Wetland Baseline & Risk Assessment for the proposed Highveld Solar Power Plant Project

Emalahleni, Mpumalanga Province, South Africa

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CLIENT

ENVIRONAMICS

Prepared by:

The Biodiversity Company

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany.com

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1 Introduction

1.1 Background

The Biodiversity Company (TBC) was appointed to undertake a wetland baseline and risk assessment for the proposed Highveld Solar Power Plants (SPP) Photovoltaic (PV) project. The proposed project involves the development of a solar facility and associated infrastructure, located 15 km north west of Emalahleni in the Mpumalanga province (Figure 1-2 and Figure 1-3).

The proposed solar facility will produce up to a total of 329 MW and it will include a PV Panel Array, inverters, and connection to the grid, and supportive infrastructure will also be developed which includes roads, fencing and small buildings. This report pertains to the assessment of the PV area and its associated footprint, as well as the supportive grid infrastructure.

In order to assess the baseline ecological state of the area and to present a detailed description of the receiving environment, both a desktop assessment as well as a field survey were conducted during October 2022. Furthermore, the desktop assessment and field survey both involved the detection, identification and description of any locally relevant water resources, and the manner in which these sensitive features may be affected by the proposed development was also investigated. A 500 m radius has been demarcated for the cluster for the identification of wetlands within the prescribed regulation area. This demarcated area is referred to as the Project Area of Influence (PAOI).

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations, 2014 (No. 326, 7 April 2017) of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998). The approach has taken cognisance of the recently published Government Notice 320 in terms of NEMA dated 20 March 2020 as well as the Government Notice 1150 in terms of NEMA dated 30 October 2020: "Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation". The National Web based Environmental Screening Tool has characterised the aquatic biodiversity theme for the area as predominantly 'Low', with limited areas designated 'Very High' sensitivity due to the presence of wetlands (National Environmental Screening Tool, 2022).

The purpose of conducting the specialist study is to provide relevant input into the overall Environmental Authorisation application process, with a focus on the proposed project activities and their associated impacts. This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Registered Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making as to the ecological viability of the proposed project.

1.2 Technical Information

The following technical information was provided by Environamics:

The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e. semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current). The key components of the proposed project are described below:

- PV Panel Array - To produce up to 329MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a northern angle in order to capture the most sun or using one-axis tracker structures to follow the sun to increase the Yield.

- Wiring to Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.

- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the proposed powerline. It is expected that generation from the facility will link to the Eskom Vulcan 400kV MTS Substation. The connection will be assessed within the 250m wide (up to 690m in some instances) grid connection corridor. Connection will be limited to the grid connection corridor. The Highveld SPP will inject up to 250MW into the National Grid. The installed capacity will be up to 329MW (Figure 1-1).

