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Xivono Weltevreden Coal Mining Project near Belfast, Mpumalanga

Aquatic and Wetland Ecological Assessment

Prepared for:

Xivono Mining (Pty) Ltd

Project Number:

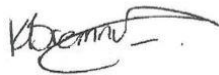


MBU5710

November 2019



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EXECUTIVE SUMMARY

Digby Wells Environmental has been appointed by Xivono Mining (Pty) Ltd to conduct the freshwater (aquatic and wetland) specialist studies to inform the Environmental Impact Assessment (EIA) process being conducted for the proposed Weltevreden Mining Project (hereafter the Project).

450.43 ha of wetland areas were identified within the proposed project area and its associated 500 m zone of regulation with 225.89 ha within the proposed project area only. Thirty hydro-geomorphic (HGM) units were identified and categorized based on terrain units. These included pans, hillslope seeps, unchannelled valley bottoms and channelled valley bottoms. Wetlands were numbered 1 – 30 for ease of reference.

The health and integrity of each of the HGM units present varied considerably, with anthropogenic disturbances being the most significant driver of change to date. These disturbances were related largely to plantations, agropastoral activities and linear infrastructures traversing the proposed project area, with an isolated portion in the south-east of the proposed project area affected by mining activities. The Present Ecological State (PES) of each of the HGM units observed were largely categorised as Ecological Category C (moderately modified) and Ecological Category D (largely modified) systems, with three isolated pans classified as an Ecological Category B (Minimally modified) and one small hillslope seepage wetland classified as Ecological Category A (Unmodified).

In terms of Ecological Importance and Sensitivity (EIS), the ecological importance and sensitivity of the various HGM units were regarded as largely dependent on their respective locations in the landscape, the surrounding landscape uses and activities, and the HGM unit type. The level of resilience and the anthropogenic impacts affecting each HGM unit was also considered. EIS for the majority of the wetlands present was observed to be *Moderate*, with that of four of the HGM units observed to be *High*. Important services in terms of flood attenuation, streamflow regulation, the assimilation of toxicants and nutrients, as well as the maintenance of biodiversity were considered the most important functions provided by the wetlands present.

According to the results of the Groundwater Study and the Soils Study (Digby Wells, 2019a; Earth Science Solutions, 2019), the water table within the proposed project area is relatively shallow due to the presence of a shallow weathered aquifer and this, along with the expansive transitional soil types observed, has given rise to the numerous pan systems and extensive hillslope seepage areas observed, which in turn, feed and supply water to the valley bottom wetlands observed within the proposed project area and its 500 m zone of regulation, with special mention of HGM units 16, 18, 19, 21 and 30 (i.e. the wetlands displaying the highest ecological integrity as well as ecological importance and sensitivity).

Water quality within the proposed project area was deemed natural in consideration of the wetland nature of the systems and the surrounding agropastoral and forestry activities (MBY4 was found to be only slightly below the lower limit of 6 with a pH of 5.86) and while the accepted indices for the determination of the general ecological integrity of the area were largely

unsuitable due to the inherent wetland nature of the aquatic ecology of the area and the unsuitability of the indices for use in artificial impoundments, the presence of some more sensitive families such as *Hydracarina*, *Aeshnidae*, *Naucoridae*, *Elmidae* and *Hydraenidae* serve as an indication that aquatic ecological conditions are adequate for maintaining a relatively high degree of biodiversity.

The proposed mining footprint, inclusive of the OC1 and OC2 pits as well as the associated surface infrastructure will result in a direct loss of approximately 94.86 ha. The potential indirect losses have not been quantified but are expected to be significant.

The impact assessment revealed a spectrum of impacts ranging from major to minor prior to the implementation of suitable mitigations. Many of these impacts can be reduced to minor and negligible impacts, however, the proposed OC2 pit will result in the direct destruction of HGM units 4, 5, 6, 13, and portions of HGM units 15, 16 and 17, and the proposed OC1 pit will result in the direct destruction of a portion of HGM unit 19, and HGM units 20, and 25. HGM units 5, 6, 16, 17, 19, 20 and 25 are important hillslope seepage and valley bottom wetland systems supplying water to the downstream wetland and aquatic ecology and the destruction of these systems is likely to have both a direct and indirect impacts to the downstream ecology in terms of impacts to water quality as a result of decant (Digby Wells, 2019a) as well as due to loss of water supply. The quantified destruction of 91.41 ha (exclusive of surface infrastructure (3.45 ha)) of wetland habitat due to the proposed open pit mining activities, and the unquantified destruction and degradation of the remaining wetland ecology, as well as the downstream ecology of the Klein Komati River, as a result of desiccation and decant are regarded as a fatal flaw to the proposed project in terms of the wetland and aquatic ecology of the greater area. Therefore, open pit mining within the proposed project area, with special mention of the OC1 pit is not recommended.

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1 Introduction

1.1 Project Background

Xivono Mining (Pty) Ltd (hereafter Xivono) intends to undertake Environmental Authorisations, an Integrated Water Use Licence (IWUL) and Mining Right Application (MRA) for the proposed Weltevreden Project. Xivono is set to submit an MRA in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) to the Department of Mineral Resources (DMR). Activities that require a Mining Right, trigger Activity 17 of GNR984 of the EIA Regulations, 2014, in accordance with the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and requires a Scoping and Environmental Impact Assessment (EIA) process to be undertaken. Further to this, an Integrated Water Use Licence Application (IWULA) process will be undertaken for Section 21 water uses as per the National Water Act (NWA) (Act 36 of 1998). Thus, for the purposes of fulfilling the requirements of the EIA and IWULA processes, a detailed freshwater impact assessment (wetland and aquatics) is required. This report should be read in collaboration with the EIA and IWULA as well as the other specialist reports (specifically soil, fauna & flora, hydrology and groundwater).

1.2 Project Description and Locality

Xivono has an existing Prospecting Right (PR) for the proposed Weltevreden Mining Project area, approximately 8km south of Belfast in the Mpumalanga province of South Africa. The PR includes Portion 381, the Remaining Extent (RE), RE of Portion 3, Portion 9, Portion 10, RE of Portion 11, Portion 21, Portion 23 and Portion 24 of the Farm Weltevreden 381 JS. The Prospecting Right is divided into an east and west section by the R33 which runs in a north-south direction through the site. The proposed mining activities will only take place on the western half of the PR, which covers a surface area of approximately 800 hectares. The eastern portion will not be mined nor accommodate any mining-related infrastructure.

Xivono proposes to mine two pits, OC1 (162 ha footprint) and OC2 (200 ha footprint). Xivono plans to utilise containers for the mine offices and workshop infrastructure which will occupy a footprint of approximately 0.03 ha (300m²). Other surface infrastructure proposed for the site includes a pollution control dam, crushing and screening plant (no washing to take place on site), Run of Mine (ROM) pad, overburden dump, stockpiles, pipelines and lined trenches. The conceptual mine layout is currently being developed and is expected to have a footprint of approximately 1 ha.

1.3 Terms of Reference

Digby Wells Environmental (hereafter Digby Wells) has been requested by Xivono to conduct the freshwater (aquatic and wetland) specialist studies to inform the Environmental Impact Assessment (EIA) process being conducted for the proposed Weltevreden Mining Project (hereafter the Project).

1.4 Policy and Legal Framework

This freshwater resource assessment aims to support the following regulations, regulatory procedures and guidelines:

- Section 19 of the National Water Act (NWA), 1998 (Act 36 of 1998);
- Section 21 (c), (g) and (i) of the National Water Act (Act 36 of 1998);
- Section 24 of the Constitution – Environment (Act 108 of 1996);
- National Environmental Management Biodiversity Act (NEMBA), 2004 (Act 10 of 2014); and
- Section 5 of the National Environmental Management Act (NEMA), 1998 (Act No. 7 of 1998).

1.5 Assumptions and Limitations

The following limitations were encountered during this study:

- Aquatic component:
 - To obtain a comprehensive understanding of the dynamics of the aquatic biota present within a watercourse (e.g. migratory pathways, seasonal prevalence, breeding cycles, etc.), studies should include investigations conducted during different seasons, over a number of years and through extensive sampling efforts. Given the time constraints of the baseline assessment, such long-term research was not feasible and could not be conducted. Consequently, the findings presented are based on professional experience, supported by a literature review, and extrapolated from the data collected at the time of the field survey.
- Wetland component:
 - Access to some of the systems was limited due to the areas being on mine property. The systems that were not verified during the field survey were scrutinised at a desktop level and have been demarcated as such for transparency;
 - Wetlands situated within the 500 m zone of regulation were assessed largely on a desktop level with very limited ground-truthing and some discrepancies within this zone may occur; and
 - This wetland study forms part of a larger Environmental Impact Assessment (EIA) and should be read in conjunction with the EIA and other related specialist studies.

1.6 Conditions of this Report

Findings, recommendations and conclusions provided in this report are based on the author's best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the

author and/or a relevant reference to the report by the inclusion of an appropriately detailed citation. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

2 Details of the Specialist

Kieren Jayne Bremner: Wetlands manager. Kieren completed an MSc (Aquatic Health) from the University of Johannesburg and has 11 years of consulting experience. In her early career she was exposed to various sectors of the Environmental Management field such as water use licensing, BAs, EIAs and public participation. During this time she was given the opportunity to initiate and manage various aquatic biomonitoring programmes within the mining and energy production sectors within South Africa. In 2009, Kieren began to focus largely on wetland and aquatic specialist assessments, gaining invaluable and extensive experience in the biomonitoring and water monitoring field in rivers and wetlands throughout South Africa. International countries of project experience include: Botswana, the Democratic Republic of Congo, Malawi, Mali, Senegal and Ghana. Kieren is registered by the South African River Health Programme (SA RHP) as an accredited aquatic biomonitoring specialist.

3 Description of the environment

Biodiversity within inland water ecosystems in southern Africa is both highly diverse and of great regional importance to local livelihoods and economies, as these valuable natural resources (including any associated biota) provide a broad array of goods and services e.g. a source of water for domestic, industrial and agricultural purposes, as well as integral roles in the power generation and waste disposal industries (Darwall, Smith, Tweddle, & Skelton, 2009; Dudgeon *et al.*, 2006). However, the fact that these freshwater systems may well be the most endangered ecosystems in the world threatens any of the 126,000 described species that depend upon freshwater habitats for any critical part of their life cycle, as well as any associated provisioning and/or regulatory ecosystem services (Dudgeon *et al.*, 2006).

Major global threats identified within these species-rich systems include ecosystem destruction, habitat alteration, changes in water chemistry, and direct additions and/or losses of aquatic biota (Malmqvist & Rundle, 2002). The magnitude of the threat to, and loss of, biodiversity in these vulnerable ecosystems is an indicator of the extent to which current practices are unsustainable. Hence, the importance of implementing conservation and management strategies that protect all elements of freshwater biodiversity, which in turn, also help to guarantee water availability in the future (Dudgeon *et al.*, 2006).

The fact that South Africa is a water-scarce country makes these aquatic ecosystems even more susceptible to anthropogenic activities and their associated impacts. Consequently, the state (quality and quantity) of the country's water resources is fully dependant on good land management practices within catchments. Therefore, in order to achieve ecological and socio-economic sustainability, our natural water resources rely upon an integrated ecosystem-based

approach to natural resource management (i.e. Integrated Water Resource Management, IWRI).

3.1 Biophysical Description

Ecoregions are regions characterised by a relative similarity in the type of ecosystems and ecosystem components, i.e. biotic and abiotic, aquatic and terrestrial. The project area is located within the Highveld ecoregion (Level II Ecoregion 11.02), falling under the Southern Temperate Highveld freshwater ecoregion according to Darwall *et al.* (2009). It is characterised by plains with a moderate to low relief and soils that are mostly coarse, sandy and shallow. Consequently, the drainage density is mostly low, but medium in some areas. There are various grassland vegetation types (with moist types present towards the east and drier types towards the west and south). Table 3-1 provides a summary of the main attributes of the Highveld ecoregion (Kleynhans, Thirion, & Moolman, 2005).

Table 3-1: Main attributes of the Highveld Ecoregion

Main Attributes	Highveld Ecoregion
Terrain Morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief; Plains; Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	Mixed Bushveld (limited); Rocky Highveld Grassland; Dry Sandy Highveld Grassland; Dry Clay Highveld Grassland; Moist Cool Highveld Grassland; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (m a.m.s.l) (modifying)	1100-2100, 2100-2300 (very limited)
MAP (mm) (Secondary)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max. temp. (°C): February	20 to 32
Mean daily max. temp. (°C): July	14 to 22
Mean daily min. temp. (°C): February	10 to 18

Mean daily min temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

3.2 Climate

Altitudes within the project area range from 1800 – 1950 m above mean sea level (a.m.s.l.). Relative to the country's average mean annual precipitation (MAP) of 490 mm, this ecoregion experiences low to moderately high rainfall within the range of 400-1000 mm falling predominantly during early to late summer (Worldwide Fund for Nature - South Africa, 2016). The Highveld ecoregion is hot in the west and moderate in the east with a mean annual temperature of 12-20°C (Kleynhans *et al.*, 2005).

3.3 Associated Watercourses

The water resources of South Africa are divided into quaternary catchments, which are regarded as the principal water management units in the country (DWA, 2011). These catchments represent the fourth order of the hierarchical classification system, in which the primary catchments are the major units. The primary drainages are further grouped into or fall under Water Management Areas (WMA) and Catchment Management Agencies (CMA). The Department of Water and Sanitation (DWS) has established nine WMAs and nine CMAs as contained in the National Water Resource Strategy 2 (2013) in terms of Section 5 subsection 5(1) of the National Water Act, 1998 (Act No. 36 of 1998). The establishment of these WMAs and CMAs is to improve water governance in different regions of the country, to ensure a fair and equal distribution of the Nations freshwater resources, while making sure that the resource quality is sustained.

The Weltevreden project area falls within primary drainage region X of the Inkomati WMA and the X11D quaternary catchment situated in the Komati River Catchment. Nearby tributaries are the Klein-Komati (reach code: X11D-01129) and the Waarkraalloop (reach code: X11D-01137) streams. These tributaries both drain into the Komati River approximately 18 km south of the proposed Project area. Figure 3-1 indicates the freshwater resource management classification associated with the study area.

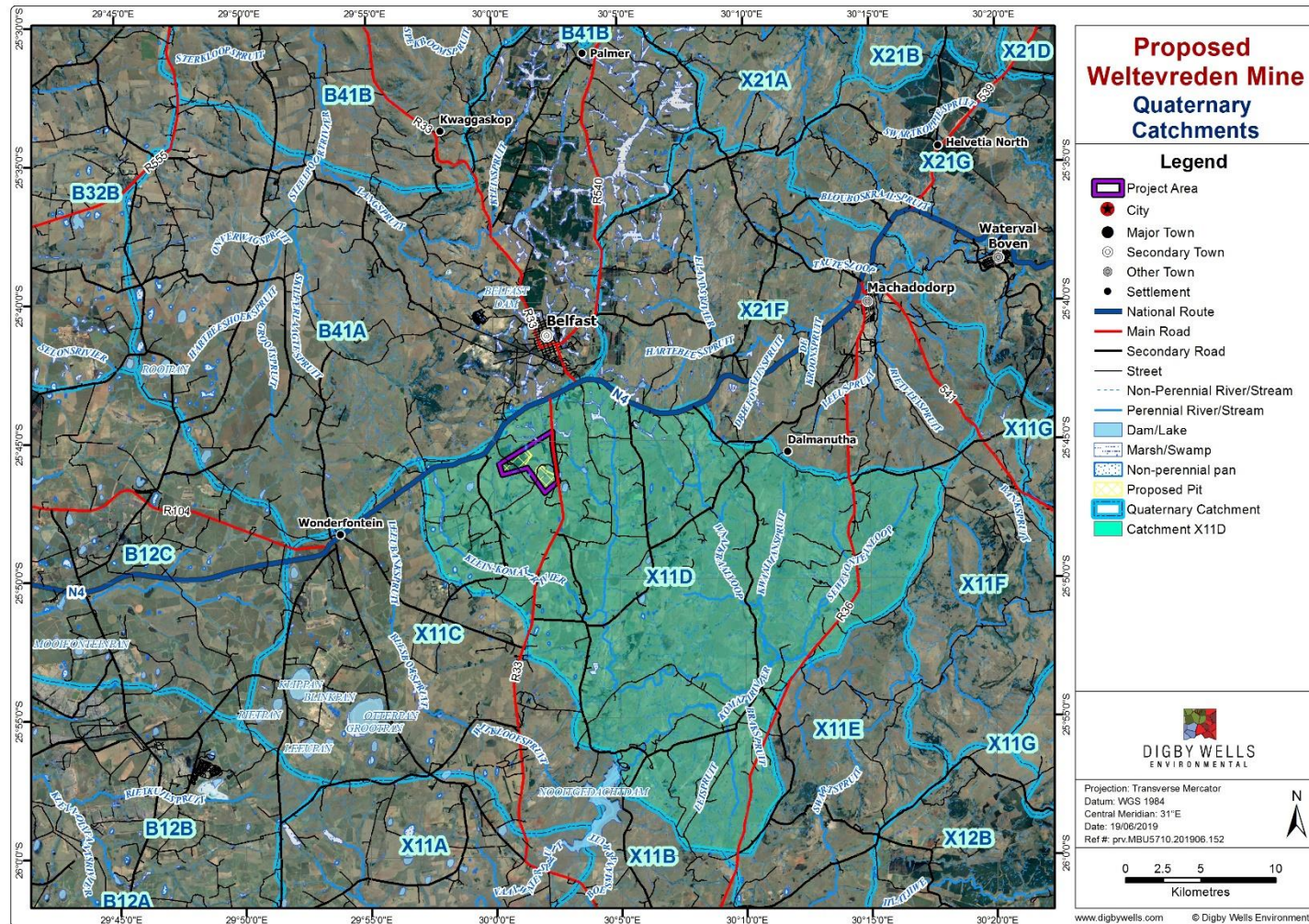


Figure 3-1: Quaternary Catchments

3.3.1 Regional Vegetation

The project area is located within the Grassland Biome (Mucina & Rutherford, 2012), one of the nine South African plant Biomes and the second most bio-diverse biome in South Africa. The Grassland Biome is situated primarily on the central plateau of South Africa, and the inland areas of Kwa-Zulu-Natal and the Eastern Cape provinces. This biome is rich in flora and fauna diversity but is under threat due to rapid urbanisation and expansion of mining and industrial activities.

