentle slope of mostly 0-2%.

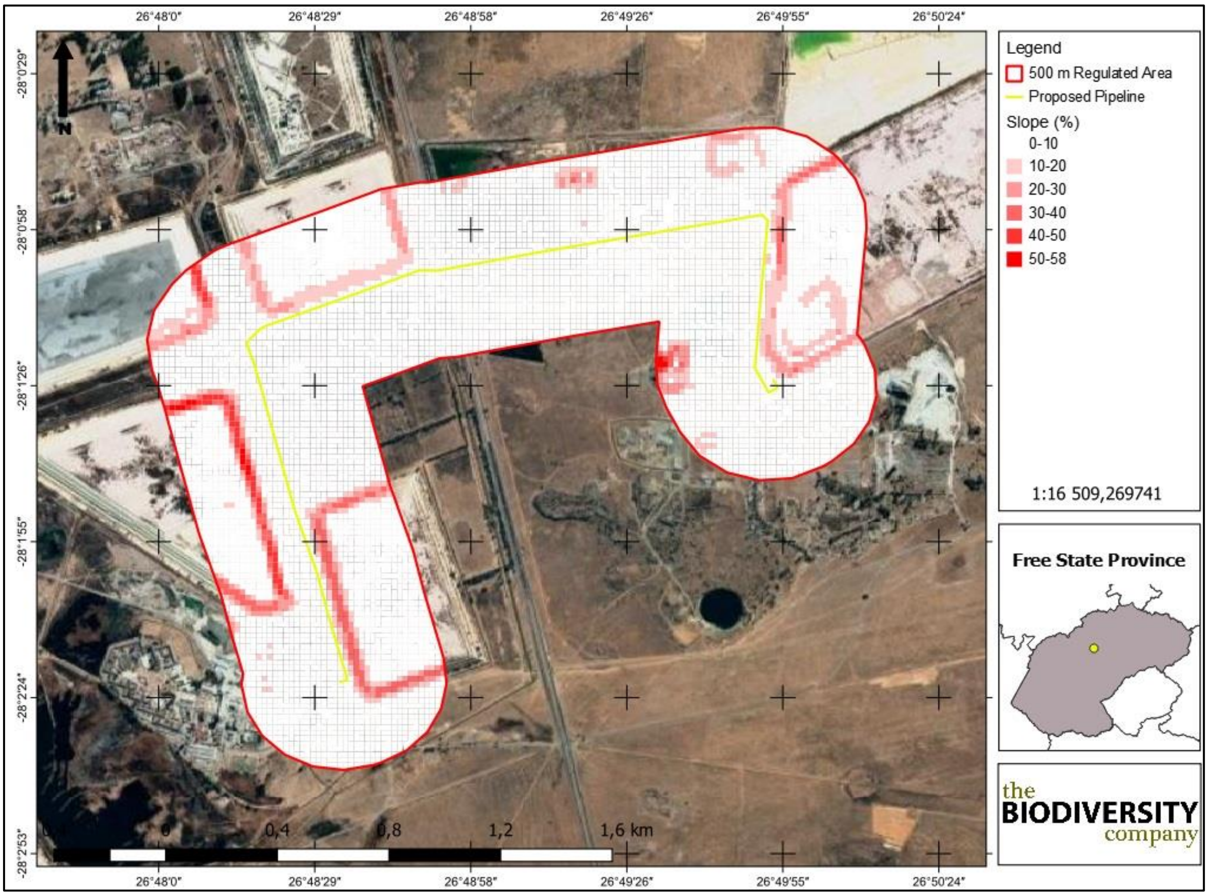

Figure 6-4 Slope percentage of the 500 m regulated area

7 Results and Discussion

7.1 Wetland Assessment

The wetland areas were delineated in accordance with the DWAF (2005) guidelines (see Figure 7-7). The majority of the 500 m regulated area is characterised by significant disturbances from tailings facilities, mining activities, dumping, overspills from artificial canals etc. (see Figure 7-2). These areas are characterised by spills from the tailings facilities as well as their cut-off trenches, with water assumed to be seeping through the unlined cut-off trenches into the adjacent areas.

Additionally, spills and aeolian distribution of tailings material has resulted in the topsoil being covered in between 10 and 20 cm of tailings material, which mostly comprised of silt. Silt, being the smallest particle size in soils, is characterised by extremely high water holding capacities due to the small pore sizes between particles. Therefore, the topsoil in these areas is characterised by higher than normal water moisture contents. For these reasons, approximately 90% of the areas labelled as “artificially wet zones” are characterised by signs of wetness, be it hydromorphic or hydrophytic of nature. Hydrophytic plants grow with great ease within these areas due to the high water moisture contents.

It is however clear that in the event that these tailings facilities be reclaimed and rehabilitated, that these artificial wetlands will dry up and lose any and all functionality. In addition, significant modification and degradation has resulted in surface and sub-surface flow dynamics being altered with the input of Transported Technosols that according to DWAF (2005) cannot be classified as a hydromorphic soil form (see 7.4.1- “Hydromorphic Soils” for more details pertaining to this anthropogenic soil form). Examples of transported technosols are illustrated in Figure 7-1.