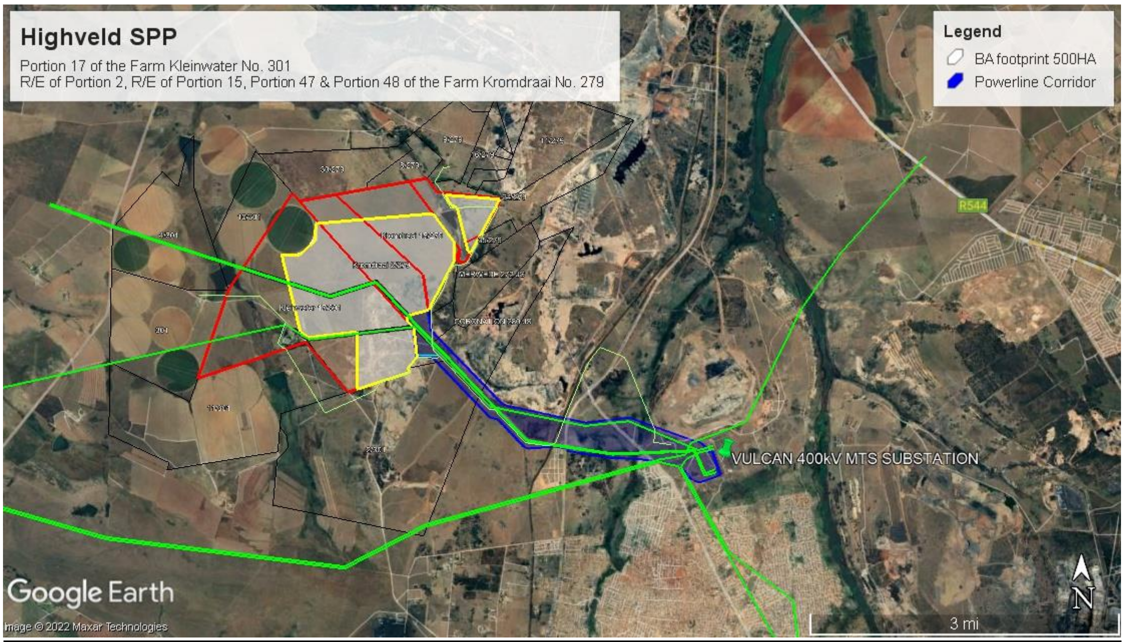

Figure 1-1 Powerline corridor

- Electrical reticulation network – An internal electrical reticulation network will be required and will be lain ~2-4m underground as far as practically possible.

- Supporting Infrastructure – The supporting infrastructure such as the auxiliary buildings will be situated in an area measuring up to 4 ha.

- Battery storage – A Battery Storage Facility with a maximum height of 8m and a maximum volume of 1,740 m^3 of batteries and associated operational, safety, and control infrastructure.

- Roads – Access will be obtained via an unnamed road off of the N4 to the south of the site and via another unnamed road to the east of the site. An internal site road network will also be required to provide access to the solar field and associated infrastructure. The access and internal roads will be constructed within a 25- meter corridor. Access Points: coordinates 25°49'14.48"S; 29° 3'4.95"E and 25°48'55.80"S; 29° 3'43.84"E.

- Fencing - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height of 2.5 meters will be used.

Table 1.2 Technical details for the proposed facility

Component	Description / dimensions
Height of PV panels	6 meters
Area of PV Array	500 hectares (Development footprint)
Number of inverters required	Minimum 50
Area occupied by inverter / transformer stations / substations / BESS	Central inverters+ LV/MV trafo: 750 m^2 HV/MV substation with switching station: 15 000 m^2 BESS: 40 000 m^2
Capacity of on-site substation	132kV
Capacity of the powerline	132kV
Area occupied by both permanent and construction laydown areas	Total Footprint Area: 500 hectares Construction laydown area: within ~ 5.74 ha
Area occupied by buildings	Security Rooms (3): ~405 m^2 O&M laydown: Within 5.74 ha
Battery storage facility	Maximum height: 8m Maximum volume: 1740 m^3 Capacity: Up to 500 MW
Length of internal roads	Approximately 16.41 km
Width of internal roads	Between 4 and 6 meters
Proximity to grid connection	Approximately 5.3km
Grid connection corridor width	Between 250 and 690 m
Grid connection corridor length	Approximately 5.3km
Powerline servitude width	32m
Height of fencing	Approximately 2.5 meters