The Project area occurs in the Eastern Highveld Grassland vegetation type in the Mesic Highveld Grassland Group (Mucina and Rutherford, 2012). Table 3-2 lists the species characteristic of the Eastern Highveld Grassland. The Eastern Highveld Grassland is listed as Vulnerable on the National List of Threatened Terrestrial Ecosystems (Mucina and Rutherford, 2012).

Table 3-2: Plant Species Characteristic of the Eastern Highveld Grasslands (Mucina & Rutherford, 2012)

Plant Form	Species
Graminoids	<i>Aristida aequiglumis</i> , <i>A. congesta</i> , <i>A. junciformis</i> subsp. <i>galpinii</i> , <i>Brachiaria serrata</i> , <i>Cynodon dactylon</i> , <i>Digitaria monodactyla</i> , <i>D. tricholaenoides</i> , <i>Elionurus muticus</i> , <i>Eragrostis chloromelas</i> , <i>E. capensis</i> , <i>E. curvula</i> , <i>E. gummiflua</i> , <i>E. patentissima</i> , <i>E. plana</i> , <i>E. racemosa</i> , <i>E. sclerantha</i> , <i>Heteropogon contortus</i> , <i>Loudetia simplex</i> , <i>Microchloa caffra</i> , <i>Monocymbium cerasiiforme</i> , <i>Setaria sphacelata</i> , <i>Sporobolus africanus</i> , <i>S. pectinatus</i> , <i>Themeda triandra</i> , <i>Trachypogon spicatus</i> , <i>Tristachya leucothrix</i> , <i>T. rehmannii</i> , <i>Alloteropsis semialata</i> subsp. <i>eckloniana</i> , <i>Andropogon appendiculatus</i> , <i>A. schirensis</i> , <i>Bewisia biflora</i> , <i>Ctenium concinnum</i> , <i>Diheteropogon amplexans</i> , <i>Harporchloa falx</i> , <i>Panicum natalense</i> , <i>Rendlia altera</i> , <i>Schizachyrium sanguineum</i> , <i>Setaria nigrirostris</i> , <i>Urelytrum agropyroides</i>
Herbs	<i>Berkheya setifera</i> , <i>Haplocarpha scaposa</i> , <i>Justicia anagalloides</i> , <i>Pelargonium luridum</i> , <i>Acalypha angustata</i> , <i>Chamaecrista mimosoides</i> , <i>Dicoma anomala</i> , <i>Euryops gilfillanii</i> , <i>E. transvaalensis</i> subsp. <i>setilobus</i> , <i>Helichrysum aureonitens</i> , <i>H. caespitium</i> , <i>H. callicomum</i> , <i>H. oreophilum</i> , <i>H. rugulosum</i> , <i>Ipomoea crassipes</i> , <i>Pentanisia prunelloides</i> subsp. <i>latifolia</i> , <i>Selago densiflora</i> , <i>Senecio coronatus</i> , <i>Vernonia oligocephala</i> , <i>Wahlenbergia undulata</i> .
Geophytic herbs	<i>Gladiolus crassifolius</i> , <i>Haemanthus humilis</i> subsp. <i>hirsutus</i> , <i>Hypoxis rigidula</i> var. <i>pilosissima</i> , <i>Ledebouria ovatifolia</i>
Succulent Herbs	<i>Aloe ecklonis</i>
Low Shrubs	<i>Anthospermum rigidum</i> subsp. <i>pumilum</i> , <i>Seriphium plumosum</i>

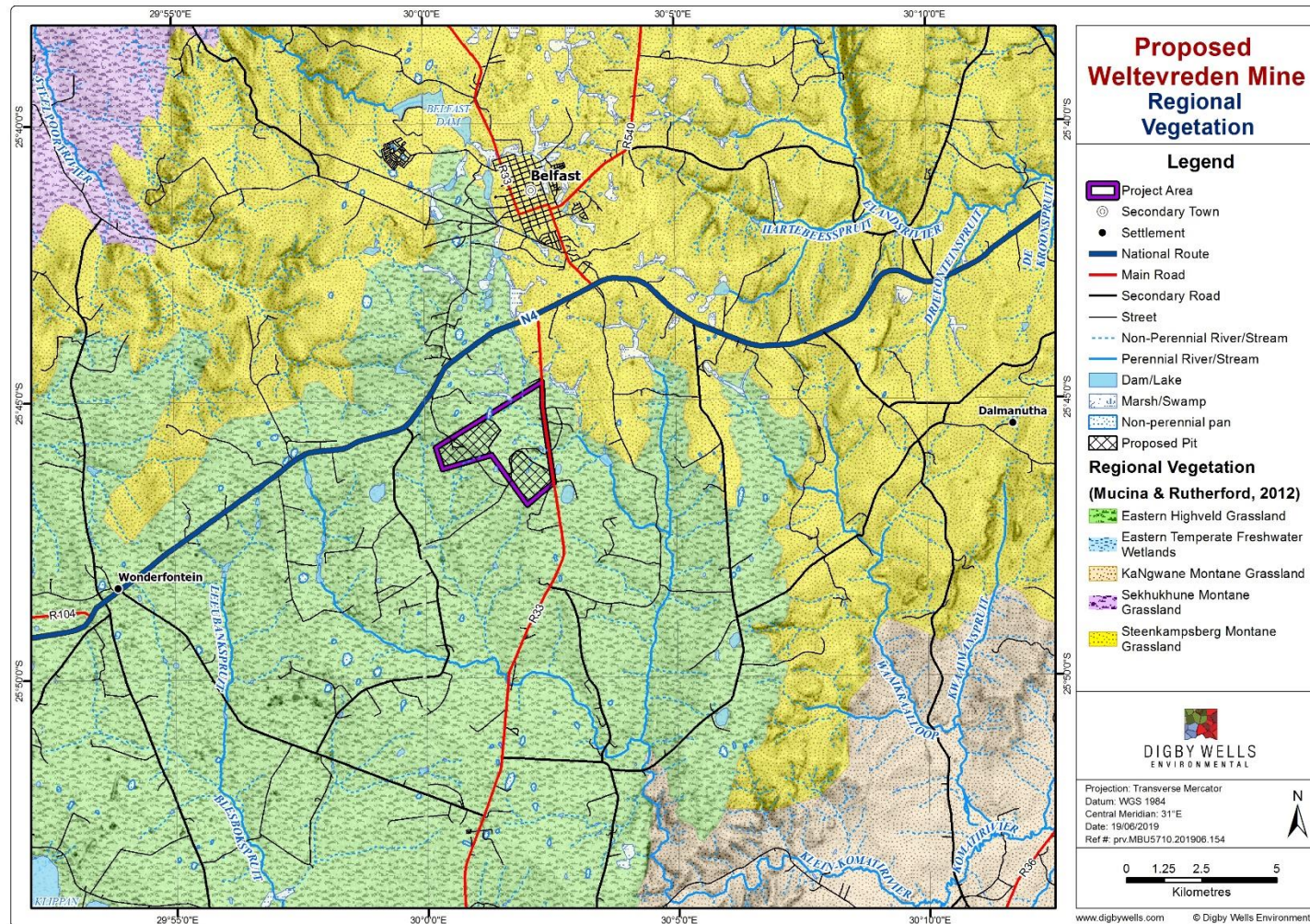


Figure 3-2: Regional Vegetation

3.4 Bioregional Context

The project area is located within the Southern Temperate Highveld freshwater ecoregion according to Darwall *et al.* (2009) and Scott (2015). This ecoregion is situated in the interior of South Africa, with the western boundary formed by the Magaliesberg, Pilanesberg and Waterberg mountain ranges, the northern boundary formed by the Soutpansberg, and the eastern boundary formed by the Drakensberg Mountains (Scott, 2015).

The dominant limnological features are rivers and seasonal pans. The main drainages are those of the westward-flowing Vaal River (the main tributary of the Orange River), and some stretches of the middle Caledon and Orange Rivers. The headwaters of the Crocodile, Marico, Sabie, Komati (or Incomati), Usutu, Pongola, and Tugela Rivers also drain from the highveld plateau to the east and northeast (Scott, 2015).

The area is also characterized by multiple pans, as well as a few river-associated wetlands. The wetlands are species-rich and contain few rare or endemic species. The dominant species within the eastern wetlands include *Carex acutiformis* and *Cyperus fastigiatus*. The wetland systems in the east remain fresh all year round, whereas the wetlands in the western part tend to become saline (Darwall *et al.*, 2009). Table 3-3 provides a summary of the relevant location-specific environmental attributes associated with the study area.

Table 3-3: Summary of site characteristics and attributes of the associated study area

Political Region	Mpumalanga
Level 1 Ecoregion	11. Highveld
Level 2 Ecoregion	11.02
Freshwater Ecoregion	Southern Temperate Highveld
Geomorphic Province	Mpumalanga Highlands
Vegetation Type	Eastern Highveld Grassland
Water Management Area	Inkomati
Secondary Catchment	X1
Quaternary Catchment	X11D
Watercourse	Komati River and adjoining tributaries
Slope Class	D – Upper foothills
Seasonality	Perennial

3.5 Regional Biodiversity Importance

3.5.1 National Freshwater Ecosystem Priority Areas

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

1. Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
2. Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity within the context of equitable social and economic development. The second aim is comprised of two separate components: the (i) national component aimed to align DWA (or currently the DWS) and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems, while the (ii) sub-national component is aimed to use three case studies to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes. The project further aimed to maximize synergies and alignment with other national level initiatives, including the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation (Driver *et al.*, 2011).

Based on a desktop-based modelled wetland condition and a combination of special features, including expert knowledge (e.g. intact peat wetlands, presence of rare plants and animals, etc.) and available spatial data on the occurrence of threatened frogs and wetland-dependent birds, each of the wetlands within the inventory were ranked in terms of their biodiversity importance and as such, Wetland FEPA's were identified in an effort to achieve biodiversity targets (Driver *et al.*, 2011). Table 3-4 below indicates the criteria that were considered for the ranking of each of these wetland areas. Whilst being an invaluable tool, it is important to note that the NFEPA's were delineated and studied at a desktop and low-resolution level. Thus, the wetlands delineated via the ground-truthing work done through this study may differ from the NFEPA layers. The NFEPA assessment does, however, hold significance from a national perspective.

Table 3-4: NFEPA Wetland Classification Ranking Criteria

NFEPA Wetland Criteria	NFEPA Rank
Wetlands that intersect with a RAMSAR site.	1

NFEPA Wetland Criteria	NFEPA Rank
Wetlands within 500 m of an IUCN threatened frog point locality; Wetlands within 500 m of a threatened water bird point locality; Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes; Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.	2
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.	3
Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).	4
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.	5
Any other wetland (excluding dams).	6

Based on the aforementioned criteria, the landscape comprises of bench depression and bench flat wetlands as well as hillslope seep wetlands. The identified wetlands were all Rank 6 wetlands. Figure 3-3 shows these NFEPA wetlands in relation to the project area.

According to current outputs of the NFEPA project (Nel et al., 2011; Figure 3-4), the sub-quaternary catchment associated with the Klein-Komati River was defined as a FEPA catchment. These catchments help to achieve national biodiversity targets, as the ecological condition of the associated systems are currently regarded as being in a good condition (A or B ecological category) and as such, these catchments and adjacent areas should be managed in a way that maintains their ecological condition, so as to conserve freshwater ecosystems and protect water resources for sustainable human use (Nel et al., 2011).

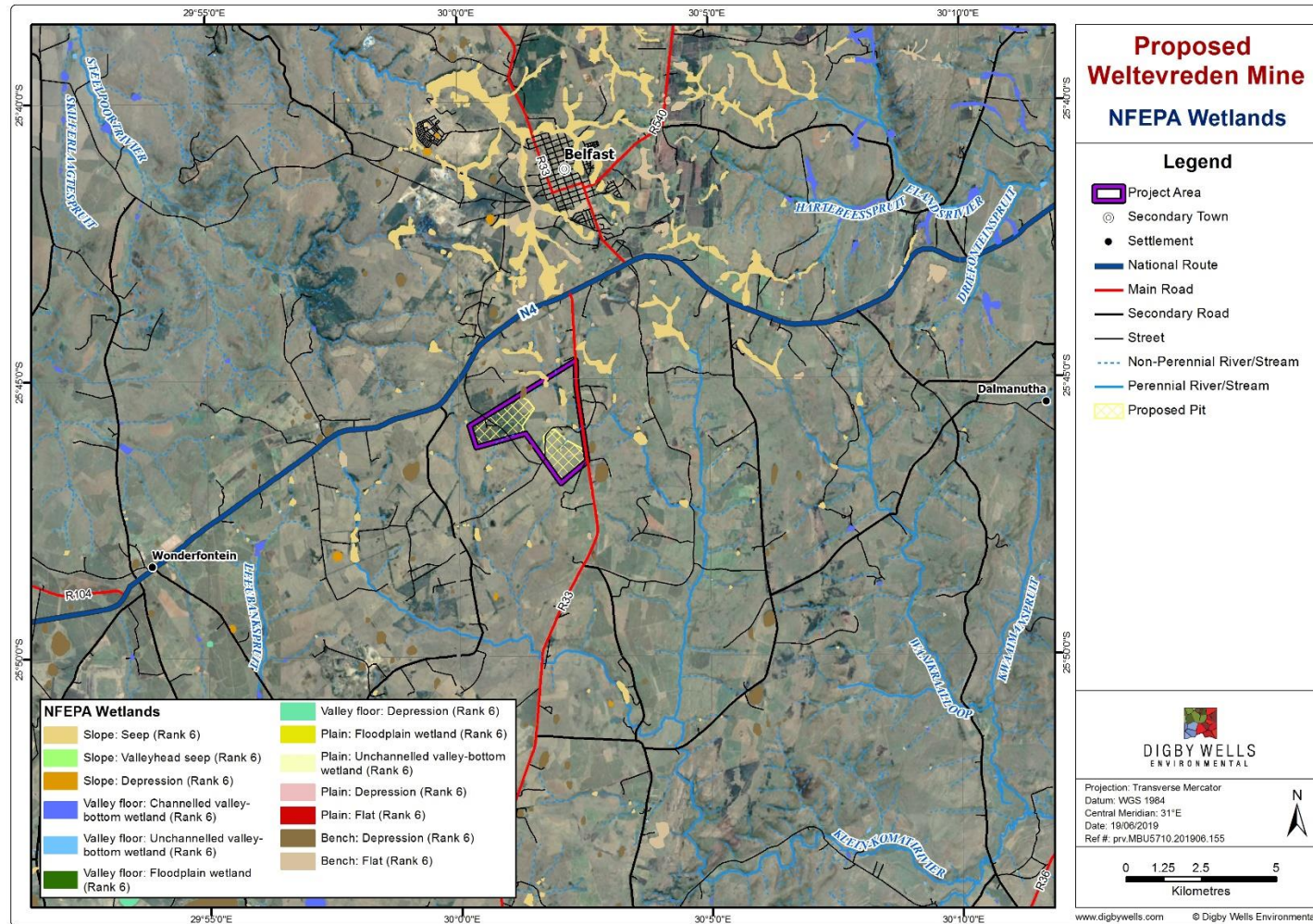


Figure 3-3: NFEPA Wetlands

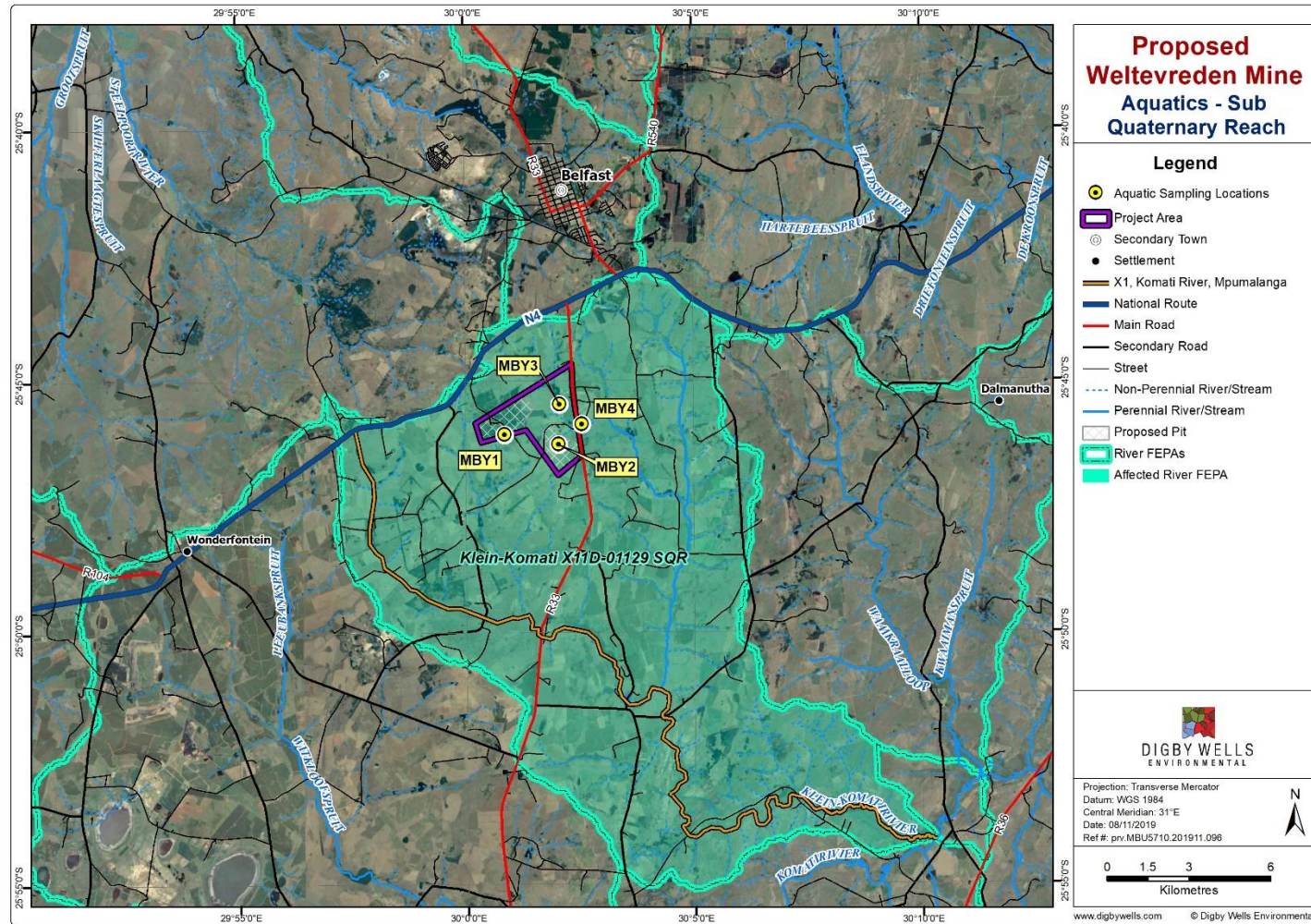


Figure 3-4: River FEPAs

3.5.2 Mpumalanga Biodiversity Sector Plan

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land-use and development planning, environmental assessment and regulation, and natural resource management. Strategically the MBSP enables the province to:

- Implement the NEMBA, 2004 provincially, and comply with requirements of the National Biodiversity Framework, 2009 (NBF) and certain international conventions;
- Identify those areas of highest biodiversity that need to be considered in provincial planning initiatives, and
- Address threat of climate change (ecosystem-based adaptation).