Figure 7-1 Transported technosols

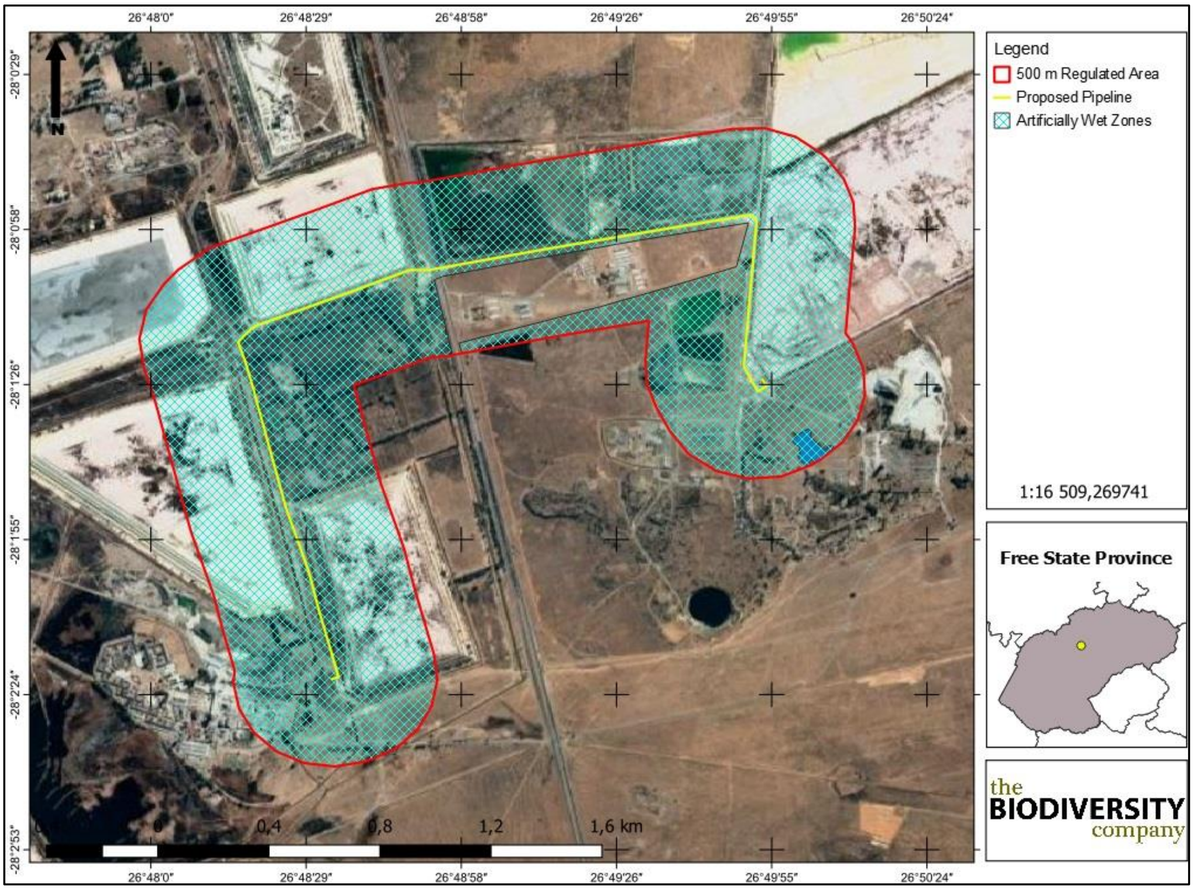

Figure 7-2 Areas characterised as artificially wet zones

In addition to those wetland areas formed by mining related activities and disturbances, various other wetlands have been formed by water inputs from constantly leaking pipelines and sewage systems as well as from overspill from canals during sporadic run-off events. Examples of these artificial wetlands and their sources are illustrated in Figure 7-3 and Figure 7-4 with all artificial wetlands (in addition to the "artificially wet zones") together with man-made canals depicted in Figure 7-5.

Figure 7-3 Examples of artificial wetlands formed due to leaking pipes and sewage infrastructure

Figure 7-4 Artificial wetlands formed due to unlined canals and overspilling canals