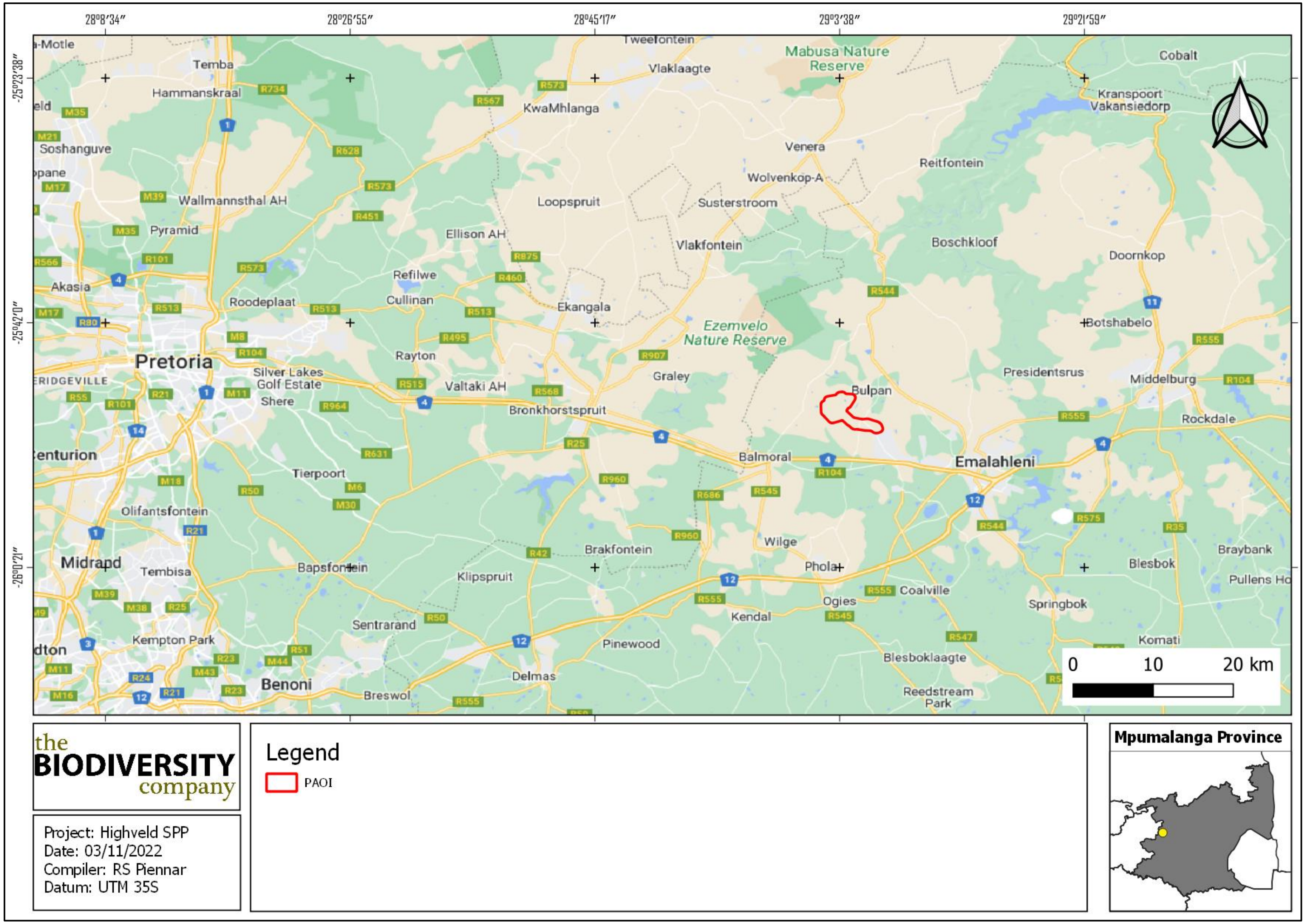

Figure 1-2 Map illustrating the location of the proposed PV Project

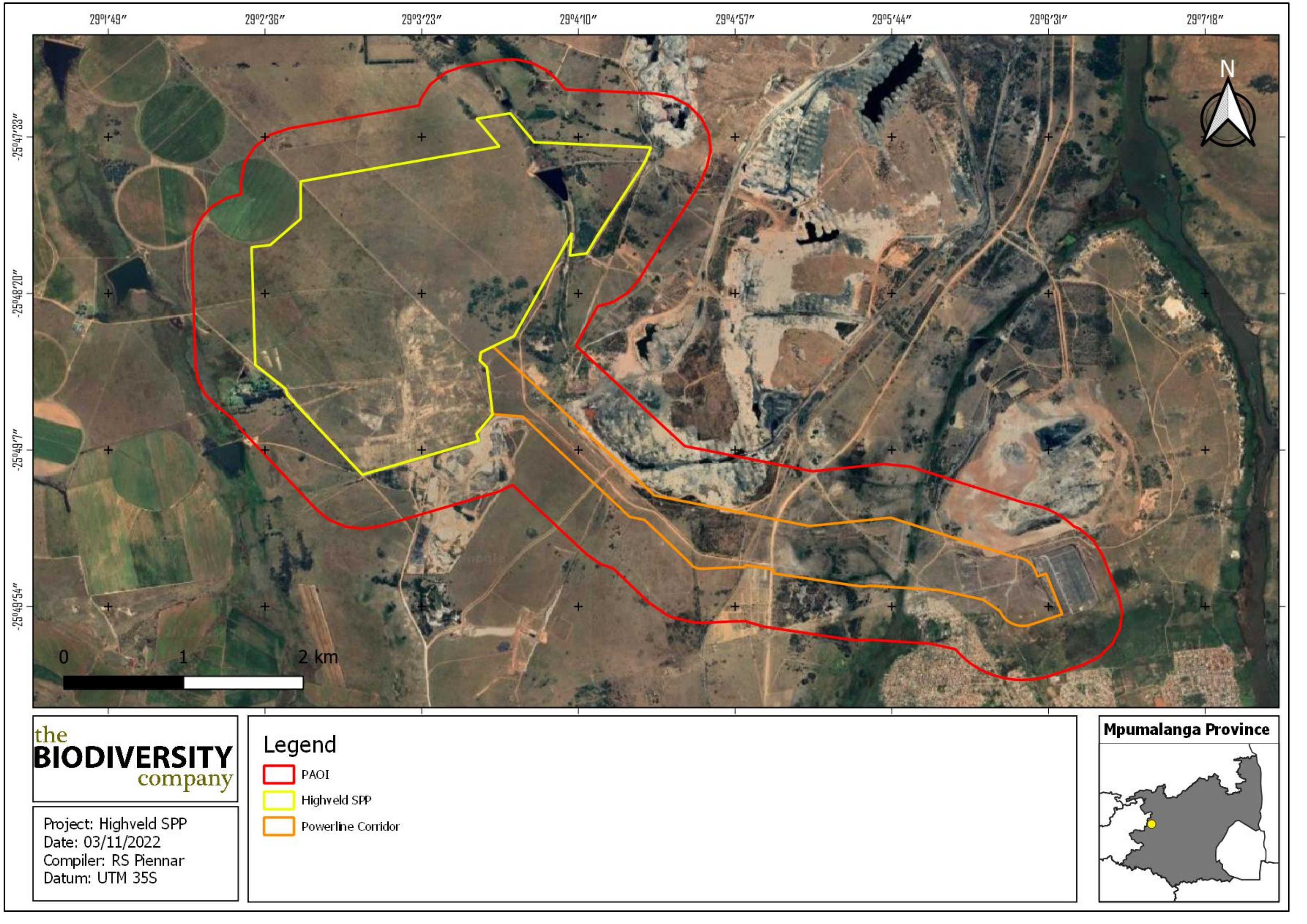

Figure 1-3 ***Highveld SPP Solar Energy Facility broad layout***

1.3 Specialist Details

Report Name	**Wetland Baseline & Risk Assessment for the proposed Highveld Solar Project**
Reference	**Highveld Solar PV**
Submitted to	ENVIRONAMICS
Report Writer & Fieldwork	**Rian Pienaar**
	Rian Pienaar is an aquatic ecologist (Cand. Sci. Nat. 135544) with experience in wetland identification and delineations. Rian completed his M.Sc. in environmental science at the North-West University Potchefstroom Campus. Rian has been part of wetland studies for road and culvert upgrades, power station and dam construction.
Reviewer	**Andrew Husted**
	Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 13 years' experience in the environmental consulting field.
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

1.4 Terms of Reference

The following tasks were completed in fulfilment of the terms of reference for this assessment:

- The delineation, classification and assessment of wetlands within 500 m of the project area;
- Conduct risk assessments relevant to the proposed activity;
- Recommendations relevant to associated impacts; and
- Report compilation detailing the baseline findings.

1.5 Key Legislative Requirements

1.5.1 National Water Act (NWA, 1998)

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

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

A watercourse means;

- A river or spring;
- A natural channel in which water flows regularly or intermittently;

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

The NWA recognises that the entire ecosystem and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS. Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) and (i).

1.5.2 National Environmental Management Act (NEMA, 1998)

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

2 Methods

A single wetland site visit was conducted from the 18th to the 20th of October 2022, this would constitute a dry season survey.