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs). Wetlands in Mpumalanga Province have been extensively degraded and, in many cases, irreversibly modified and lost through a combination of inappropriate land-use practices, development and mining. Wetlands represent ecosystems of high value for delivering, managing and storing good quality water for human use, and they are vulnerable to harmful impacts. It is therefore in the interest of national water security that all wetlands are protected by law. The management objectives of these areas are summarised below (Table 3-5).

Table 3-5: Mpumalanga Biodiversity Sector Plan Categories

Map category	Definition	Desired management objectives
PA	Those areas that are proclaimed as protected areas under national or provincial legislation, including gazetted protected environments.	Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.
CBAs	Areas that are required to meet biodiversity targets, for species, ecosystems or ecological processes. CBA Wetlands are those that have been identified as FEPA wetlands that are important for meeting biodiversity targets for freshwater ecosystems.	Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.

Map category	Definition	Desired management objectives
ESAs	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services. ESAs Wetlands are those that are non-FEPA and ESA Wetland Clusters are clusters of wetlands embedded within a largely natural landscape that function as a unit, and allow for the migration of species such as frogs and insects between individual wetlands.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorisation process that ensures the underlying biodiversity objectives are not compromised.
ONAs	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritised for biodiversity, they are still an important part of the natural ecosystem.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.
Heavily or Moderately Modified Areas	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritised for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximise ecological functionality and authorisation is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilised and restored where possible, especially for soil carbon and water-related functionality.

Based on these primary outputs, the project area falls predominantly within the areas classified as 'Moderately and Heavily Modified', with the 'Moderately Modified Areas' described as old lands. A fair portion of the study area is classified as 'Other Natural Areas', while the north-eastern most corner is classified as CBA irreplaceable. Further to this, a large portion land to the east of the project area is regarded as CBA irreplaceable (Figure 3-5).

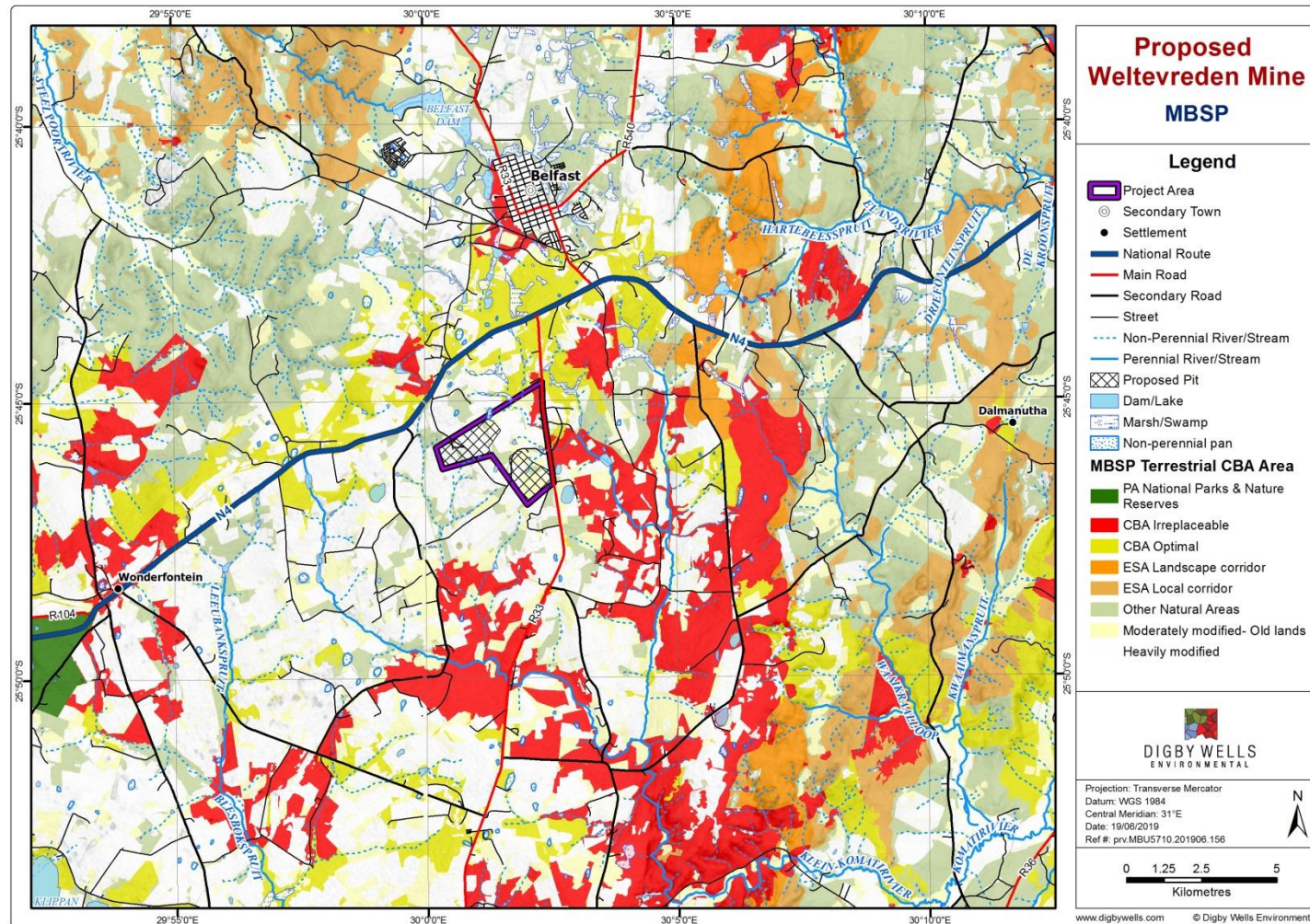


Figure 3-5: Mpumalanga Biodiversity Sector Plan (MBSP)

3.5.3 Mining and Biodiversity Guideline

The Mining and Biodiversity Guideline was developed collaboratively by the South African Biodiversity Institute (SANBI), the Department of Environmental Affairs (DEA), the Department of Mineral Resources (DMR), the Chamber of Mines and the South African Mining and Biodiversity Forum in 2013. The purpose of the guideline was to provide the mining sector with a manual to integrate biodiversity into the planning process thereby encouraging informed decision-making around mining development and environmental authorisations. The aim of the guideline is to explain the value for mining companies to consider biodiversity management throughout the planning process. The guideline highlights the importance of biodiversity in managing the social, economic and environmental risk of the proposed mining project. The country has been mapped into biodiversity priority areas including the four categories listed in Table 3-6 below, each with associated risks and implications (DEA *et al.*, 2013)

Table 3-6: Mining and Biodiversity Categories (Department of Environmental Affairs *et al.*, 2013)

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

The proposed Project area is dominated by areas classified as 'Highest Biodiversity Importance - Highest Risk for Mining', with only a small portion in the vicinity of the proposed OC2 pit classified as 'Moderate Biodiversity Importance - Moderate Risk for Mining' (Figure 3-6).

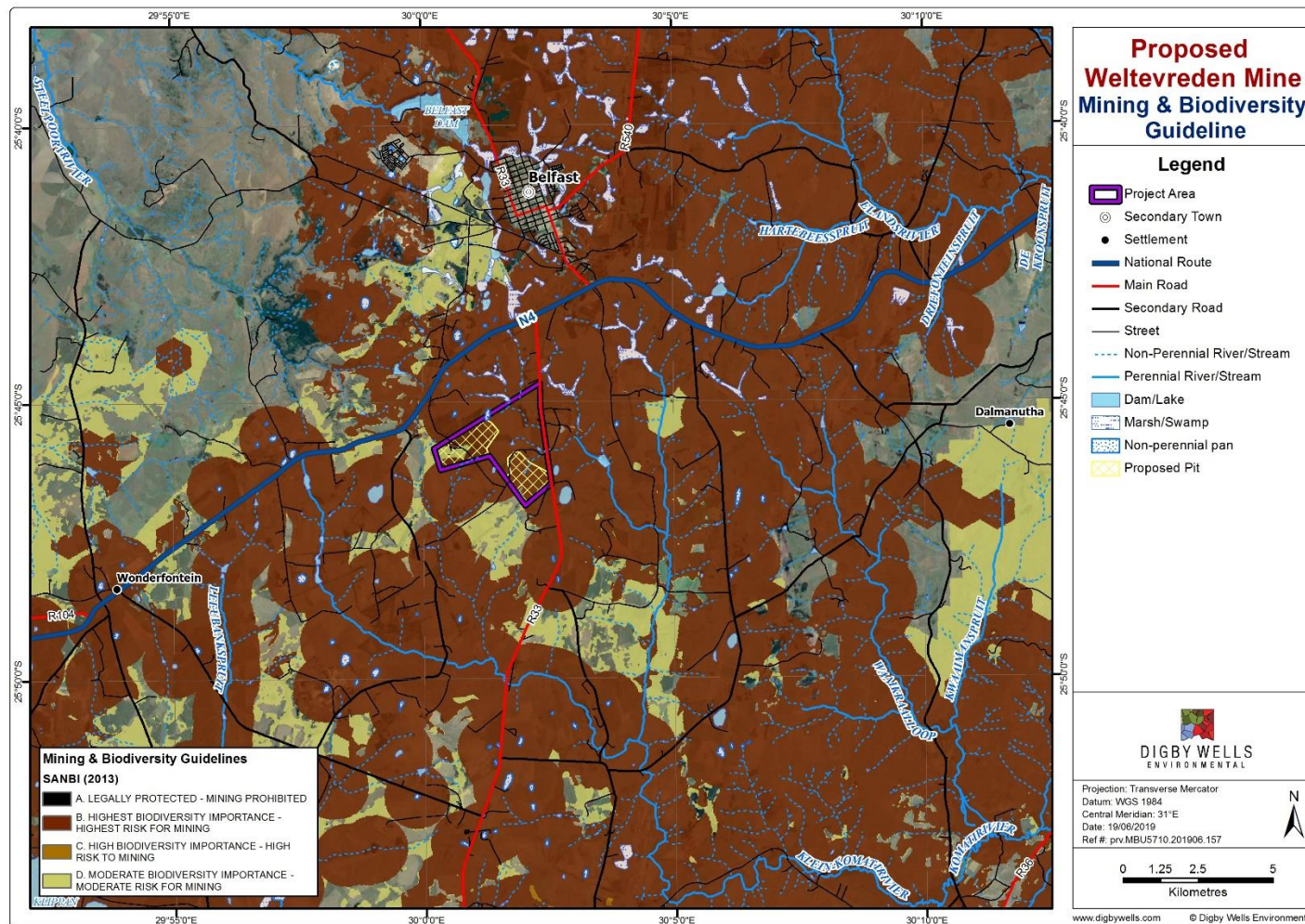


Figure 3-6: Mining and Biodiversity Guideline

4 Methodology




4.1 Wetland Ecology Assessment Approach




The following sections describe the methodology adopted during the wetland ecology field assessment.

4.1.1 The Wetland Identification and Classification

In accordance with the guidelines provided by the Department of Water and Sanitation (DWS) (formerly known as the Department of Water Affairs and Forestry (DWAF) (DWAF, 2005) wetlands are identified and classified into various hydro-geomorphic (HGM) units based on their individual characteristics. The HGM unit system of classification focuses on the hydro-geomorphic setting of wetlands which incorporates geomorphology; water movement into, through and out of the wetland; and landscape / topographic setting. Once wetlands have been identified, they are categorised into HGM units as shown in Table 4-1.

Table 4-1: Description of the various HGM Units for Wetland Classification

Hydromorphic wetland type	Diagram	Description
Floodplain		Valley bottom areas with a well-defined stream channel stream channel, gently sloped and characterised by floodplain features such as oxbow depression and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom with a channel		Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from the main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from the channel entering the wetland and also from adjacent slopes.

Hydromorphic wetland type	Diagram	Description
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterised by colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.
Isolated hillslope seepage		Slopes on hillsides that are characterised by colluvial transport (transported by gravity) movement of materials. Water inputs are from sub-surface flow and outflow either very limited or through diffuse sub-surface flow but with no direct link to a surface water channel.
Pan/Depression		A basin-shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. It is inward draining). It may also receive subsurface water. An outlet is usually absent and so this type of wetland is usually isolated from the stream network.

4.1.1.1 Soil Form Indicator

Hydromorphic soils are taken into account for the Soil Form Indicator (SFI) which will display unique characteristics resulting from prolonged and repeated water saturation (DWAF, 2005). The continued saturation of the soils results in the soils becoming anaerobic and thus resulting in a change of the chemical characteristics of the soil. Iron and manganese are two soil components which are insoluble under aerobic conditions and become soluble when the soil becomes anaerobic and thus begin to leach out into the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils.

Resulting from the prolonged anaerobic conditions, iron is dissolved out of the soil, and the soil matrix is left a greying, greenish or bluish colour, and is said to be "gleyed". Common in wetlands which are seasonally or temporarily saturated is a fluctuating water table, resulting in alternation between aerobic and anaerobic conditions in the soil (DWAF, 2005). Iron will return to an insoluble state in aerobic conditions which will result in deposits in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated (DWAF, 2005).

4.1.1.2 Soil Wetness Indicator

In practice, the Soil Wetness Indicator (SWI) is used as the primary indicator (DWAF, 2005). Hydromorphic soils are often identified by the colours of various soil components. The frequency and duration of the soil saturation periods strongly influences the colours of these

components. Grey colours become more prominent in the soil matrix the higher the duration and frequency of saturation in a soil profile (DWAF, 2005). A feature of hydromorphic soils are coloured mottles which are usually absent in permanently saturated soils and are most prominent in seasonally saturated soils, and are less abundant in temporarily saturated soils (DWAF, 2005). The hydromorphic soils must display signs of wetness within 50cm of the soil surface, as this is necessary to support hydrophytic vegetation.

4.1.1.3 Vegetation Indicator

Plant communities undergo distinct changes in species composition along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas. Valuable information for determining the wetland boundary and wetness zone is derived from the change in species composition. A supplementary method for employing vegetation as an indicator is to use the broad classification of the wetland plants according to their occurrence in the wetlands and wetness zones (DWAF, 2005). This is summarised in Table 4-2 below. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2005). Areas where soils are a poor indicator (black clay, vertic soils), vegetation (as well as topographical setting) is relied on to a greater extent and the use of the wetland species classification as per Table 4-2 becomes more important. If vegetation was to be used as a primary indicator, undisturbed conditions and expert knowledge are required (DWAF, 2005). Due to this uncertainty, greater emphasis is often placed on the SWI to delineate wetland areas. In this assessment, where possible, the SWI has been relied upon to delineate wetland areas due to the high level of anthropogenic impacts characterising the wetlands and freshwater resources of the general area. The identification of indicator vegetation species and the use of plant community structures have been used to validate these boundaries.

Table 4-2: Classification of Plant Species According to Occurrence in Wetlands

Type	Description
Obligate Wetland species (OW)	Almost always grow in wetlands: >99% of occurrences.
Facultative Wetland species (FW)	Usually grow in wetlands but occasionally are found in non-wetland areas: 67 – 99 % of occurrences.
Facultative species (F)	Are equally likely to grow in wetlands and non-wetland areas: 34 – 66% of occurrences.
Facultative dry-land species (FD)	Usually grow in non-wetland areas but sometimes grow in wetlands: 1 – 34% of occurrences.

(Source: DWAF, 2005)

4.1.2 Wetland Ecological Health Assessment (WET-Health)

According to Macfarlane, Kotze, & Ellery (2009) the health of a wetland can be defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. A level 1 WET-Health assessment was done on the wetlands in accordance with the method described by (Macfarlane *et al.*, 2009) to determine the integrity (health) of the characterised HGM units for the study area. Level 1 was selected due to the large size of the study area. A Present Ecological State (PES) analysis was conducted to establish baseline integrity (health) for the associated wetlands. The health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions.

Central to WET-Health is the characterisation of HGM units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described above.

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 State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and PES categories are provided in Table 4-3 (Macfarlane *et al.*, 2009).

Table 4-3: Impact Scores and Present Ecological State Categories used by WET-Health

Impact Category	Description	Combined Impact Score	PES Category
None	Unmodified, natural.	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	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.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E

Impact Category	Description	Combined Impact Score	PES Category
Critical	Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

As is the case with the PES, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 4-4) (Macfarlane *et al.*, 2009).