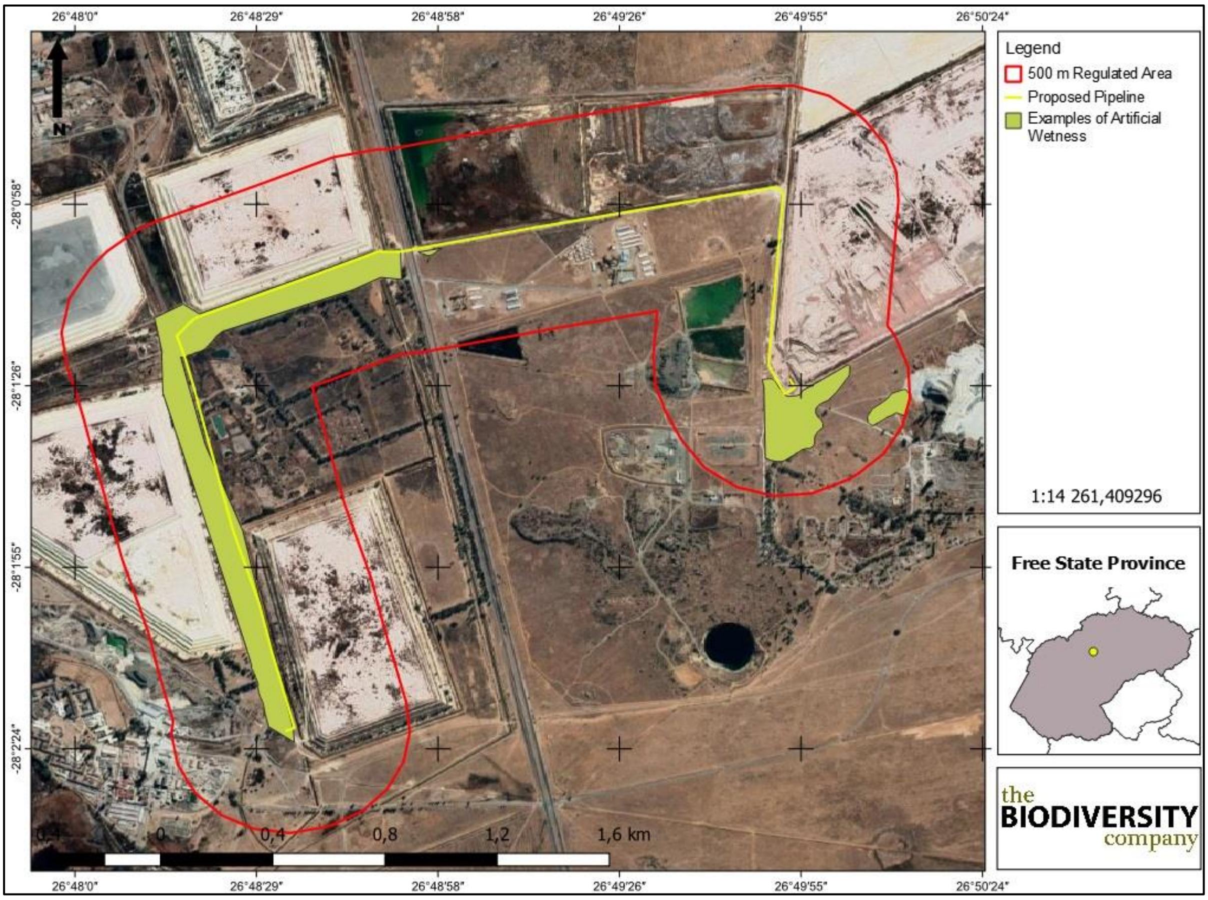

Figure 7-5 Some of the examples of artificial wetlands and canals identified within the 500 m regulated area

One natural wetland system was identified within the 500 m regulated area, which has been classified as a depression (HGM 1) (see Figure 7-6). This system is located in the centre portion of the 500 m regulated area approximately 300 m south of the pipeline.