2.1 Identification and Mapping

The wetland areas were delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 2-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

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

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

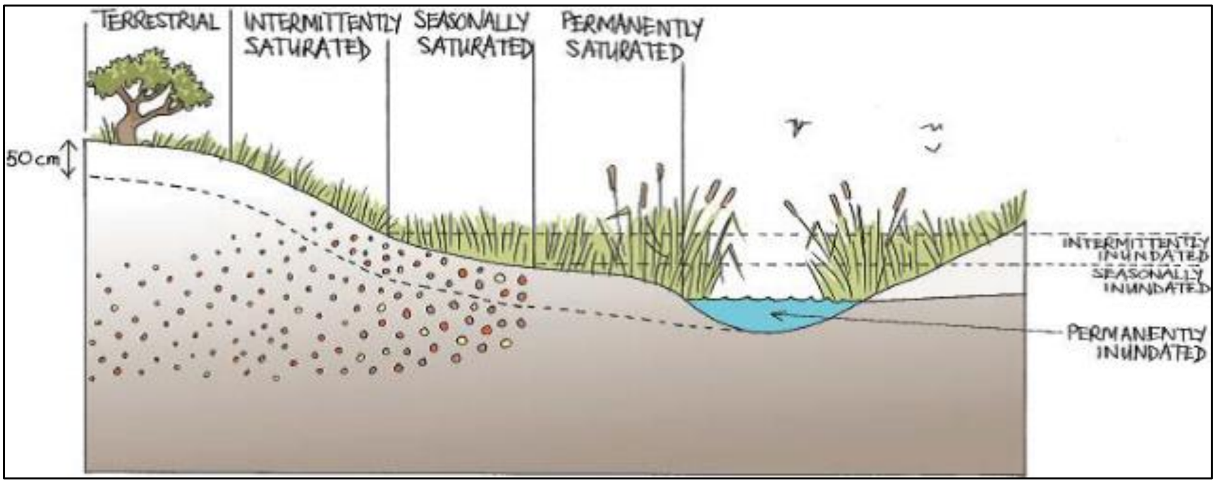

Figure 2-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al. 2013)

2.2 Delineation

The wetland indicators described above are used to determine the boundaries of the wetlands within the project area. These delineations are then illustrated by means of maps accompanied by descriptions.

2.3 Functional Assessment

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands as well as humans. Eco Services serves as the main factor contributing to wetland functionality.

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze *et al*. 2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 2-1).

Table 2-1 Classes for determining the likely extent to which a benefit is being supplied

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

2.4 Present Ecological Status

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 2-2.

Table 2-2 The Present Ecological Status categories (Macfarlane, et al., 2008)

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

2.5 Importance and Sensitivity

The importance and sensitivity of water resources is determined to establish resources that provide higher than average ecosystem services, biodiversity support functions or are particularly sensitive to impacts. The mean of the determinants is used to assign the Importance and Sensitivity (IS) category as listed in Table 2-3.

Table 2-3 Description of Importance and Sensitivity categories

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

2.6 Ecological Classification and Description

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

2.7 Buffer Requirements

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

2.8 Assumptions and Limitations

The following assumptions and limitations are applicable for this assessment:

- The focus area was based on the spatial files provided by the client and any alterations to the area and/or missing GIS information would have affected the area surveyed;
- Only the outline area of the proposed site was provided to the specialist; and
- The GPS used for the survey has a 5 m accuracy and therefore any spatial features may be offset by 5 m.

3 Results and Discussion

3.1 Desktop Baseline

3.1.1 Vegetation Type

The project area falls within two vegetation types namely the Rand Highveld Grassland (Gm 11) and the Eastern Highveld Grassland (Gm 12) vegetation types.

The distribution of the Rand Highveld Grassland ranges between the North-West, Gauteng, Free State and Mpumalanga provinces. This vegetation type can be found between rocky ridges specifically between Witbank and Pretoria. The Rand Highveld Grassland extends into these ridges in the Stoffberg area as well as west of Krugersdorp stretching all the way to Potchefstroom. The preferred altitude for this vegetation type is between 1 300 metres above sea level and 1 635 metres above sea level.

Grass species commonly found in these regions include the genera *Themeda. Eragrostis, Elionurus* and *Heteropogon*. The diversity of herbs is high in these regions with rocky ridges and hills being colonized by sparse woodlands accompanied by a rich suite of shrubs with the genus *Rhus* making up the bulk thereof. The sparse woodlands in this vegetation type includes species like *Protea caffra* subsp., *Caffra, Acacia caffra, P. Welwitschii* etc.

The Eastern Highveld Grassland (Gm 12) vegetation type is located in the Gauteng and Mpumalanga province within the plains between Belfast and Johannesburg. This vegetation type also extends to Bethal, the western areas of Piet Retief and Ermelo. The altitude in which this vegetation type occurs ranges between 1 520 meters above sea level to 1 780 meters above sea level, Mucina & Rutherford (2006).