Table 4-4: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

4.1.3 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term.

The methodology outlined in Rountree, Malan, & Weston (2013) was used for this study. In this method there are three suites of importance criteria; namely:

- **Ecological Importance and Sensitivity:** incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- **Hydro-functional Importance:** which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland or freshwater resource may provide; and
- **Importance in terms of Basic Human Benefits:** this suite of criteria considers the subsistence uses and cultural benefits of the wetland or freshwater system.

These determinants are assessed for the wetlands and the freshwater resources present on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. It is recommended that the highest of these three suites of scores be used to determine the overall Importance and Sensitivity category of the wetland or freshwater system, as defined in (Table 4-5) (Rountree et al., 2013).

Table 4-5: Interpretation of overall Ecological Importance and Sensitivity (EIS) Scores for biotic and habitat determinants

Ecological Importance and Sensitivity Category (EIS)	Range of Scores
Very high	>3 and ≤4
Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	
High	>2 and ≤3
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	
Moderate	>1 and ≤2

Ecological Importance and Sensitivity Category (EIS)	Range of Scores
Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	
Low/marginal	
Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1

4.2 Aquatic Ecology Assessment Approach

The following sections describe the methodology that was adopted during the aquatic (instream) ecology field assessment.

To enable an adequate description and the determination of the PES associated with the surrounding watercourses, it was envisaged that the following indicators be evaluated as part of the study:

- Stressor Indicators:
 - *In situ* water quality (Temperature, pH, Electrical Conductivity, and Dissolved Oxygen);
- Habitat Indicators:
 - Adapted Invertebrate Habitat Assessment System (IHAS, Version 2.2).
- Response Indicators:
 - Aquatic macroinvertebrates with the use of the South African Scoring System (SASS, Version 5) rapid bio-assessment protocol and the Macro-Invertebrate Response Assessment Index (MIRAI, Version 2);

4.2.1 Water Quality Parameters

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

4.2.2 Integrated Habitat Assessment System (IHAS), Version 2.2

Assessment of the available habitat for aquatic macroinvertebrate colonization at each of the sampling sites is vital for the correct interpretation of results obtained following biological

assessments. It should be noted that the available methods for determining habitat quality are not specific to rapid biomonitoring assessments and are inherently too variable in their approach to achieve consistency amongst users.

Nevertheless, the Integrated Habitat Assessment System (IHAS) has routinely been used in conjunction with the South African Scoring System version 5 (SASS5) as a measure of the variability of aquatic macroinvertebrate biotopes available at the time of the survey (McMillan, 1998). The scoring system was traditionally split into two sections, namely the sampling habitat (comprising 55% of the total score) and the general stream characteristics (comprising 45% of the total score), which were summed together to provide a percentage and then categorized according to the values in Table 4-6.

However, the lack of reliability and evidence of notable variability within the application of the IHAS method has prompted further field validation and testing, which implies a cautious interpretation of results obtained until these studies have been conducted (Ollis, Boucher, Dallas, & Esler, 2006). In the interim and for the purpose of this assessment, the IHAS method was adapted by excluding the assessment of the *general stream characteristics*, which resulted in the calculation of a percentage score out of 55 that was then categorised by the aforementioned table.

Table 4-6: Adapted IHAS Scores and associated description of available aquatic macroinvertebrate habitat

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

4.2.3 South African Scoring System, Version 5 (SASS5)

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

SASS5 is essentially a biological assessment index which determines the health of a river based on the aquatic macroinvertebrates collected on-site, whereby each taxon is allocated a score based on its perceived sensitivity/tolerance to environmental perturbations (Dallas,

1997). However, the method relies on a standardised sampling technique using a handheld net (300 mm x 300 mm, 1000 micron mesh size) within each of the various habitats available for standardised sampling times and/or areas. Niche habitats (or biotopes) sampled during SASS5 application include:

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

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

4.2.4 Macroinvertebrate Response Assessment Index

In order to determine the Present Ecological State (PES; or Ecological Category) of the aquatic macroinvertebrates collected/observed, the SASS5 data is used as a basic input (i.e. prevalence and abundance) into the recently improved Macroinvertebrate Response Assessment Index (MIRAI) (Version 2, Thirion. C., *pers. comm.*, 2015). This biological index integrates the ecological requirements of the macroinvertebrate taxa in a community (or assemblage) and their response to flow modification, habitat change, water quality impairment and/or seasonality (C. Thirion, 2008). The presence and abundance of aquatic macroinvertebrates are compared to a derived list of families/taxa that are expected to be present under natural, un-impacted conditions. Consequently, the aforementioned metric groups were combined within the model to derive the ecological condition of the site in terms of aquatic macroinvertebrates (Table 4-7).

Table 4-7: Allocation protocol for the determination of the Present Ecological State for aquatic macroinvertebrates following application of the MIRAI

MIRAI (%)	Ecological Category	Description
90-100	A	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	B	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	C	Moderately modified. Community structure and function are less than the reference condition. Community composition is lower than expected due to

MIRAI (%)	Ecological Category	Description
		loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	D	Largely modified. Fewer species present than expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	E	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	F	Critically modified. Few species present. Only tolerant species present, if any.

4.2.1 Fish Response Assessment Index (FRAI)

The FRAI (Kleynhans, 2007) is based on the premise that “drivers” (environmental conditions) may cause fish stress which shall then manifest as changes in fish species assemblage. The index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions. Intolerances and preferences are divided into metric groups relating to preferences and requirements of individual species. This allows cause-effect relationships to be understood, i.e. between drivers and responses of the fish assemblage to changes in drivers. These metric groups are subsequently ranked, rated and finally integrated as a fish Ecological Category (EC) (Table 4-8 and Figure 4-1).

Table 4-8: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

(Source: Kleynhans, 1999)



Figure 4-1: Ecological categories (EC) eco-status A to F continuum approach employed

The fish community of each site was sampled for a period of 15 minutes by means of a battery operated electro-fishing device and cast netting. Fish species identified were compared to those expected to be present at the site, which were compiled from a literature survey including Skelton (2001) and Kleynhans (2007).

4.3 Impact Assessment Methodology

Details of the impact assessment methodology used to determine the significance of potential impacts associated with the project are provided below.

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

$$\text{Significance} = \text{Consequence} \times \text{Probability} \times \text{Nature}$$

Where

$$\text{Consequence} = \text{Intensity} + \text{Extent} + \text{Duration}$$

And

$$\text{Probability} = \text{Likelihood of an impact occurring}$$

And

$$\text{Nature} = \text{Positive (+1) or negative (-1) impact}$$

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

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 4-9. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 4-10 which is extracted from Table 4-9. The description of the significance ratings is discussed in Table 4-11.

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

Table 4-9: Impact Assessment Parameter Ratings

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	<u>International</u> The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	<u>National</u> Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	<u>Province/ Region</u> Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	<u>Municipal Area</u> Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	<u>Local</u> Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	<u>Limited</u> Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	<u>Very limited/Isolated</u> Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 4-10: Probability/Consequence Matrix

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

Table 4-11: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the project. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe effects	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative)

5 Results and Discussion

A site visit was conducted in April 2019 (24th – 26th April 2019) to assess the aquatic ecological integrity, to delineate the wetlands within the project area and determine their PES and EIS values. This report includes a consolidation of the aforementioned assessments, along with the potential impacts the proposed Weltevreden Project will have on the freshwater ecology (i.e. the aquatic and wetland systems) of the area.

5.1 Wetland Ecology Assessment

5.1.1 Wetland Delineation and Classification

450.43 ha of wetland areas were identified within the proposed project area and its associated 500 m zone of regulation with 225.89 ha within the proposed project area, of which 94.86 ha are affected by the proposed OC1 and OC2 pits and the proposed surface infrastructure. Thirty HGM units were identified and categorized based on terrain units. These included pans, hillslope seeps, unchannelled valley bottoms and channelled valley bottoms. Table 5-1 indicates the extent of the various HGM types within the proposed project area. Figure 5-1 indicates the location of each in relation to the surrounding landscape.

Table 5-1: HGM Units within the proposed Project area within 500m zone of regulation

HGM unit name	HGM unit type	Area (Ha)
1	Unchannelled valley bottom	1.33
2	Unchannelled valley bottom	16.23
3	Hillslope seep	1.97
4	Hillslope seep	0.74
5	Unchannelled valley bottom	4.46
6	Unchannelled valley bottom	9.43
7	Unchannelled valley bottom	4.68
8	Hillslope seep	34.74
9	Pan	9.49
10	Unchannelled valley bottom	1.89
11	Hillslope seep	11.31
12	Unchannelled valley bottom	4.63
13	Pan	0.65
14	Pan	12.92
15	Pan	8.79
16	Unchannelled valley bottom	96.65

HGM unit name	HGM unit type	Area (Ha)
17	Hillslope seep	22.83
18	Unchannelled valley bottom	23.35
19	Unchannelled valley bottom	34.35
20	Hillslope seep	58.65
21	Channelled valley bottom	7.33
22	Hillslope seep	3.58
23	Pan	10.46
24	Pan	2.83
25	Hillslope seep	16.86
26	Hillslope seep	5.35
27	Unchannelled valley bottom	12.63
28	Hillslope seep	20.32
29	Hillslope seep	4.91
30	Unchannelled valley bottom	7.05
TOTAL		450.43

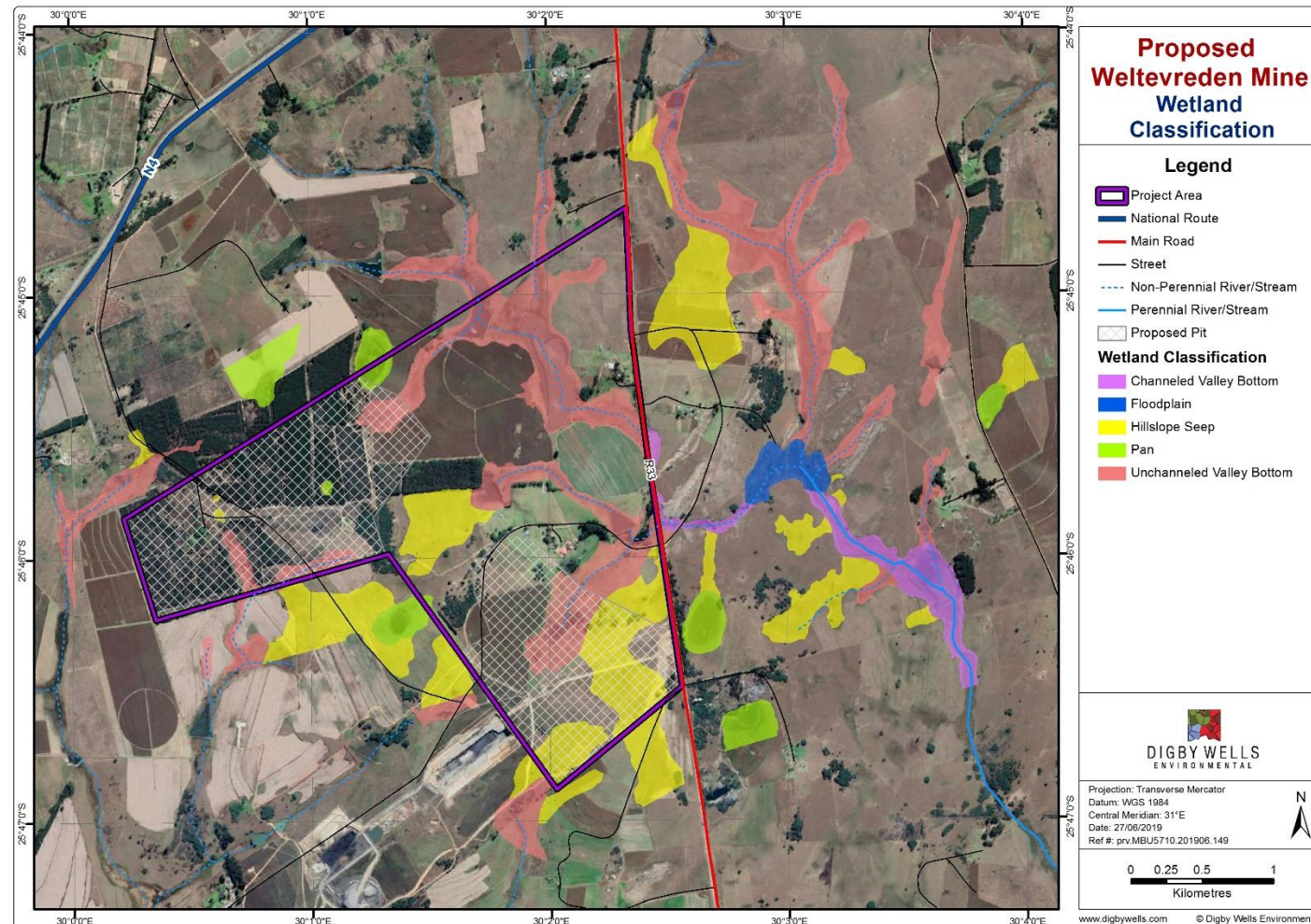


Figure 5-1: Wetland Delineation

5.1.2 Terrain Indicator and Geohydrology

The terrain unit indicator was used extensively in the identification of wetlands and their various HGM units. Use was made of topographical maps and five-meter contours in the preliminary identification of wetland areas. Further to this, the underlying geology and geohydrology of the area was investigated to gain a greater understanding of the potential movement of subsurface water and potential areas of daylighting.

The proposed project area is situated along the northern boundary of the Karoo basin where the major lithostratigraphic units of the Karoo Supergroup crop out. The major formation underlying the proposed project area is the Vryheid Formation (largely of course-grained sandstone, siltstone, shale and coal seams, with dolerite intrusives) and pre-Karoo rocks of the Dwyka and Lakenvlei Formations (diabase (to the north) and quartzite (to the east); Johnson et. al, 2006; Digby Wells, 2019a).

According to the Geohydrological Study (Digby Wells, 2019a), some of the identified wetlands are associated with changes in geology. East of the proposed mining areas quartzites of the pre-Karoo Lakenvlei Formation are close to surface in a low-lying area where the overlying Vryheid Formation has been eroded away. HGM units 19 and 20, associated with this outcrop, indicates the low aquifer potential of the underlying quartzite which is likely causing the local accumulation of water in this area which is then discharged into the associated stream that flows in a general south-south-eastern direction. HGM unit 16, just north of the site, is likely associated with an intruded sill. Other HGM units are related to Karoo sediments and were indicated to be related to hillslope seepages and unchannelled valley bottoms.

Finally, according to the Geohydrological Study (Digby Wells, 2019a), the presence of an upper weathered aquifer (one of three types identified within the project area) has the potential to support the formation of perched aquifers on top of fresh bedrock, as was observed in the vicinity of HGM units 20, 21 and 22.

Large areas of ferricrete layers were observed that retarded water ingress and led to widespread saturated soil conditions.

5.1.3 Vegetation Indicator

Vegetation structures of the various wetlands and their respective HGM units were relatively variable. Large portions of the natural vegetation structures had been historically altered due to the predominant surrounding land-use activities. These included plantations, areas of land cleared for crops and use of the land for grazing and pastures.

Wetland plant species used in the identification and delineation of the various HGM units observed included the following:

- Obligate wetland species – *Agrostis lachnantha*, *Leersia hexandra*, *Phragmites australis*, *Paspalum distichum*;
- Facultative wetland species – *Andropogon eucomis*, *Hemarrthria altissima*, *Hyparrhenia tamba*, *Paspalum urvillei*;

- Seasonal wetland species – *Setaria sphacelata*; *Aristida junciformis*, *Themeda triandra*, *Eragrostis gummiflua*;
- Temporary wetland species – *Imperata cylindrica*; *Paspalum dilatatum*; and
- Mostly wetland dependant species – *Typha capensis*, *Juncus* sp., *Cyperus* sp., *Persecaria* sp.

Plantations were dominated by *Eucalyptus grandis* and some other areas were dominated by *Pinus patula*. Isolated areas of *Acacia mearnsii* were also observed. It is regarded as likely that these areas may have resulted in serious modifications to historically wet or moist grasslands, valley bottoms, pans and hillslope seeps, thus influencing the wetland delineation at these points.

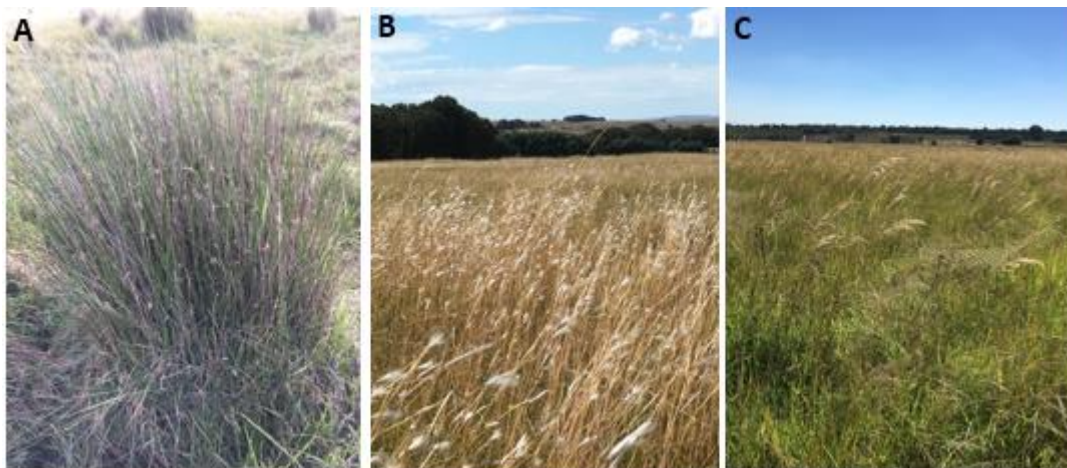


Figure 5-2: Wetland vegetation - A: *Juncus effuses*; B: *Andropogon eucomis*; C: *Agrostis lachnantha*

5.1.4 Soil indicator

Soil indicators such as soil types as well as indicators of soil wetness, such as mottling and gleying of soils, were used extensively throughout the proposed project area. It should be noted that the use of mottling as an indicator within the proposed project area was complicated in the areas where ferricrete was observed, as ferricrete is characterised by a layer of iron mottles not indicative of a fluctuating water table.