Figure 7-6 Example of HGM 1- depression

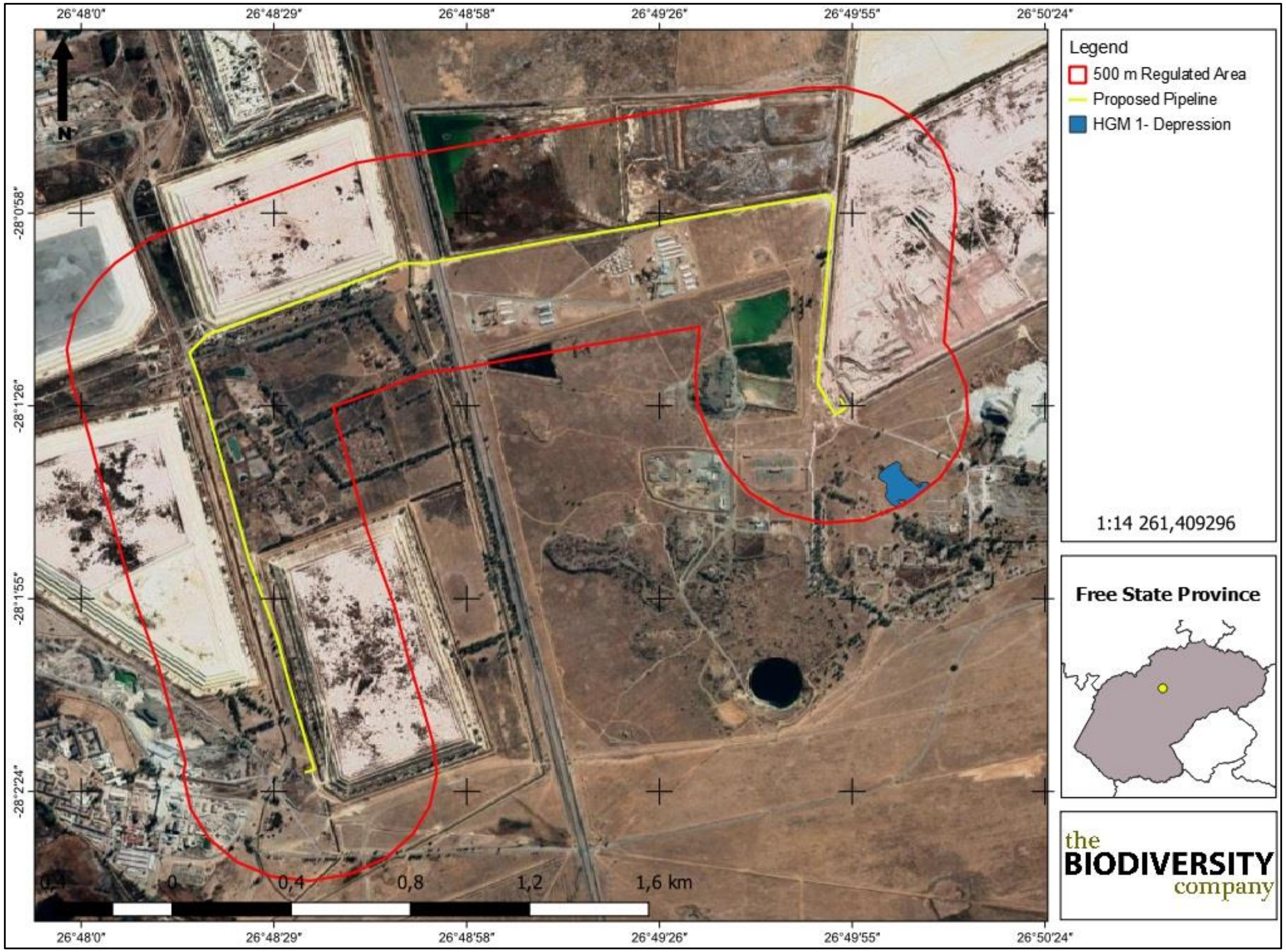

Figure 7-7 Delineation of natural wetlands within 500 m regulated area

7.2 Wetland Unit Identification

The wetland classification as per SANBI guidelines (Ollis *et al.,* 2013) is presented in Table 7-1. One wetland type has been identified, namely HGM 1. The system classifies as an inland system within the Highveld DWS ecoregion. The NFEPA Wet Veg group has been identified as the Dry Highveld Group 3. The depressions classifies as an endorheic system without channelled outflow.

Table 7-1 Wetland classification as per SANBI guideline (Ollis et al. 2013)

Wetland System	Level 1	Level 2		Level 3	Level 4		
	System	**DWS Ecoregion/s**	**NFEPA Wet Veg Group/s**	**Landscape Unit**	**4A (HGM)**	**4B**	**4C**
HGM 1	Inland	Highveld	Dry Highveld Grassland Group 3	Valley Floor	Depression	Endorheic	Without Channelled Outflow

7.3 Wetland Unit Setting

The relevant depression, as mentioned in Figure 7-8, is located on the "valley floor" landscape unit. Depressions are inward draining basins with an enclosing topography which allows for water to accumulate within the system. Depressions, in some cases, are also fed by lateral sub-surface flows in cases where the dominant geology allows for these types of flows. Figure 7-8 presents a diagram of the relevant HGM unit, showing the dominant movement of water into, through and out of the system.

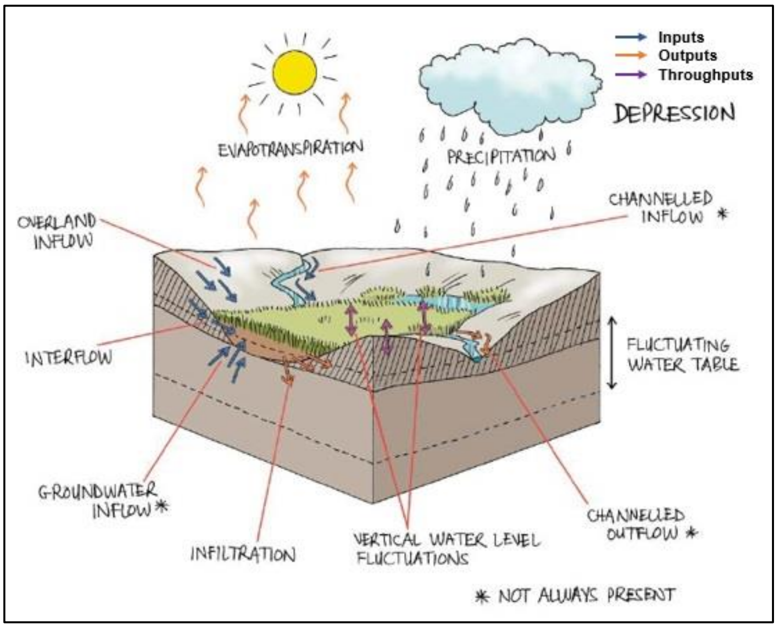

Figure 7-8 Amalgamated diagram of the HGM unit, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

7.4 Wetland Indicators

7.4.1 Hydromorphic Soils

According to (DWAF, 2005), soils are the most important characteristic of wetlands in order to accurately identify and delineate wetland areas. One dominant soil form was identified within the delineated wetlands, namely that of the Rensburg soil form.

The Rensburg soil form consists of a vertic topsoil on top of a gley horizon. The soil family group identified for the Rensburg soil form on-site has been classified as the "1000" soil family due to the non-calcareous nature of the gley horizon.

Vertic topsoils have high clay content with smectic clay particles being dominant (Soil Classification Working Group, 2018). The smectic clays have swell and shrink properties during wet and dry periods respectively. Peds will be shiny, well-developed with a highly plastic consistency during wet periods as a result of the dominance of smectic clays. During shrinking periods, cracks form on the surface and rarely occurs in shallow vertic clays.

Gley horizons that are well developed and have homogenous dark to light grey colours with smooth transitions. Stagnant and reduced water over long periods is the main factor responsible for the formation of a Gley horizon and could be characterised by green or blue tinges due to the presence of a mineral called Fougerite which includes sulphate and carbonate complexes. Even though grey colours are dominant, yellow and/or red striations can be noticed throughout a Gley horizon. The structure of a Gley horizon mostly is characterised as strong pedal, with low hydraulic conductivities and a clay texture, although sandy Gley horizons are known to occur. The Gley soil form commonly occurs at the toe of hillslopes (or benches) where lateral water inputs (sub-surface) are dominant and the underlaying geology is characterised by a low hydraulic conductivity. The Gley horizon usually is second in diagnostic sequence in shallow profiles yet is known to be lower down in sequence and at greater depths (Soil Classification Working Group, 2018).