The vegetation of this vegetation type is characterised by short and dense grasslands that occur in moderately undulating plains which include low hills and pan depressions. Small scattered rocky outcrops are common in this area with wiry, sour grasses accompanied by some woody species which include *Celtis africana, Parinari capensis, Protea caffra* etc.

The conservation status of the Gm 12 vegetation type is endangered with a target percentage of 24. Half of the area is already transformed into agriculture, mining, urban etc. with a handful of conservation areas still up and running. These include Holkranse, Nooitgedacht Dam and Morgenstond (just to name a few).

3.1.2 Soils and Geology

According to the land type database (Land Type Survey Staff, 1972 - 2006), the project area is characterised by three different landtypes namely Bb 11, Bb 12 and Bb 13 land types. This land types consists of plinthic catena. Upland duplex and margalitic soils are rare and dystrophic and/or mesotrophic red soils are not widespread.

The geology of this vegetation type is characterised by the Pretoria group and the Witwatersrand Subgroup's quartzite ridges as well as the Rooiberg Group's Selons River Formation which is from the Transvaal Supergroup. The parent geology from this vegetation type supports shallow soils like Glenrosa and Mispah which typically forms on slopes and ridges where topsoil is likely to wash off (Mucina and Rutherford, 2006).

3.1.3 Climate

The Gm 11 and 12 vegetation types is characterised by is characterised by a summer rainfall with a mean annual precipitation of 654 mm which is slightly lower in the western parts of this vegetation type, see (Figure 3-1). These areas are known to have warm-temperate conditions with dry winters. The likelihood of frost however is greater in the western parts with the incidence of frost ranging from 30 to

40 days compared to the east which has a frost incidence of 10 to 35 days. This vegetation type is also classified as endangered even though very little conservation has been done for this vegetation type.

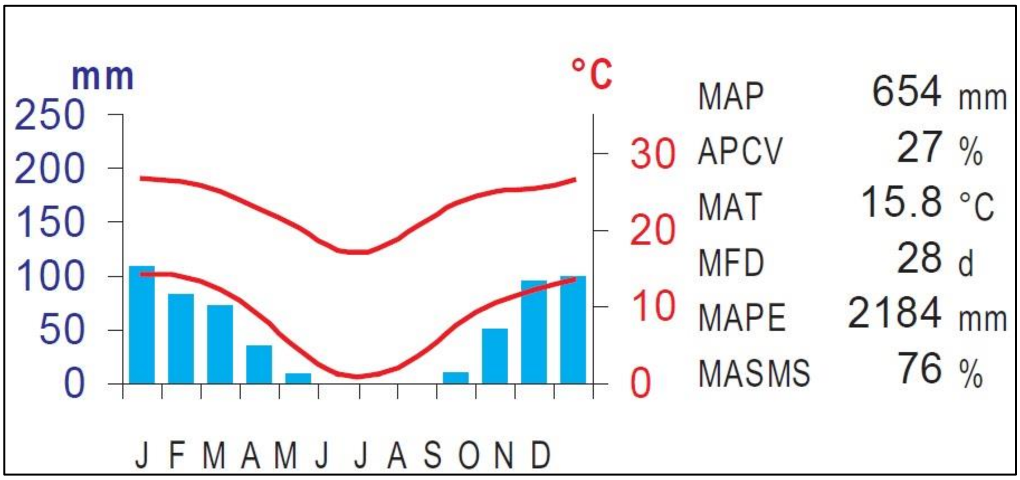

Figure 3-1 Climate for the Gm 11 and Gm 12 vegetation types (Mucina & Rutherford, 2006)

3.1.4 South African Inventory of Inland Aquatic Ecosystems

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

Two wetland types were identified by means of this data set. The wetlands are classified as being channelled valley bottoms and hillslope seeps respectively. The channelled valley bottoms conditions were classified as being a C (Moderately Modified) and the hillslope seep was classified as being a D/E/F (Critically Modified).

3.1.5 NFEPA Wetlands

Three wetland types have been identified within the project area of influence, namely multiple channelled valley bottom wetlands, three wetland flats and an unchanneled valley bottom wetland (see Figure 3-2).