According to the Soil Study (Earth Science Solutions, 2019), the dominant soil forms encountered during the site investigation include those of the orthic phase Hutton, Clovelly, Griffin and the shallower Mispah and Glenrosa, with sub dominant forms that include the Glencoe and Dresden forms. In addition, and of importance to the area in question, is the significantly large proportion of the area that comprises wet based soils. These hydromorphic form soils are extremely prevalent and of significance to the overall site sensitivity analysis. The low angled topographic slopes and resulting wide expansive drainage lines coupled with the presence of restrictive sedimentary layers (sandstone predominantly), have resulted in proportionately much larger areas of transition zone moist grasslands and wet based soils that meet the wetland classification both pedologically as well as ecologically.

The hydromorphic soils range from extremes of deep Avalon, Bloemdal, Glencoe and Pinedene forms on the transition zone slopes, and shallow Avalon, Westleigh, Longlands and Katspruit Forms associated with the lower slopes and lower midslopes, to structured and gleyed soil forms (Katspruit) associated with the alluvial floodplains (Earth Science Solutions, 2019).

The Avalon and Glencoe soils are comprised of orthic topsoil layers, overlaying yellow-brown apedal soils, which in turn overlay soft plinthic and hard plinthic horizons, respectively, while the Bloemdal soils are comprised of orthic topsoil, overlaying red apedal subsoils, in turn overlaying a gleyic horizon (ARC-Institute for soil, 2018). These soils were observed on the transition wetland zones throughout the proposed project area.

Katspruit soil types are comprised of an orthic topsoil horizon and a gley subsoil horizon (ARC-Institute for soil, 2018). These soils are generally subjected to long durations of saturation with stagnant and reduced water and are generally indicative of the permanent zones in wetlands as were observed in HGM units 18 and 19.

Longlands soils types, comprised of an orthic topsoil horizon and an albic subsoil horizon overlaying soft plinthic, were restricted to HGM unit 5. Longlands soils are regarded as wetlands soils (Gary Patterson, pers. communication, 2018), with bleached coloration characteristic of the albic horizon due to lateral movement of water and changes in the oxidation state of iron minerals and from reduction (ARC-Institute for soil, 2018).

Westleigh soils were observed in the northern portion of HGM unit 16. This soil is comprised of an orthic topsoil horizon, with a soft-plinthic subsoil horizon and is categorised by the prominent extent of vesicular and randomly distributed mottling due to periods of saturation with water (ARC-Institute for soil, 2018).

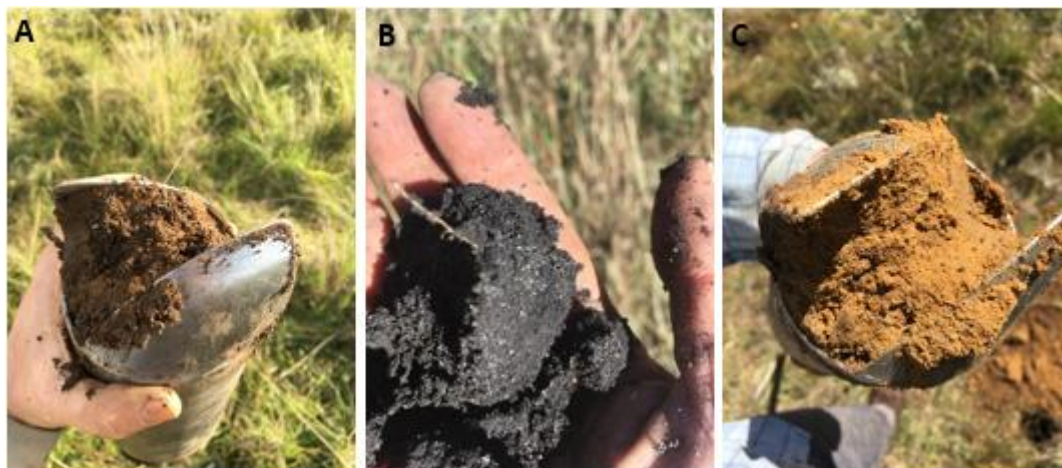


Figure 5-3: Selected examples of soil forms and indicators observed within the proposed project area – A: Soft plinthic with mottles; B: Katspruit orthic; C: Yellow-brown apedal with mottles

5.1.5 Wetland Health and Integrity (Wet-Health)

The health and integrity of each of the HGM units observed within the proposed project area and its 500 m zone of regulation was assessed at the time of the field assessment. The wetlands in the vicinity of the proposed project area have been subject to various impacts, the most significant impacts related to agropastoral activities and plantations.

HGM units 2, 3, 4, 5, 6, 13, 14, 15, the north-eastern portion of 16, and 17, on the north-eastern portion of the proposed project area and in the vicinity of the proposed OC2 pit, have all been impacted hydrologically due to loss of water supply related to plantations within their respective catchment areas. In many instances, this has resulted in geomorphological changes and impacts to the vegetation integrity due to moisture stress and the onset of erosion and loss of carbon storage capability.

Agricultural activities have impacted HGM units 1, 8, 10, 12, 14, 16, 18, 25, 26, 27, 28, 29 and 30 to varying degrees both directly and indirectly due to removal of natural vegetation for planting of crops, loss of surface roughness, increased sediment loads. Pastoral and grazing activities were observed in HGM units 17, 18 and 19, which has resulted in impacts related to trampling and loss of biodiversity due to preferential grazing habits.

Large dams and impoundments were observed in HGM units 16, 18 and 19.

Mining activities of a neighbouring mining company in the south-eastern portion of the proposed project area have resulted in impacts to HGM units 20, 25 and 26 due to excavation activities, the construction of an access road, vegetation removal, digging of trenches, etc. resulting in loss of water supply, sedimentation and erosion, impacts to the geohydrology and loss of biodiversity.

Alien and invasive vegetation encroachment has resulted in alterations to the soils, loss of carbon retention and loss of biodiversity and, finally, linear infrastructures throughout the proposed project area have resulted in the fragmentation of the freshwater systems through compaction of soils and inadequately installed culverts and drainage structures.

The results of the WET-Health assessment are summarised in section 5.1.7 and indicated in Figure 5-4.

5.1.6 Ecological Importance and Sensitivity

The ecological importance and sensitivity (EIS) of the various HGM units were regarded as largely dependent on their respective locations in the landscape, the surrounding landscape uses and activities and the HGM unit type. The level of resilience and the anthropogenic impacts affecting each HGM unit was also considered.

The majority wetlands present within the proposed project area and its 500 m zone of regulation were regarded as of *moderate* ecological importance and sensitivity, except for HGM units 5, 16, 18, 19 and 30, which were regarded as *high*, and 10, which was regarded as *low*.

HGM units 5, 16, 18, 19 and 30 were regarded as important for the maintenance of biodiversity as well as for streamflow regulation and flood attenuation.

The results of the EIS are summarized in section 5.1.7 and represented graphically in Figure 5-5.

5.1.7 Results summary

Table 5-2: Summary of results for the various HGM units within the proposed project area and within the 500 m zone of regulation

HGM unit name	HGM unit type	WET-Health	EIS
1	Unchannelled valley bottom	C (3.22)	Moderate (1.5)
2	Unchannelled valley bottom	D (5.19)	Moderate (1.8)
3	Hillslope seep	C (3.57)	Moderate (1.4)
4	Hillslope seep	C (3.39)	Moderate (1.4)
5	Unchannelled valley bottom	C (3.96)	High (2.3)
6	Unchannelled valley bottom	D (4.86)	Moderate (1.3)
7	Unchannelled valley bottom	C (2.83)	Moderate (1.5)
8	Hillslope seep	C (3.27)	Moderate (1.6)
9	Pan	B (1.97)	Moderate (1.7)
10	Unchannelled valley bottom	D (4.71)	Low (0.8)
11	Hillslope seep	C (3.27)	Moderate (1.6)
12	Unchannelled valley bottom	D (4.54)	Moderate (1.6)
13	Pan	D (4.97)	Moderate (1.7)
14	Pan	D (5.23)	Moderate (1.7)
15	Pan	C (3.26)	Moderate (1.7)
16	Unchannelled valley bottom	D (4.91)	High (2.2)
17	Hillslope seep	C (3.24)	Moderate (1.4)
18	Unchannelled valley bottom	D (4.96)	High (2.2)
19	Unchannelled valley bottom	C (3.89)	High (2.2)
20	Hillslope seep	C (2.12)	Moderate (1.8)
21	Channelled valley bottom	C (3.11)	Moderate (1.5)
22	Hillslope seep	A (0.71)	Moderate (1.7)
23	Pan	B (1.97)	Moderate (1.8)
24	Pan	B (1.92)	Moderate (1.7)

HGM unit name	HGM unit type	WET-Health	EIS
25	Hillslope seep	C (2.16)	Moderate (1.6)
26	Hillslope seep	C (2.96)	Moderate (1.6)
27	Unchannelled valley bottom	C (3.11)	Moderate (1.6)
28	Hillslope seep	C (3.53)	Moderate (1.6)
29	Hillslope seep	C (3.41)	Moderate (1.6)
30	Unchannelled valley bottom	C (2.7)	High (2.2)

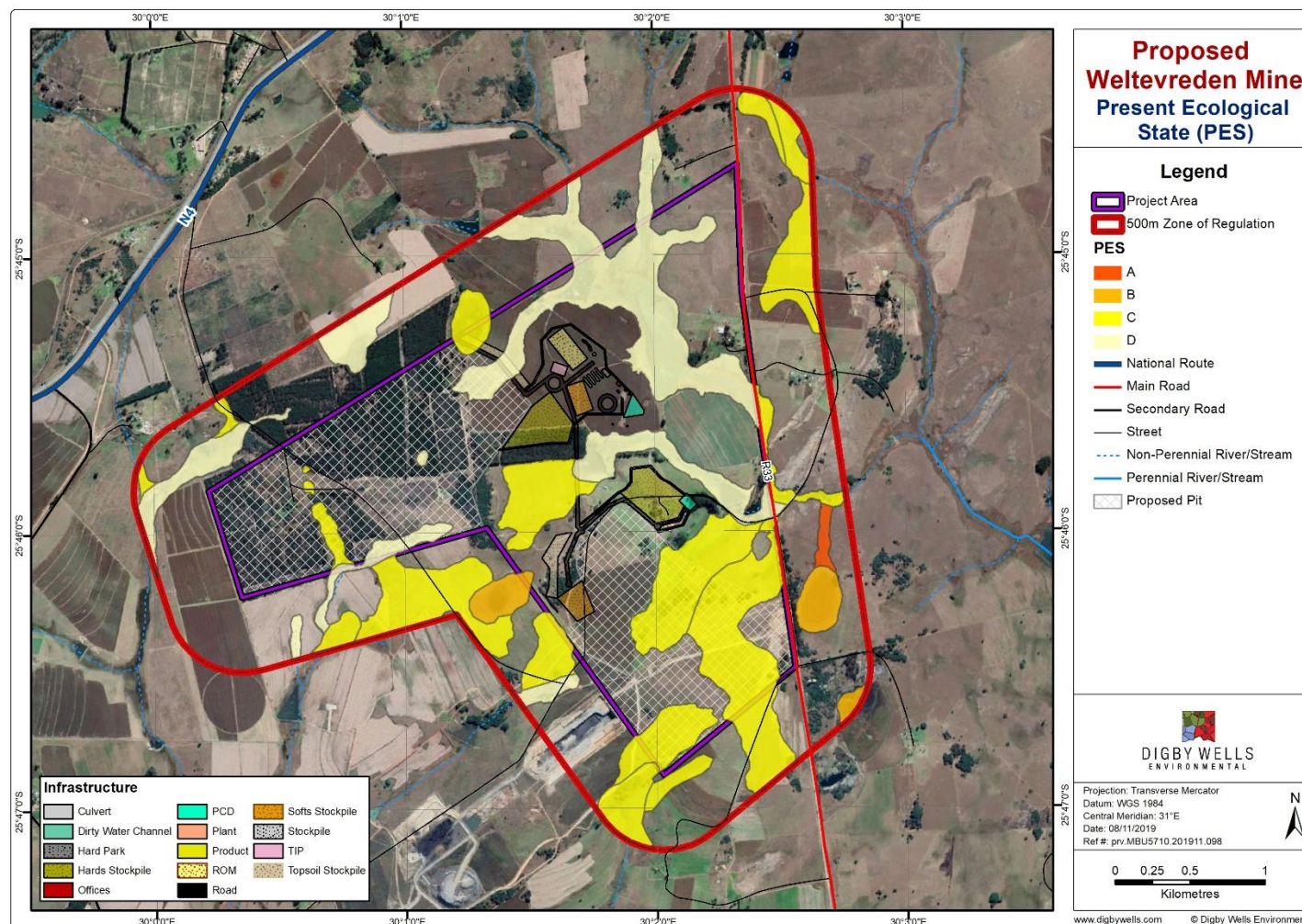


Figure 5-4: Wetland Present Ecological State

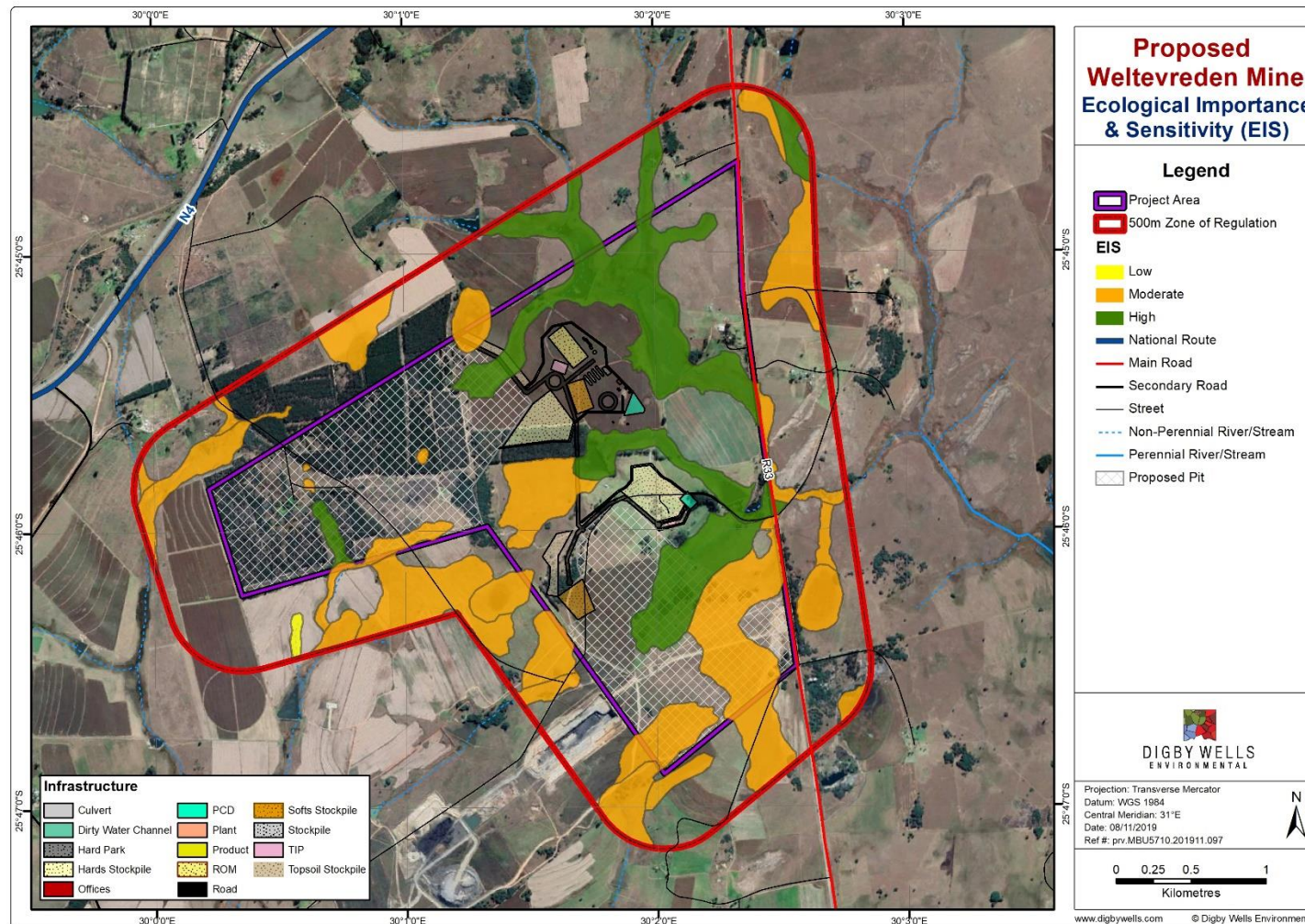


Figure 5-5: Ecological Importance and Sensitivity

The wetland assessment carried out in April 2019 revealed the presence of thirty HGM units within the proposed project area and its 500 m zone of regulation.

The HGM unit types observed within the proposed project area included: pans, hillslope seeps, channelled and unchannelled valley bottom systems. These HGM units were categorized largely on topography and their respective locations within the landscape and verified during the field assessment.

The health and integrity of each of the HGM units present varied considerably, with anthropogenic disturbances being the most significant driver of change to date. These disturbances were related largely to plantations, agropastoral activities and linear infrastructures traversing the proposed project area, with an isolated portion in the south-east of the proposed project area affected by mining activities.

Importance services related to the maintenance of biodiversity, streamflow regulation, flood attenuation, sediment trapping, assimilation of nutrients and toxicants and water supply were noted.