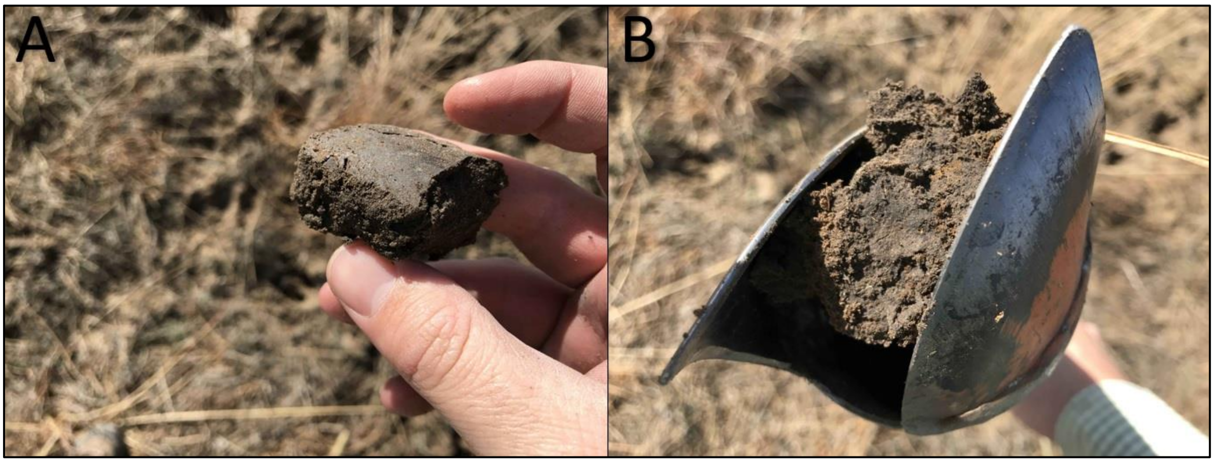

Figure 7-9 Soil horizons identified on-site. A) Ped with slick-and-slide properties. B) Vertic topsoil.

7.5 General Functional Description

The generally impermeable nature of depressions and their inward draining features are the main reasons why the streamflow regulation ability of these systems is mediocre. Regardless of the nature of depressions in regard to trapping all sediments entering the system, sediment trapping is another Eco Service that is not deemed as one of the essential services provided by depressions, even though some systems might contribute to a lesser extent. The reason for this phenomenon is due to winds picking up sediments within pans during dry seasons which ultimately leads to the removal of these sediments and the deposition thereof elsewhere. The assimilation of nitrates, toxicants and sulphates are some of the higher rated Eco Services for depressions. This latter statement can be explained the precipitation as well as continues precipitation and dissolving of minerals and other contaminants during dry and wet seasons respectively, (Kotze et al., 2009).

It is however important to note that the descriptions of the above-mentioned functions are merely typical expectations. All wetland systems are unique and therefore, the ecosystem services rated high for these systems on site might differ slightly to those expectations.

7.6 Ecological Functional Assessment

The ecosystem services provided by the wetland units identified on site were assessed and rated using the WET-EcoServices method (Kotze *et al.,* 2008). The summarised results for HGM 1 are shown in Table 7-2. The average ecosystem score for HGM 1 has been scored “Intermediate”. Only one ecosystem service has been scored a “High” rating, namely education and research. This score is attributed to the reference site suitability of the system, the ease of access to this system (open to the public).

This system does not provide any assistance to agriculture or subsistence farming in the form of irrigation, which renders the majority of direct benefits provided by this system “Low”. This system has continuously been subjected to various impacts concerning historic mining activities, which slightly increases the indirect benefits pertaining to the assimilation of contaminants.

Table 7-2 The ecosystem services being provided by the HGM units

			Wetland Unit		HGM 1
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		1.5
			Streamflow regulation		1.5
			Water Quality enhancement benefits	Sediment trapping	1.5
				Phosphate assimilation	1.7
				Nitrate assimilation	2.0
				Toxicant assimilation	1.9
				Erosion control	1.9
			Carbon storage		2.0
	Direct Benefits	**Biodiversity maintenance**			**1.1**
		Provisioning benefits	Provisioning of water for human use		0.9
			Provisioning of harvestable resources		0.0
			Provisioning of cultivated foods		0.0

		Cultural benefits	Cultural heritage	0.0
			Tourism and recreation	0.6
			Education and research	3.0
Average Eco Services Score				1.3

7.7 The Ecological Health Assessment

The PES for the assessed HGM units is presented in Table 7-3. The overall Present Ecological State (PES) for HGM 1has been determined to be "Seriously Modified". This indicates a large degree of modification. The hydrological component of the wetland is affected by significant modifications within the wetland's catchment associated with historic mining activities and ancillary infrastructure which significantly alters the flow dynamics of the area.

The geomorphological component, similarly, is affected by these modifications together with drainage features (artificial) entering the system. These systems don't only affect the surface flow dynamics of the area but also increases sediment inputs into HGM 1, of which tailings material are a part of. The latter, in turn, also contributes to an increase of contaminants (especially heavy metals).