5.2 Sensitivity mapping

As discussed in sections 5.1.2 and 5.1.4, the results of the Groundwater Study and the Soils Study (Digby Wells, 2019a; Earth Science Solutions, 2019), the water table within the proposed project area is relatively shallow due to the presence of a shallow weathered aquifer and this, along with the expansive transitional soil types observed, has given rise to numerous pan systems and extensive hillslope seepage areas, which in turn, feed and supply water to the valley bottom wetlands observed within the proposed project area and its 500 m zone of regulation, with special mention of HGM units 16, 18, 19, 21 and 30 (i.e. the wetlands displaying the highest ecological integrity as well as ecological importance and sensitivity).

The proposed OC2 pit will result in the direct destruction of HGM units 4, 5, 6, 13, and portions of HGM units 15, 16 and 17. The proposed OC1 pit will result in the direct destruction of a portion of HGM unit 19, and HGM units 20, and 25. HGM units 5, 6, 16, 17, 19, 20 and 25 are important hillslope seepage and valley bottom wetland systems supplying water to the downstream wetland and aquatic ecology and the destruction of these systems is likely to have both a direct and indirect impacts to the downstream ecology in terms of impacts to water quality as a result of decant (Digby Wells, 2019a) as well as due to loss of water supply.

For this reason, a 100 m buffer, in line with the 100 m zone of regulation triggered by GN 704 is not regarded as suitable protection for the wetland systems present, with special mention of the downstream preservation of the ecological integrity of the Klein Komati River, which forms part of a FEPA river catchment. Further to this, due to the short-comings of the Buffer tool described by Macfarlane & Bredin (2017), the tool is not deemed suitable for application to open pit mining activities and it is highly recommended that a hydro-pedological assessment be carried out for the determination of suitable buffers should the proposed mining activities be approved.

5.3 Aquatic Ecological Assessment

5.3.1 Site Selection

Co-ordinates of the sampling sites (Table 5-3) utilised during this investigation were determined using a Garmin Global Positioning (GPS) device and are presented graphically in Figure 5-6. Table 5-4 provides a brief description of the characteristics observed at each of the assessment sites, accompanied by a photograph of each.

Table 5-3: Location and description of the aquatic sampling sites assessed

Site	Co-Ordinates	Description
MBY1	25°45'52.75"S 30°02'33.43"E	A small stream located to the east of the proposed project area and the R33 on the Farm Weltevreden 381 (portion RE/3/381).
MBY2	25°46'16.42"S 30°02'02.62"E	An artificial impoundment located within a valley bottom wetland (HGM unit 19) on the south-eastern portion of the Farm Weltevreden 381 (portion RE/3/381).
MBY3	25°45'28.83"S 30°02'04.13"E	An artificial impoundment located within a valley bottom wetland (HGM unit 16) on the central portion of the Farm Weltevreden 381 (portion RE/3/381).
MBY4	25°46'04.70"S 30°00'51.65"E	An artificial impoundment located on the Farm Weltevreden 381 (portion 9/381).

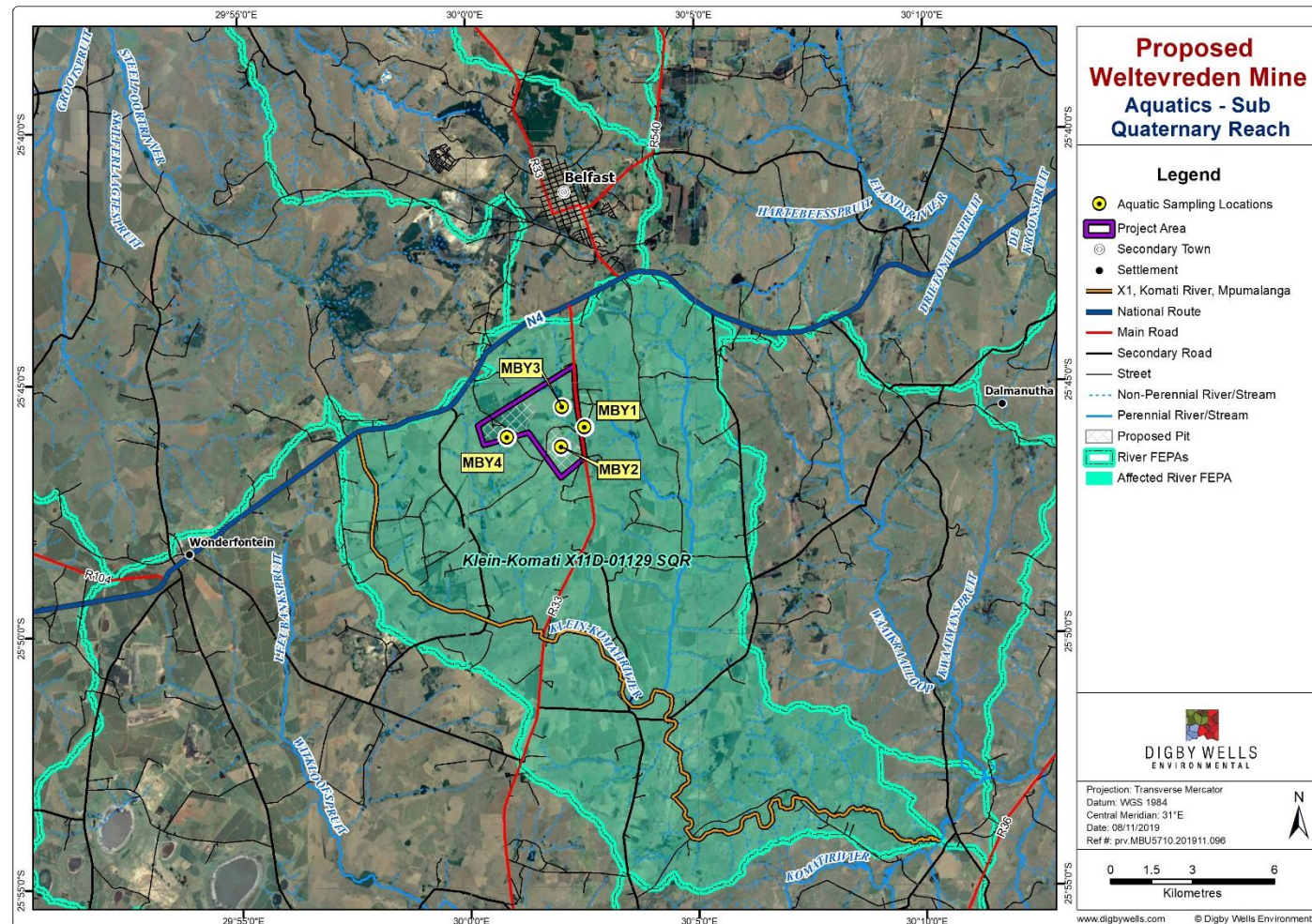






Figure 5-6: Aquatic sampling sites

Table 5-4: Visual assessment and site characteristics

Sampling site	Attributes		Photographs
MBY1	Substrate	Mud and sand deposits, and instream and marginal vegetation. Isolated algal proliferation.	
	Depth profiles	Shallow, approx. 0.5m deep	
	Flow condition	Slow	
	Riparian zone characteristics	Very well vegetated grasslands and sedges	
	Water clarity and odour	Discoloured, no odour	
MBY2	Substrate	Mud, marginal and aquatic vegetation	
	Depth profiles	0.5m – 1.0m	
	Flow condition	Standing/still	
	Riparian zone characteristics	Grasslands and sedges	
	Water clarity and odour	Clear, no odour	

Sampling site	Attributes		Photographs
MBY3	Substrate	Mud deposits, marginal and aquatic vegetation.	
	Depth profiles	0.5m – 1.5m	
	Flow condition	Standing/still	
	Riparian zone characteristics	Grasslands and sedges	
	Water clarity and odour	Opaque, no odour	
MBY4	Substrate	Mud deposits, marginal and aquatic vegetation.	
	Depth profiles	0.5m – 1.5m	
	Flow condition	Standing/still	
	Riparian zone characteristics	Grasslands and sedges, <i>Acacia mearnsii</i> , bankside vegetation absent in some places	
	Water clarity and odour	Discoloured, no odour	

5.3.2 *In Situ* Water Quality

Table 5-5 provides the *in-situ* water quality data obtained at each of the four aquatic sampling sites.

Table 5-5: *In situ* water quality variables recorded at each of the sites assessed during the April 2019 aquatic assessment

Site	Temp. (°C)	pH	Electrical Conductivity (µS/cm)	Dissolved oxygen	
				(mg/ℓ)	(% sat)
Guideline values		6 - 8	< 500		<120-80>
MBY1	17.4	7.35	327.0	6.41	67.6
MBY2	23.3	6.73	115.4	11.56	124.9
MBY3	17.8	7.25	336.0	5.49	55.0
MBY4	19.8	5.86	74.2	7.35	77.99

Temperature ranges recorded at each of the sampling sites were regarded as natural in relation to both the diurnal and seasonal timings of each site surveyed.

Most aquatic systems within South Africa are relatively well-buffered, as a result of dissolved bicarbonate/carbonate ions originating from exposed geological formations and atmospheric deposits, and as such, most of the stereotypical systems usually exhibit close-to-neutral pH levels (i.e. pH 6-8; Department of Water Affairs and Forestry (DWAF), 1996; Dallas & Day, 2004). Thus, the pH values observed at the sites surveyed were regarded as within the natural ranges expected for a water body in South Africa. The lower value observed at site MBY4 is likely related to acidification related to the forestry activities in the vicinity of the site.

The electrical conductivity values at each of the sites, were all below the upper guideline value for a river in this section of the Klein Komati catchment. The elevated conductivity values observed may be regarded as typical of wetland systems. The lower value observed at site MBY4 is likely related to the surrounding landuse activities, with a reduced agricultural return potential at this point as this catchment area is largely related to historical forestry activities.

Dissolved oxygen saturation levels of 80-120% are considered necessary to protect all life stages of the vast majority of aquatic organisms that are endemic (or adapted) to inhabiting aerobic warm water habitats (Department of Water Affairs and Forestry, 1996). In light of this expected range, the dissolved oxygen saturation levels fell well below the accepted range, except for MBY2, where dissolved oxygen concentrations exceeded the upper limit. This observation presents an innate limitation to a diversity of habitats and flows (comprising of standing/still water bodies of variable depths throughout the proposed project area) and dissolved oxygen levels are expected to be low (Dallas & Day, 2004).

The general water quality observed within the proposed project area was thus deemed natural in consideration of the wetland nature of the systems and the surrounding agropastoral and

forestry activities.

5.3.3 Invertebrate Habitat Assessment System

The Invertebrate Habitat Assessment System (IHAS, Version 2.2), developed by McMillan (1998), has routinely been used in conjunction with the SASS5 approach as a measure of variability in the quantity and quality of representative aquatic macroinvertebrate biotopes available during sampling. The IHAS score indicates the availability and suitability of the sampled macroinvertebrate habitat at a particular site. Site MBY1 achieved a score of 27.3%, which indicates *Poor* suitability for colonisation of the site by a diversity of aquatic macroinvertebrate families. This score is largely attributed to the limited habitat diversity, with the absence of stones and/or cobbles in current, as well as limited flow.

The IHAS could, however, not be applied to sites MBY2, MBY3 or MBY4 as it is restricted to application within flowing systems and therefore, it was not deemed to be appropriate for use within these artificial impoundments sampled. These sites were dominated by mud deposits, with both marginal and aquatic vegetation and while an IHAS score cannot be allocated to these three sites, it is expected that flow dependant sensitive species will be absent from the proposed project area based on the general habitat available.

5.3.4 South African Scoring System, version 5

The application of the SASS5 Index within impoundments or valley bottom wetland systems should be interpreted with caution, as the assessment index was primarily designed to be used exclusively within flowing systems. Nevertheless, for the purpose of using a standardised sampling approach the SASS5 method was deemed suitable for the determination of the baseline macro-invertebrate community assemblages within the proposed project area.

Historical data and specialist knowledge was used to compile an expected species list for aquatic macro-invertebrates in the Klein Komati River catchment, whereby 44 macroinvertebrate taxa were identified as likely to occur within the proposed project area (Department of Water and Sanitation, 2014; Griffiths et al., 2015). Families requiring fast-flowing cobble habitat were excluded from this expected species list. In total, 30 families were observed within the proposed project area. These are indicated in Table 5-6 below.

Table 5-6: Expected and observed aquatic macroinvertebrate taxa associated with the proposed project area

Expected Species	Observed Species			
	MBY1	MBY2	MBY3	MBY4
<i>Turbellaria</i>	B	B	B	
<i>Oligochaeta</i>	A	1	1	B
<i>Hirudinea</i>		C		A
<i>Potamonautidae</i> *	A			
<i>Atyidae</i>				

Expected Species	Observed Species			
<i>Hydracarina</i>		B	B	B
<i>Baetidae spp</i>	B	1	A	B
<i>Caenidae</i>	B		B	
<i>Coenagrionidae</i>			1	B
<i>Aeshnidae</i>		1		B
<i>Lestidae</i>				
<i>Corduliidae</i>				
<i>Gomphidae</i>				
<i>Libellulidae</i>				A
<i>Belostomatidae*</i>		1		1
<i>Corixidae*</i>	B	C	B	B
<i>Gerridae*</i>			1	A
<i>Hydrometridae*</i>				
<i>Naucoridae*</i>		B	A	
<i>Nepidae*</i>	1	A	1	A
<i>Notonectidae*</i>				A
<i>Pleidae*</i>	B	B	B	B
<i>Veliidae*</i>		1	B	B
<i>Hydropsychidae spp</i>				
<i>Hydroptilidae</i>				
<i>Leptoceridae</i>	A			1
<i>Dytiscidae*</i>	1	B	B	B
<i>Elmidae*</i>				1
<i>Gyrinidae*</i>	1			1
<i>Hydraenidae*</i>		1		1
<i>Hydrophilidae*</i>		A	A	
<i>Dixidae*</i>				
<i>Ceratopogonidae</i>		A	1	1
<i>Chironomidae</i>	B	B	B	B
<i>Culicidae*</i>	1	A	B	A
<i>Muscidae</i>				

Expected Species	Observed Species			
<i>Simuliidae</i>	C			
<i>Tabanidae</i>				
<i>Tipulidae</i>				
<i>Ancylidae</i>				
<i>Lymnaeidae</i> *		1	1	
<i>Physidae</i> *		1	1	
<i>Planorbinae</i>				
<i>Sphaeriidae</i>				
SASS5 Score	53	84	77	100
Number of Taxa	14	20	19	22
ASPT	3.8	4.2	4.1	4.5
* = Air-breathers				

Of the 30 species observed, 13 were air-breathers, meaning that these species are not reliant on dissolved oxygen within the water column to ensure their survival and are thus more tolerant of low levels of dissolved oxygen, which is often typical of standing/still water systems, such as pans or artificial impoundments. Further to this observation, the remaining species observed may be regarded as relatively tolerant of low levels of dissolved oxygen and higher conductivities. Nonetheless, the presence of some more sensitive species such as *Hydracarina*, *Aeshnidae*, *Naucoridae*, *Elmidae* and *Hydraenidae* serve as an indication that conditions are adequate for maintaining a relatively high degree of biodiversity despite the inherent wetland nature of the systems present within the proposed project area.

5.3.5 Macroinvertebrate Response Assessment Index (MIRAI)

The aim of the MIRAI is to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic macroinvertebrate community (assemblage) from the reference condition (Thirion, 2008). It is, however, intended exclusively for application within flowing systems and no PES could be determined for sites MBY2, MBY3 or MBY4. However, the index was applied to MBY1.

In relation to perceived reference conditions, it was determined that the ecological condition of the macroinvertebrate assemblages collected within the study area each exhibited largely modified conditions (i.e. Ecological Category D). Further interrogation of the applied MIRAI index suggested that the primary driver was related to the limited available habitat present, which was to be expected within a channelled valley bottom wetland system (i.e. HGM unit 21).

5.4 Fish Response Assemblage Index

Due to the absence of flowing water within the proposed project area (i.e. sites MBY2, MBY3 and MBY4) at the time of the assessment, and the lack of fish species observed at site MBY1, the FRAI was not applied for the purposes of this study.

Personal communication with landowners revealed the presence of three fish species within the MBY2 impoundment: *Clarias gariepinus*, *Opasridium peringueyi* and *Cyprinus carpio*. However, this requires confirmation.

Although not necessarily within the proposed project area, approximately 127 freshwater fish species are known to inhabit the waters of the Southern Temperate Highveld freshwater ecoregion, of which 23 are endemic (Darwall *et al.*, 2009). Four endemic species of the Odonata fauna occur within this ecoregion. These include: *Pseudagrion vaalense*, *P. citricola*, *Africallagma sapphirinum* and *Proischnura rotundipennis*. The species *Varicorhinus nelspruitensis* is endemic to the upper Komati and Pongola systems (Scott, 2015).

Although occurring at altitudes too low to be of direct relevance to the proposed project area specifically, a number of species are reliant on the aquatic resources further downstream of the proposed project area. *Kneria auriculata* is restricted to altitudes between 1,100 m and 1,400 m above sea level and five relict populations are known from tributaries to the Crocodile River (Scott, 2015), with which the Komati River conflues near the town of Komatipoort. *Amphilius natalensis* lives only in tributaries of the Komati and Olifants rivers, between 900 and 1,300 m and the rare Incomati rock catlet, *Chiloglanis bifurcus*, is endemic to the Komati River system and is found only between 900 and 1,200 m (Scott, 2015).

6 Impact Assessment

This section aims to rate the significance of the identified potential impacts pre-mitigation and post-mitigation. The potential impacts identified in this section are a result of both the environment in which the proposed project activities take place, as well as the actual activities. The potential impacts are discussed per aspect and per each phase of the project i.e. the Construction Phase, Operational and Decommissioning/ Closure Phases where applicable.

6.1 Construction Phase

6.1.1 Impact Description

The proposed construction footprint, inclusive of the OC1 and OC2 pits as well as the associated surface infrastructure will result in a direct loss of approximately 94.86 ha. The potential indirect losses have not been quantified but are expected to be significant.