The vegetation components are solely affected by dumping, grazing of cattle as well as alien invasive species. These components alter the functionality of the system due to the absence of indigenous plant species.

Table 7-3 Summary of the scores for the wetland PES

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Score	Rating	Score	Rating	Score
HGM 1	E: Seriously Modified	6.5	D: Largely Modified	5.8	E: Seriously Modified	6.9
Overall PES Score	6.4		Overall PES Class		E: Seriously Modified	

7.8 The Importance & Sensitivity Assessment

The results of the ecological IS assessment are shown in Table 7-4. Various components pertaining to the protection status of a wetland is considered for the IS, including Strategic Water Source Areas (SWSA), the NFEPA wet veg protection status and the protection status of the wetland itself considering the NBA wetland data set. The IS for HGM 1 has been calculated to be "Moderate", which combines the relatively high protection status of the wet veg type and the low protection status of the wetland itself.

Table 7-4 The IS results for the delineated HGM unit

HGM Type	Wet Veg			NBA Wetlands		SWSA (Y/N)	Calculated IS
	Type	Ecosystem Threat Status	Ecosystem Protection Level	Wetland Condition	Ecosystem Threat Status 2018		
HGM 1	Dry Highveld Grassland Group 3	Endangered	Moderately Protected	N/A	N/A	N	**Moderate**

7.9 Hydropedology

A hydropedological component was included in this assessment to ensure a holistic understanding of the hillslope hydrology and potential impacts towards the vadose zone properties. The entire hillslope is characterised by deep recharge hydropedological types in the form of the Ermelo soil form besides the main receptor (depression wetland), which is characterised by a responsive hydropedological type.

It is clear from the cross profile depicted in Figure 7-10 that the proposed pipeline will not have any effect on the hillslope hydrology or vadose zone properties of the relevant hillslope. Therefore, zero percent loss of total moisture content to the depression is expected.

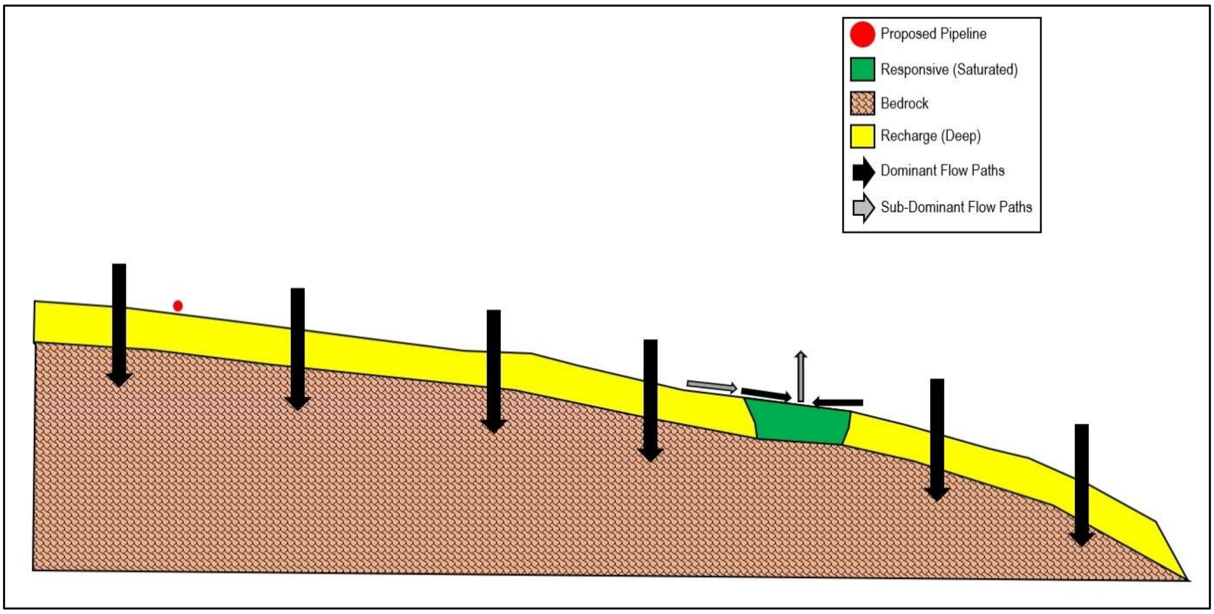

Figure 7-10 Conceptual cross profile of the hillslope associated with the relevant pipeline

7.10 Buffer Requirements

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane *et al.,* 2014) was used to determine the appropriate buffer zone for the proposed activity. A pre-mitigation buffer zone of 30 m is recommended for the identified wetland, which can be decreased to 15 m with the addition of all prescribed mitigation measures (see Table 7-5).

Table 7-5 Pre- and post-mitigation buffer sizes

	Buffer Widths
Pre-mitigation buffer	30 m
Post-mitigation buffer	15 m

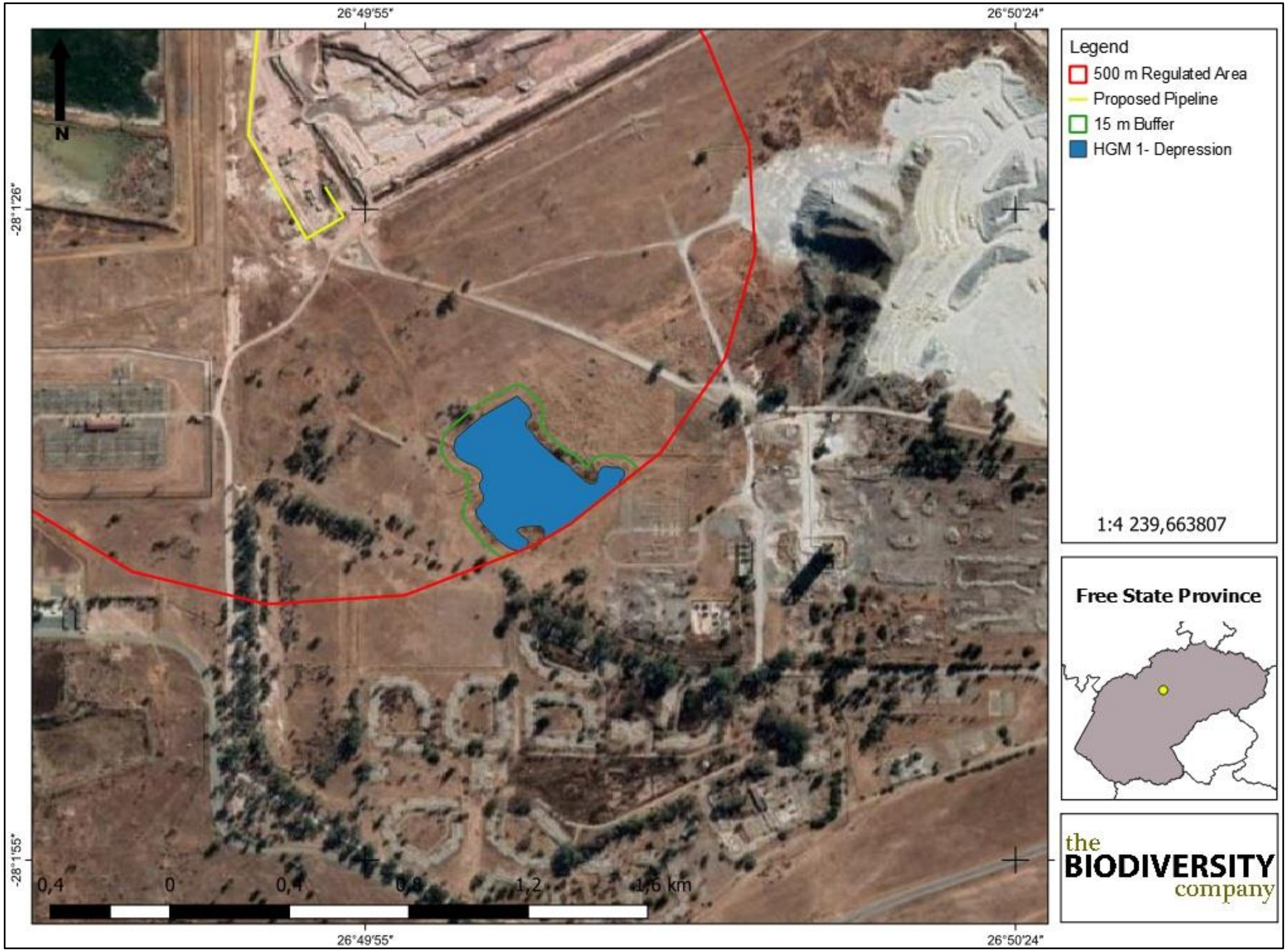

Figure 7-11 Recommended buffer zone

8 Risk Assessment

The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) will be considered for this component of the assessment (Figure 8-1). 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. The buffer section illustrates the extent of the recommended buffer zones for the identified wetlands. It is evident from these illustrations that the proposed is located well outside of any natural wetland systems (approximately 300 m). Considering the distance between the proposed pipeline and the wetland as well as the fact that the area between the proposed pipeline and the relevant HGM units are characterised by Ermelo soil forms with deep, freely drained yellow-brown apedal horizons (which limits overland flow), no indirect risks are foreseen. This explanation is also emphasised by the hydropedological component which suggests that no impacts are foreseen and that a zero percent loss of moisture to the depression is expected.

In regard to the artificial wetlands located within close proximity to the proposed pipeline, it is important to keep in mind that once all anthropogenic inputs are remediated, no wetlands will exist. Therefore, any risk associated with these systems are deemed acceptable. Considering these statements, it's clear that the first step in the mitigation hierarchy, namely avoidance, will be met.