Apart from the obvious loss of vegetation and the associated loss of biodiversity, vegetation clearing and disturbance of soils within wetland areas for the construction of the proposed pits and surface infrastructure are likely to result in fragmentation of hillslope seep areas and ultimately a loss of water supply and catchment yield to the downstream valley bottom wetland systems. Compaction of soils, the creation of preferential flow paths and the onset of erosion

have the potential to result in degradation and fragmentation of the wetlands present. The risk of sedimentation and increased sediment loads into wetlands is deemed likely.

There is a risk of contaminants associated with construction activities and machinery entering wetlands from the access roads and the construction footprint, as well as organic waste and domestic litter, which has the potential to result in water quality impacts.

The activities related to the construction phase include:

- Site clearing, involving the removal of vegetation and the disturbance of soils; and
- Construction of mine related surface infrastructure.

6.1.1.1 Management objectives

The main objective for mitigation would be to limit the areas proposed for disturbance/vegetation clearance combined with remaining as far as possible from wetland areas. Areas of disturbance should be limited to the construction footprint.

6.1.1.2 Management actions and mitigation measures

The following management actions are proposed for the construction phase:

- Wherever possible, surface infrastructure should be relocated outside of wetland areas and a buffer of at least 100 m should be put in place to ensure there is no risk of fragmentation of the wetland systems;
- Should any road crossing or linear infrastructures be required to cross river or wetland areas, these should be designed in such a way as to allow the free movement of water between the upslope and the downslope reaches with minimal disturbance to the wetland or river areas;
- Environmental Practitioner and botanist to be present during vegetation clearing to prevent unnecessary clearing of extensive areas not part of the direct footprint area;
- Clearly marked buffer zones must be established, which are defined as regions of natural vegetation between watercourses/wetlands and developments or activities (WRC, 2015). This is a key management action that should take place by revising proposed infrastructure locations in line with the wetland characterisation and sensitivity mapping discussed in sections 5.1.1 and 5.2.
- Limit vegetation removal and construction activities to the infrastructure footprint area only, where removed or damaged vegetation areas should be revegetated as soon as possible;
- An alien and invasive plant species management programme must be in place during the construction phase. In this regard, special mention is made of *A. mearnsii*, which is the dominant alien invasive tree species observed in the watercourses at the time of the assessment;

- Bare land surfaces downstream of construction activities must be vegetated to limit erosion from surface runoff associated with infrastructure areas. Actively re-vegetate disturbed areas immediately after construction. Refer to Rehabilitation Study (Digby Wells, 2019c) for guidance;
- Ensure a soil management programme is implemented and maintained to minimise erosion and sedimentation;
- If destruction of wetlands is unavoidable disturbance must be minimised and suitably rehabilitated;
- Ensure no incision and canalisation of the wetland features takes place;
- All erosion within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan;
- Permit only essential personnel within the buffer areas for all freshwater features identified;
- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel;
- No crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;
- At areas where road crossings have been designed, these roads should cross wetland or river features at the narrowest point and at a 90-degree angle with suitable drainage designed into the relevant bridge/culvert crossing;
- No material will be dumped or stockpiled within any rivers, tributaries or drainage lines in the vicinity of the proposed footprint area.
- Environmentally friendly barrier systems, such as silt nets or, in severe cases, use of trenches, downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses (i.e. installation of clean and dirty water separation systems);
- Construction during high rainfall periods (usually November to March) should be avoided to decrease surface runoff in areas of vegetation removal and disturbed soils in an attempt to limit erosion and sedimentation into wetlands and instream aquatic systems;
- Erosion berms should be installed on roadways and downstream of stockpiles and the discard dump to prevent gully formation and siltation of the freshwater resources;

- The clean and raw water separation systems must be some of the first infrastructures installed on site and care must be taken to ensure that contamination of the receiving environment as a result of mining activities is minimised as far as possible;
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated buffer zones. All vehicles must remain on demarcated roads and within the construction footprint and access roads;
- All vehicles must be regularly inspected for leaks;
- Re-fuelling must take place on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into the topsoil;
- Construction chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions;
- All spills should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility, and
- Wetland monitoring must be carried out during the construction phase by a wetland specialist to ensure no unnecessary impact to the freshwater resources occur; and if so, a solution must be put in place as soon as possible.

6.1.1.3 Impact ratings

Table 6-1 and Table 6-2 present the impact ratings associated the construction phase of the project.

Table 6-1: Potential impact of clearing for construction

Activity and Interaction 1: Site clearing, including the removal of vegetation and disturbance of soils			
Impact Description: Construction and development activities within a greenfield site are likely to result in negative impacts to functioning freshwater resources and the catchment. This is realised through the resultant habitat fragmentation, spreading of alien and invasive species, soil disturbance and/or compaction, increased incidence of erosion, sedimentation from erosion, potential water quality deterioration, and disturbance to avifauna and other fauna utilising the freshwater resources thus resulting in an overall loss of biodiversity.			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The impacts caused during the construction will have a long-lasting effect if not mitigated as the current infrastructure layout will result in a direct loss of wetland habitat. Impacts must be managed proactively.	Moderate negative (-75)

Activity and Interaction 1: Site clearing, including the removal of vegetation and disturbance of soils			
Extent	Municipal (4)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality, sediments or alien invasive species to travel significant distances; especially downstream. Habitat fragmentation is also a catchment scale impact.	
Intensity	Serious medium term (4)	These impacts are serious medium-term threats to the important and sensitive freshwater resource habitats.	
Probability	Likely (5)	These impacts are likely.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Medium term (3)	The potential impacts caused during the construction will remain a threat throughout the project-life but the mitigated impact may potentially have a medium term impact in the ecosystem.	Negligible negative (-32)
Extent	Local area (3)	Management and mitigation measures have the potential to prevent the impacts from spreading beyond the local development site.	
Intensity	Minor (2)	With fully functional management, monitoring and mitigation plans, the impact to the ecosystem functioning will be minimal.	
Probability	Probable (4)	Despite all intentions to prevent impacts, it is probable that impacts will still be realised due to the nature of the activity and the proximity to sensitive freshwater resource receptors. These potential residual impacts must be managed accordingly.	
Nature	Negative		

Table 6-2: Potential impact from construction of mine infrastructure

Activity and Interaction 2: Construction of mine related surface infrastructure
Impact Description: Fragmentation of the freshwater resources as a result of road crossings. Loss of freshwater resource habitat (soils and vegetation) due to both direct and indirect impacts. These impacts may result in complete loss of wetland ecosystems or part thereof. Although some of these

Activity and Interaction 2: Construction of mine related surface infrastructure			
freshwater resources are not in pristine condition, they are providing significant ecological services at the local and catchment scale.			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The construction activities will result in the installation of permanent infrastructure, the permanent loss of freshwater resource habitat in some areas and permanent alterations to the surrounding landscape.	Major negative (-119)
Extent	Municipal (4)	Loss of significant freshwater resources on a catchment scale.	
Intensity	Irreplaceable loss of highly sensitive environment (6)	Freshwater resources are sensitive natural ecosystems providing significant ecological services that are experiencing high levels of cumulative loss and damage. Thus, all remaining functional freshwater resources are even more important and sensitive to impacts that threaten their ecological integrity; directly or indirectly.	
Probability	Definite (7)	According to the proximities of the infrastructure layout, this impact will occur if no mitigation measures are implemented.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The construction activities will result in the installation of permanent infrastructure, the permanent loss of freshwater resource habitat in some areas and permanent alterations to the surrounding landscape.	Minor negative (-65)
Extent	Local area (3)	Management and mitigation measures have the potential to prevent the impacts from spreading beyond the local development site.	
Intensity	Moderate (3)	With fully functional management, monitoring and mitigation plans, the impact to the ecosystem functioning will be moderate.	
Probability	Likely (5)	Despite all intentions to prevent impacts, it is probable that impacts will still be realised due to the nature of the activity and the proximity to	

Activity and Interaction 2: Construction of mine related surface infrastructure			
		sensitive freshwater resource receptors. These potential residual impacts must be managed accordingly.	
Nature	Negative		

6.1 Operational Phase

6.1.1 Impact Description

Operational activities such as transport of topsoil, overburden, waste rock and coal have the potential to result in impacts such as erosion, sedimentation, compaction and contamination of the surrounding habitat. Crossing of rivers and wetlands may result in sedimentation and impacts on water quality, as well as the ingress of hydrocarbons related to the operation of heavy machinery.

Stockpiles and dumps have the potential to result in water quality impacts as a result of runoff and erosion, which in turn has the potential to result in sedimentation within the adjacent river and wetland areas.

The proposed OC2 pit will result in the direct destruction of HGM units 4, 5, 6, 13, and portions of HGM units 15, 16 and 17. The proposed OC1 pit will result in the direct destruction of a portion of HGM unit 19, and HGM units 20, and 25. HGM units 5, 6, 16, 17, 19, 20 and 25 are important hillslope seepage and valley bottom wetland systems supplying water to the downstream wetland and aquatic ecology and the destruction of these systems is likely to have both a direct and indirect impacts to the downstream ecology in terms of impacts to water quality as a result of decant (Digby Wells, 2019a) as well as due to loss of water supply.

Open pit mining within wetlands and watercourses may lead to hydrological and geomorphic changes in these systems, resulting in altered functioning of these. Dewatering may result in desiccation and drying out of wetlands leading to fragmentation and habitat degradation.

Operation of the proposed open pits has the potential to result in serious impacts in terms of water quality to the downstream water resources as a result of seepage and decant, as well as an increased potential for erosion and sedimentation and loss of water supply to the downstream areas.

Operational impacts include compaction of soils and hardening of surfaces, loss of catchment yield and surface water recharge, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream organisms and further fragmentation of the systems present. Hardened surfaces have the potential to result in sheet runoff and there is likely to be a loss in wetland service provision in terms of flood attenuation, sediment trapping and assimilation of toxicants and other pollutants.

The activities related to the operational phase include:

- Operational open pit mining activities, including excavation and dewatering will result in a direct loss of 91.41 ha (exclusive of surface infrastructure constructed during the construction phase) of wetland habitat and an unquantified indirect loss of habitat;
- Uncontrolled runoff of storm water or water generated from the mining operations from or through the surface infrastructure;
- Use and maintenance of haul roads for the transportation of coal and waste rock.

6.1.1.1 Management objectives

Measures to prevent desiccation of the surrounding wetland areas and rivers due to the loss of upstream wetland habitat must be implemented to prevent the loss of water supply to the lower-lying wetland areas. Further to this, water should not be allowed to flow freely from the operational area. Dirty water or water runoff from mine related infrastructure should be stored in PCDs and utilised as intended.

It is imperative that operational activities are limited to the operational area and no areas outside of the operational area should be disturbed.

6.1.1.2 Management actions and mitigation measures

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

- Channelled water should not be dispersed in a concentrated manner. Baffles should be incorporated into artificial drainage lines/channels around the surface infrastructure to decrease the kinetic energy of water as it flows into the natural environment;
- Bare surfaces downstream from the developments where silt traps are not an option should be vegetated in order to attempt to limit erosion and runoff that might be carrying contaminants;
- All erosion noted within the operational footprint should be remedied immediately and included as part of an ongoing rehabilitation plan;
- Ensure that no incision and canalisation of the wetland features present takes place;
- Erosion berms should be installed on roadways and downstream of stockpiles and the discard dump to prevent gully formation and siltation of the freshwater resources;
- Monitoring of all wetland areas affected as a result of infrastructure developments, including linear infrastructures such as roads watercourses should be carried out by a suitably qualified wetland ecologist in order to determine localities of areas subjected to erosion and increased runoff; where after, new mitigation actions should be implemented as per the specialist's recommendations.

The following management and mitigation measures should be put in place to minimise the impact of the open pit operational activities:

- During the operational phase of the project the Storm Water Management Plan (SWMP) (Digby Wells, 2019b) should already be implemented. This should consider all wetlands and other watercourses associated with the new developments/infrastructure which should divert storm water away from the pits and surface infrastructure and back into natural watercourses to maintain catchment yield as far as possible. The SWMP should also convey storm water to silt traps where needed in order to limit erosion and the subsequent increase of suspended solids in downstream watercourses;
- If possible, clean water removed as part of the dewatering activities should be released downgradient of the operational areas to ensure water supply to the lower lying wetlands is maintained.

The following management and mitigation measures should be put in place to ensure impacts to the wetland ecology of the area as a result of the general operational activities is reduced:

- Environmental Practitioner to be present during operational phase to prevent any additional clearing of extensive areas or vegetation or dumping of waste rock and/or coal in areas not part of the direct footprint area.
- The edge of the non-directly impacted freshwater resources, and at least a 100m buffer or 1:100 floodline buffer, should be clearly demarcated in the field with wooden stakes painted white as no-go zones that will last for the duration of the operational phase.
- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel;
- Freshwater resource monitoring must be carried out during the operational phase by a wetland specialist to ensure no unnecessary impact to the freshwater resources present; and if so that a remedy is put in place as soon as possible.
- Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation;
- Implement and maintain alien vegetation management programme;
- If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated;
- No material is to be dumped or stockpiled within any rivers, tributaries or drainage lines;
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or their buffer areas. All vehicles must remain on demarcated roads and within the operational footprint;
- All vehicles must be regularly inspected for leaks;
- Re-fuelling must take place on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil;

- All spills should be immediately cleaned up and treated accordingly; and
- Appropriate sanitary facilities must be provided for the duration of the operational phase and all waste must be removed to an appropriate waste facility.

6.1.1.3 Impact ratings

Table 6-3: Potential impacts of the operational open pit mining activities

Activity and Interaction 3: Operational open pit mining activities, including excavation and dewatering			
Impact Description: Operational open pit mining activities, including excavation and dewatering will result in a direct loss of 91.41 ha of wetland habitat and an unquantified indirect loss of habitat. Dewatering activities are likely to result in the loss of water supply to the wetlands, with special mention of the lower lying wetlands and moisture stress to the surrounding wetland areas.			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The impacts caused during the operational phase will result in permanent changes to the landscape.	Major negative (-133)
Extent	Region (5)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality, sediments or alien invasive species to travel significant distances; especially downstream. Habitat fragmentation is also a catchment scale impact.	
Intensity	Irreplaceable loss and damage (7)	These activities will result in an irreplaceable loss of ecologically important water sources for the region.	
Probability	Highly probable (7)	These impacts are highly probable.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The impacts caused during the operational phase will result in permanent changes to the landscape.	Major negative (-133)*
Extent	Region (5)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality, sediments or alien invasive species to travel significant distances;	

Activity and Interaction 3: Operational open pit mining activities, including excavation and dewatering			
		especially downstream. Habitat fragmentation is also a catchment scale impact.	
Intensity	Irreplaceable loss and damage (7)	These activities will result in an irreplaceable loss of ecologically important water sources for the region.	
Probability	Highly probable (7)	These impacts are highly probable.	
Nature	Negative		

*No mitigation or management measures for the destruction of wetland habitat due to open pit mining activities

Table 6-4: Potential runoff related impacts associated with the operational phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Uncontrolled runoff of storm water or water generated from the mining operations from or through the surface infrastructure			
Impact Description: Water quality and habitat deterioration of watercourses receiving unnatural/contaminated runoff			
Prior to Mitigation/Management			
Duration	Project Life (5)	It is predicted that contaminant input will continue throughout the life of the Project whenever rainfall events occur.	Minor (negative) – 56
Extent	Municipal (4)	Due to the dry nature of the watercourses in the MRA, runoff is already expected to be limited which should result in limited contaminant input. However, downstream sections of the associated systems will most likely be affected when rainfall events lead to contaminant input and as a precautionary measure for the sensitive biota observed downstream, the extent rating has been increased.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Serious - Negative (-5)	Due to the dry nature of the watercourses in the MRA, the intensity of runoff is already expected to be limited. However, aquatic systems are regarded as sensitive and the entry of contaminants will result in serious aquatic related impacts especially if water reaches the Klein Komati reach.	
Probability	Probable (4)	The impact is likely to occur throughout the life of the Project but limited due to periodic rainfall events.	
Nature	Negative		
Post-Mitigation			
Duration	Project Life (5)	Runoff will continue throughout the Project life.	Negligible (negative) – 30
Extent	Limited (2)	Runoff will most likely be largely restricted and captured after mitigation.	
Intensity x type of impact	Moderate - Negative (-3)	If mitigation measures are all incorporated for the Project, the intensity of the impact should decrease. However, contaminants are more difficult to manage compared to solid particles and are predicted to enter associated aquatic systems resulting in water quality deterioration.	
Probability	Unlikely (3)	The likelihood of the impact occurring is reduced by the mitigation actions and should only result in extreme rainfall events or if mitigation structures aren't maintained.	
Nature	Negative		

Table 6-5: Potential impacts of the Operational Phase

Activity and Interaction 1: Loading, hauling and stockpiling

Impact Description: These activities have the potential to result in an increased potential for soil compaction, erosion, sedimentation, loss of water quality, habitat and biodiversity.			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Project life (5)	The potential impacts caused during the operational phase will cease after the operational life span of the Project	Minor negative (-65)
Extent	Municipal (4)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality, sediments or alien invasive species to travel significant distances; especially downstream. Habitat fragmentation is also a catchment scale impact.	
Intensity	Serious medium term (4)	These impacts are serious medium-term threats to the important and sensitive freshwater resource habitats.	
Probability	Likely (5)	These impacts are likely.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Project life (5)	The potential impacts caused during the operational phase will cease after the operational life span of the Project	Negligible negative (-34)
Extent	Site (1)	Managing and mitigation measures have the potential to prevent the impacts from spreading beyond the operational site.	
Intensity	Minor (2)	With fully functional management, monitoring and mitigation plans, the impact to the ecosystem functioning will be minimal.	
Probability	Probable (4)	Despite all intentions to prevent impacts, it is probable that impacts will still be realised due to the nature of the activity and the proximity to sensitive freshwater resource receptors. These potential residual impacts must be managed accordingly.	
Nature	Negative		

Table 6-6: Potential impacts from the use and maintenance of haul roads

Activity and Interaction 2: Use and maintenance of haul roads for the transportation of coal and waste rock

Impact Description: Fragmentation of the freshwater resources as a result of road crossings, contamination of freshwater resources and impacts to water quality as a result of spills, compaction of soils, loss of habitat and biodiversity. Increased potential for sheet runoff from paved/cleared surfaces and increased potential for erosion.