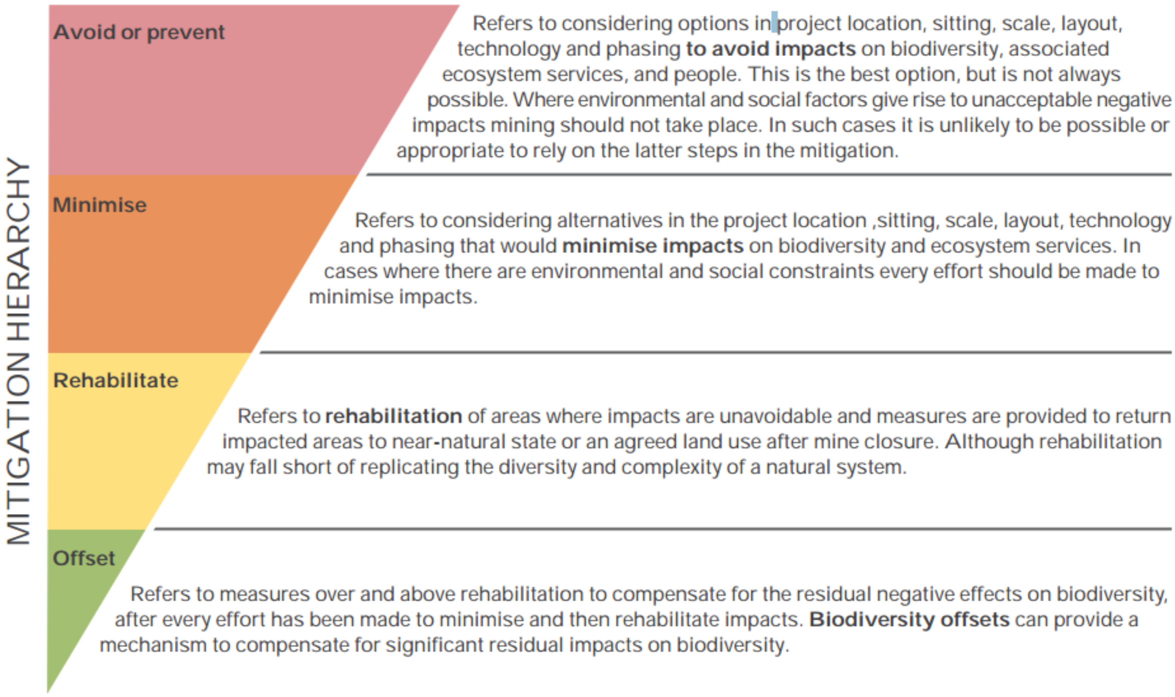

Figure 8-1 The mitigation hierarchy as described by the DEA (2013)

9 Conclusion

9.1 Wetland

One wetland HGM type was identified within the 500 m regulated area, namely a depression. Additionally, various artificial wetlands and canals were identified, which has been disregarded from this assessment. HGM 1 has been determined to have an intermediate average ecosystem service score, a moderate importance and sensitivity and is characterised by a "Seriously Modified" state. A 15 m buffer has been recommended to ensure the conservation of this wetland type, even though the proposed pipeline is located approximately 300 m from the delineated wetlands.

9.2 Risk Assessment

Considering the distance between the proposed pipeline as well as the fact that the area between the proposed pipeline and the relevant HGM units are characterised by the Ermelo soil form with deep, freely drained yellow-brown apedal horizons (which limits overland flow), no indirect risks are foreseen. This explanation is also emphasised by the hydropedological component which suggests that no impacts are foreseen and that a zero percent loss of moisture to the depression is expected.

9.3 Specialist Recommendation

Since no risks are expected towards natural wetland systems, it is recommended that the proposed activities may proceed without the application for a water use authorisation.

10 References

Department of Environmental Affairs. 2013. Mining and biodiversity guideline- Mainstreaming biodiversity into the mining sector.

Department of Water Affairs and Forestry (DWAF) 2005. Final draft: A practical field procedure for identification and delineation of wetlands and Riparian areas.

Kotze DC, Marneweck GC, Batchelor AL, Lindley DC, Collins, NB. 2008. A Technique for rapidly assessing ecosystem services supplied by wetlands. Mondi Wetland Project.

Land Type Survey Staff. (1972 - 2006). Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases. Pretoria: ARC-Institute for Soil, Climate, and Water.

Le Roux, P. A., Hensley, M., Lorentz, S. A., van Tol, J. J., van Zijl, G. M., Kuenene, B. T., Jacobs, C. C. (2015). HOSASH: (Hydrology of South African Soils and Hillslopes. Water Research Commission.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. Goge, C. 2008. WET-Health, A technique for rapidly assessing wetland health.

Macfarlane, D.M., Dickens, J. & Von Hase, F. (2009). Development of a methodology to determine the appropriate buffer zone width and type for developments associated with wetlands, watercourses and estuaries.

Mucina, L. and Rutherford, M.C. (Eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria South African.

National Environmental Management Act. 1998. National Environmental Management Act (act no. 107 of 1998)- Environmental management framework regulations.

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Ollis DJ, Snaddon CD, Job NM, and Mbona N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Rountree MW, Malan H and Weston B (editors). 2012. Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission Study. Report No XXXXXXXXX. Water Research Commission, Pretoria.

Russel, W. 2009. Wet-RehabMethods: National guidelines and methods for wetland rehabilitation. WRC

SASA, S. A. (1999). Identification & management of the SOILS of the South African sugar industry. Mount Edgecombe: South African Sugar Association Experiment Station.

Soil Classification Working Group. (1991). Soil Classification A Taxonomic system for South Africa. Pretoria: The Department of Agricultural Development.

South African National Biodiversity Institute (SANBI). 2009. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa.

Van Tol, J.J., Le Roux, P.A.L., Lorentz, S.A., Hensley, M. 2013. Hydropedological classification of South African hillslopes. Vadose Zone Journal.

Van Tol, J., Le Roux, P. & Lorentz, S. 2017. The science of hydropedology- Linking soil morphology with hydrological processes. *Water Wheel* 16(3).

Van Tol, J.J. & Le Roux, P.A.L., 2019. Hydropedological grouping of South African soil forms. South African Journal of Plant and Soil.

Van Tol., JJ., Bouwer, D. and Le Roux, P.A.L. 2021. Guideline for hydropedological assessments and minimum requirements.