Prior to Mitigation/Management

Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	The operational activities have the potential to result in the permanent fragmentation of wetland and river systems, as well as the contamination and sedimentation of the stream.	Minor negative (-56)
Extent	Municipal (4)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality or sediments to travel significant distances; especially downstream. Habitat fragmentation is also a catchment scale impact.	
Intensity	Moderate loss of sensitive habitat (3)	Freshwater resources are sensitive natural ecosystems providing significant ecological services that are experiencing high levels of cumulative loss and damage. Thus, all remaining functional freshwater resources are even more important and sensitive to impacts that threaten their ecological integrity; directly or indirectly.	
Probability	Probable (4)	These impacts are probable.	
Nature	Negative		

Post-Mitigation

Dimension	Rating	Motivation	Significance
Duration	Project life (5)	The potential impacts caused during the operational phase will cease after the operational life span of the Project	Negligible negative (-32)
Extent	Limited (2)	Managing and mitigation measures have the potential to prevent the impacts from spreading beyond the operational site.	
Intensity	Minimal (1)	With fully functional management, monitoring and mitigation plans, the impact to the ecosystem functioning will be minimal.	

Activity and Interaction 2: Use and maintenance of haul roads for the transportation of coal and waste rock			
Probability	Probable (4)	Despite all intentions to prevent impacts, it is probable that impacts will still be realised due to the nature of the activity and the proximity to sensitive freshwater resource receptors. These potential residual impacts must be managed accordingly.	
Nature	Negative		

6.2 Decommissioning and Closure Phase

6.2.1 Impact Description

Similar to the construction phase, the decommissioning and rehabilitation activities occurring within an ecologically sensitive catchment pose significant potential negative impacts to functioning wetlands and catchments. Furthermore, the rehabilitated areas could cause major negative impacts due to spread of alien invasive vegetation, increased soil compaction, erosion and subsequent sedimentation into the wetland and river ecosystems.

According to the Groundwater Study (Digby Wells, 2019a) decant is likely to occur downgradient of the OC1 and OC2 pits occur, which may be regarded as major impact to the downstream wetland and aquatic integrity, which forms part of a FEPA river catchment and may be considered sensitive.

The activities related to the decommissioning and closure phase include:

- Rehabilitation and dismantling of infrastructure;
- Rehabilitation including spreading of soil, re-vegetation and profiling or contouring (Refer to Rehabilitation Study (Digby Wells, 2019c); and
- Post-mining decant into wetlands and streams.

6.2.1.1 Management objectives

The main management objective would be to rehabilitate the affected areas to near-natural conditions without resulting in additional impacts to the wetland ecology throughout the process.

The recommendations of the Groundwater Study (Digby Wells, 2019a) should be consulted for the best measures to be put in place to mitigate the impacts of the predicted decant to the wetland and aquatic ecology of the area.

6.2.1.2 Management actions and mitigation measures

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

- High rainfall periods should be avoided during decommissioning;
- Storm water must be diverted from decommissioning activities;
- Stored mine-affected water should be treated before decommissioning of any mine-related water retention areas, such as PCDs;
- The edge of the non-directly impacted freshwater resources, and at least a 100m buffer or 1:100 floodline buffer, should be clearly demarcated in the field with wooden stakes painted white as no-go zones that will last for the duration of the decommissioning phase;
- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel;
- Actively re-vegetate disturbed areas as well as decommissioned footprint areas as part of the decommissioning process;
- Implement and maintain an alien vegetation management programme for the duration of the decommissioning phase and into closure;
- No material should be dumped within any wetlands or watercourses;
- No vehicles or heavy machinery should be allowed to drive indiscriminately within any wetland areas or their buffer areas. All vehicles must remain on demarcated roads;
- All vehicles must be regularly inspected for leaks;
- Re-fuelling must take place on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into the topsoil;
- All spills should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the duration of the decommissioning phase and all waste must be removed to an appropriate waste facility;
- Wetland monitoring must be carried out during the decommissioning phase to ensure no unnecessary impact to wetlands takes place; and
- If post-mining decant takes place within proximity to, or within wetland areas, this water should be treated prior to release into the environment. Passive and active water treatment options should be considered as a priority.

6.2.1.3 Impact ratings

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

Table 6-7: Potential impacts from rehabilitation and dismantling of infrastructure

Activity and Interaction 1: Rehabilitation of site and dismantling of infrastructure			
Impact Description: Erosion onset, sedimentation and establishment of alien plants			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Long term (4)	The impacts caused during the decommissioning activities will have a long-lasting effect if not mitigated.	Minor negative (-65)
Extent	Municipal (4)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality or alien invasive species to travel significant distances; especially downstream.	
Intensity x type of impact	Serious damage to or loss of sensitive environments (5)	These impacts are serious threats to sensitive habitats such as wetlands; especially due to their sensitivity and importance to local communities.	
Probability	Likely (5)	These are commonly observed impacts for the decommissioning phase, especially for wetlands of this climate.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Medium term (3)	Impacts will last as long as decommissioning activities are ongoing.	Minor negative (-36)
Extent	Local (3)	Mitigation will allow impacts to be within the local site.	
Intensity x type of impact	Moderate damage to sensitive environments (3)	Decommissioning activities may still have a moderate effect on the wetlands in the Project area. These wetlands are sensitive environments.	
Probability	Probable (4)	Negative impacts to the wetlands during decommissioning could occur given the nature of the task.	
Nature	Negative		

Table 6-8: Potential impacts from rehabilitation activities

Activity and Interaction 2: Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring

Impact Description: Improper infilling and profiling, resulting in the creation of preferential flow paths and thus increasing the potential for erosion. Improper rehabilitation of compacted soils, resulting in poor vegetation cover, increased potential for the spread and establishment of alien and invasive species.

Prior to Mitigation/Management

Dimension	Rating	Motivation	Significance
Duration	Long term (4)	The impacts caused during the rehabilitation activities will have a long-lasting effect if not mitigated.	Minor negative (-56)
Extent	Municipal (4)	The impact could spread beyond the local development boundaries due to the ability of degraded water quality or alien invasive species to travel significant distances; especially downstream.	
Intensity x type of impact	Serious damage to or loss of sensitive environments (5)	These impacts are serious threats to sensitive habitats such as wetlands; especially due to their sensitivity and importance to local communities.	
Probability	Likely (5)	These are commonly observed impacts for the rehabilitation phase, especially for wetlands of this climate.	
Nature	Negative		

Post-Mitigation

Dimension	Rating	Motivation	Significance
Duration	Medium term (3)	Impacts will last as long as activities are ongoing.	Negligible negative (-32)
Extent	Local (3)	Mitigation will allow impacts to be within the local site.	
Intensity x type of impact	Moderate damage to sensitive environments (3)	Rehabilitation activities may still have a moderate effect on the wetlands in the Project area. These wetlands are sensitive environments.	
Probability	Probable (4)	Negative impacts to the wetlands during rehabilitation could occur given the nature of the task.	

Nature	Negative	
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Table 6-9: Potential impacts from post-mining decant

Activity and Interaction 3: Post-mining decant into wetlands and streams			
Impact Description: Loss of habitat integrity and ecosystem services such as toxicant removal and water for human use			
Prior to Mitigation/Management			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	Water quality will continue to deteriorate for a number of years and the habitat will be permanently altered.	Major negative – 133
Extent	Region (5)	The extent of the impact will affect the entire downstream reach of the watercourse.	
Intensity x type of impact	Irreplaceable loss (7)	Due to the importance of the watercourse for the catchment, for human use and for the maintenance of biodiversity, the impact is severe.	
Probability	Definite (7)	The likelihood is assumed as definite until proven otherwise.	
Nature	Negative		
Post-Mitigation			
Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	Water quality will continue to deteriorate for several years and the habitat will be permanently altered.	Moderate negative – 95
Extent	Region (5)	The extent of the impact will affect the entire downstream reach of the watercourse.	
Intensity x type of impact	Irreplaceable loss (7)	Due to the importance of the watercourse for the catchment and for human use and for the maintenance of biodiversity, the impact is severe.	
Probability	Likely (5)	Even with mitigation, it is likely that impacts will be expressed on the downstream aquatic and wetland ecology	

Activity and Interaction 3: Post-mining decant into wetlands and streams		
Nature	Negative	

6.3 Cumulative Impacts

The current impacts to the project area were related largely to plantations (forestry) and the agropastoral activities observed. In addition to this were the linear infrastructures observed throughout the project area such as roads and powerlines and adjacent mining activities.

The forestry and agropastoral activities and the spread and proliferation of alien and invasive plant species had resulted in impacts to the health and integrity of large portions of the wetlands present, which in turn had resulted in channelization and narrowing of the wetland areas within the proposed project area. Further to this, some impacts related to fragmentation, the creation of preferential flow paths and compaction of soils due to the presence of existing roads and infrastructure had resulted in loss of water retention and erosion.

The influx of people to the area as a result of mining activities have the potential to result in further impacts related to subsistence farming activities, informal settlements and additional linear infrastructures. This may result in further degradation of the wetland systems and reflect greater modification of scores as indicated by the determined PES.

Forestry activities in the catchment were regarded as likely to contribute to impacts in relation to wetland integrity, with impacts such as loss of carbon, changes in soil chemistry and water retention capacity, and loss of surface roughness (increasing surface runoff) had the potential to increase runoff resulting in an increased potential for erosion.

The dominant land-uses of the project area were related to agropastoral activities and forestry, with some mining observed. Mining activities adjacent to the proposed project area have been granted. The approval of additional mining activities within the project area has the potential to result in further approvals for mining within the greater area. This may result in a significant overall land-use change and with this, the loss of sensitive habitats important for the maintenance of biodiversity, loss of catchment yields and decreases in water quality, the latter being of special concern as the freshwater resources downstream of the project area, with special mention of the Klein Komati River. The Klein Komati River is situated within a FEPA catchment and is classified as an ecological category B (minimally modified) and is deemed important for the maintenance of biodiversity as well as for water supply.

6.4 Unplanned and Low Risk Events

There is a risk that wetland areas associated with the mining operations/infrastructure throughout the life of the proposed project might be affected by the entry of hazardous substances, such as hydrocarbons, in the event of a spillage or unseen seepage from storage facilities; and

Accidents or deterioration of structures along the roadways and river/wetland crossings, including pipelines, may result in impacts to the habitat and water quality

Table 6-10 outlines mitigation measures that must be adopted in the event of unplanned impacts throughout the life of the proposed project.

Table 6-10: Unplanned events and associated mitigation measures

Unplanned Risk	Mitigation Measures
Chemical and (or) contaminant spills from mining operation, infrastructure and associated activities.	<ul style="list-style-type: none"> ▪ Ensure correct storage of all chemicals at operations as per each chemical's specific storage requirements (e.g. sealed containers for hydrocarbons); ▪ Ensure staff involved at the proposed project have been trained to correctly work with chemicals at the sites; and ▪ Ensure spill kits (e.g. Drizit) are readily available at areas where chemicals are known to be used. Staff must also receive appropriate training in the event of a spill, especially near wetlands, watercourses and/or drainage lines.
Unplanned structural deterioration or accidents along the roadways and pipelines in the vicinity of wetlands	<ul style="list-style-type: none"> ▪ Install safety valves and emergency switches that can be used to seal off leakages from pipelines when noticed or triggered; ▪ Ensure that spill kits and trained staff capable of using the kits are available on site in case of accidental spillages; ▪ Maintenance of roadways, river crossings and pipelines should be considered an ongoing process where leakages or issues with the pipe should be reporting to acting Environmental Control Officer (ECO) of the project immediately after notice.

7 Monitoring Programme

As the proposed project area is comprised largely of wetland habitat, it is recommended that the WET-health and WET-Ecoservices tools should be used to re-evaluate PES and eco-services on a quarterly basis by a suitably qualified wetland specialist for the duration of the construction phase, and annually for the duration of the operational phase. Upon closure and decommissioning, annual monitoring should take place for another three years to ensure no emerging impacts are identified, which may need to be addressed.

The development and initiation of an aquatic biomonitoring program will be required on tributaries of the Klein Komati River downstream of both decant points to ensure no deterioration in ecological integrity is taking place downstream of the proposed project. This biomonitoring program should be initiated prior to construction activities and continue for the

duration of the proposed project and into post closure. Recommended sampling localities and indices are indicated in Table 7-1.

Table 7-1: Proposed aquatic monitoring localities

Site	Co-Ordinates	Frequency	Parameters
Western Tributary	25°47'34.57"S 30°00'17.57"E	Bi-annually	<ul style="list-style-type: none"> • <i>In situ</i> water quality • IHAS • SASS5 • MIRAI • FRAI • Diatoms
Eastern Tributary	25°46'59.50"S 30°03'55.85"E		
Klein Komati	25°51'41.14"S 30°04'17.33"E		

NOTE: Proposed sampling localities and parameters may require optimisation based on site conditions

8 Recommendations

The following recommendations are deemed applicable:

- A 100 m buffer, in line with the 100 m zone of regulation triggered by GN 704 is not regarded as suitable protection for the wetland systems present, with special mention of the downstream preservation of the ecological integrity of the Klein Komati River, which forms part of a FEPA river catchment. Further to this, due to the short-comings of the Buffer tool described by Macfarlane & Bredin (2017), the tool is not deemed suitable for application to open pit mining activities and it is highly recommended that a hydro-pedological assessment be carried out for the determination of suitable buffers should the proposed mining activities be approved; and
- An access road for a neighbouring mine that has been constructed in the vicinity of HGM unit 20 and the proposed OC1 pit must be rehabilitated to prevent any further disturbance and degradation of the hillslope seepage wetland system, which may be regarded as ecologically significant on a catchment scale as well as important for the provision of multiple ecological services as discussed in the body of this report.

9 Conclusion and Specialist Opinion

Digby Wells has been requested by Xivono to conduct the freshwater (aquatic and wetland) specialist studies to inform the EIA process being conducted for the proposed Weltevreden Mining Project.

450.43 ha of wetland areas were identified within the proposed project area and its associated 500 m zone of regulation with 225.89 ha within the proposed project area only. Thirty HGM units were identified and categorized based on terrain units. These included pans, hillslope seeps, unchannelled valley bottoms and channelled valley bottoms. Wetlands were numbered 1 – 30 for ease of reference.

The health and integrity of each of the HGM units present varied considerably, with anthropogenic disturbances being the most significant driver of change to date. These disturbances were related largely to plantations, agropastoral activities and linear infrastructures traversing the proposed project area, with an isolated portion in the south-east of the proposed project area affected by mining activities. The PES of each of the HGM units observed were largely categorised as Ecological Category C (moderately modified) and Ecological Category D (largely modified) systems, with three isolated pans classified as an Ecological Category B (Minimally modified) and one small hillslope seepage wetland classified as Ecological Category A (Unmodified).

In terms of EIS, the ecological importance and sensitivity of the various HGM units were regarded as largely dependent on their respective locations in the landscape, the surrounding landscape uses and activities, and the HGM unit type. The level of resilience and the anthropogenic impacts affecting each HGM unit was also considered. EIS for the majority of the wetlands present was observed to be *Moderate*, with that of four of the HGM units observed to be *High*. Important services in terms of flood attenuation, streamflow regulation, the assimilation of toxicants and nutrients, as well as the maintenance of biodiversity were considered the most important functions provided by the wetlands present.

According to the results of the Groundwater Study and the Soils Study (Digby Wells, 2019a; Earth Science Solutions, 2019), the water table within the proposed project area is relatively shallow due to the presence of a shallow weathered aquifer and this, along with the expansive transitional soil types observed, has given rise to the numerous pan systems and extensive hillslope seepage areas observed, which in turn, feed and supply water to the valley bottom wetlands observed within the proposed project area and its 500 m zone of regulation, with special mention of HGM units 16, 18, 19, 21 and 30 (i.e. the wetlands displaying the highest ecological integrity as well as ecological importance and sensitivity).

Water quality within the proposed project area was deemed natural in consideration of the wetland nature of the systems and the surrounding agropastoral and forestry activities, and while the accepted indices for the determination of the general ecological integrity of the area were largely unsuitable due to the inherent wetland nature of the aquatic ecology of the area and the unsuitability of the indices for use in artificial impoundments, the presence of some more sensitive species such as *Hydracarina*, *Aeshnidae*, *Naucoridae*, *Elmidae* and *Hydraenidae* serve as an indication that aquatic ecological conditions are adequate for maintaining a relatively high degree of biodiversity.

The impact assessment revealed a spectrum of impacts ranging from major to minor prior to the implementation of suitable mitigations. Many of these impacts can be reduced to minor and negligible impacts, however, the proposed OC2 pit will result in the direct destruction of HGM units 4, 5, 6, 13, and portions of HGM units 15, 16 and 17, and the proposed OC1 pit will result in the direct destruction of a portion of HGM unit 19, and HGM units 20, and 25. HGM units 5, 6, 16, 17, 19, 20 and 25 are important hillslope seepage and valley bottom wetland systems supplying water to the downstream wetland and aquatic ecology, and the destruction of these systems is likely to have both a direct and indirect impacts to the downstream ecology in terms of impacts to water quality as a result of decant (Digby Wells, 2019a) as well as due

to loss of water supply. The quantified destruction of 91.41 ha of wetland habitat due to the proposed open pit mining activities, and the unquantified destruction and degradation of the remaining wetland ecology, as well as the downstream ecology of the Klein Komati River, as a result of desiccation and decant are regarded as a fatal flaw to the proposed project in terms of the wetland and aquatic ecology of the greater area. Therefore, open pit mining within the proposed project area, with special mention of the OC1 pit is not recommended.

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