3.1.6 Topographical Inland Water and River Lines

The topographical inland and river line data for “2529” quarter degree was used to identify potential wetland areas within the PAOI. This data set indicates multiple inland water areas of which were classified as being dams and marsh vlei’s as well as perennial and non-perennial river lines located within the PAOI (see Figure 3-2).

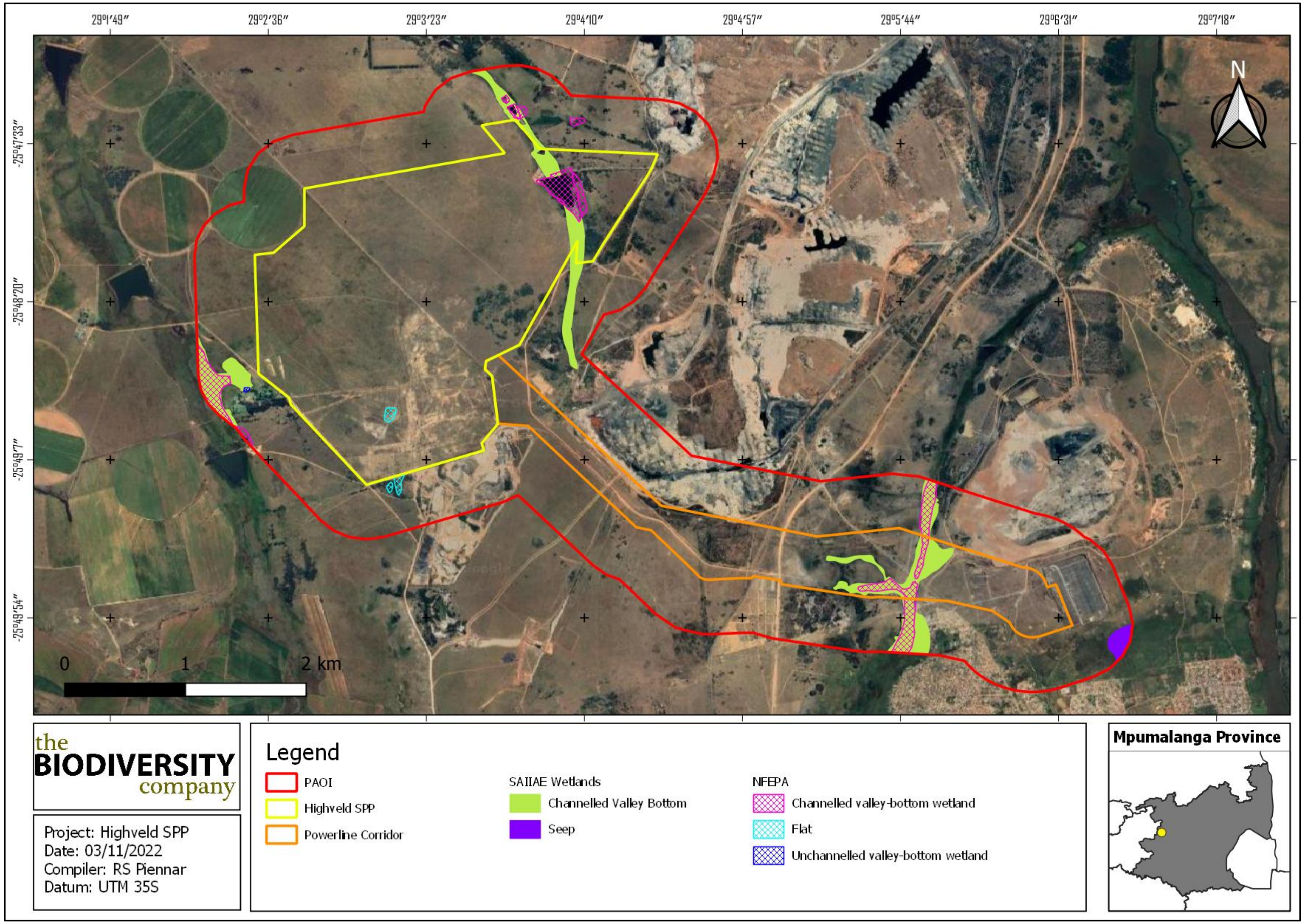

Figure 3-2 **SAIIAE and NFEPA wetlands located within PAOI**

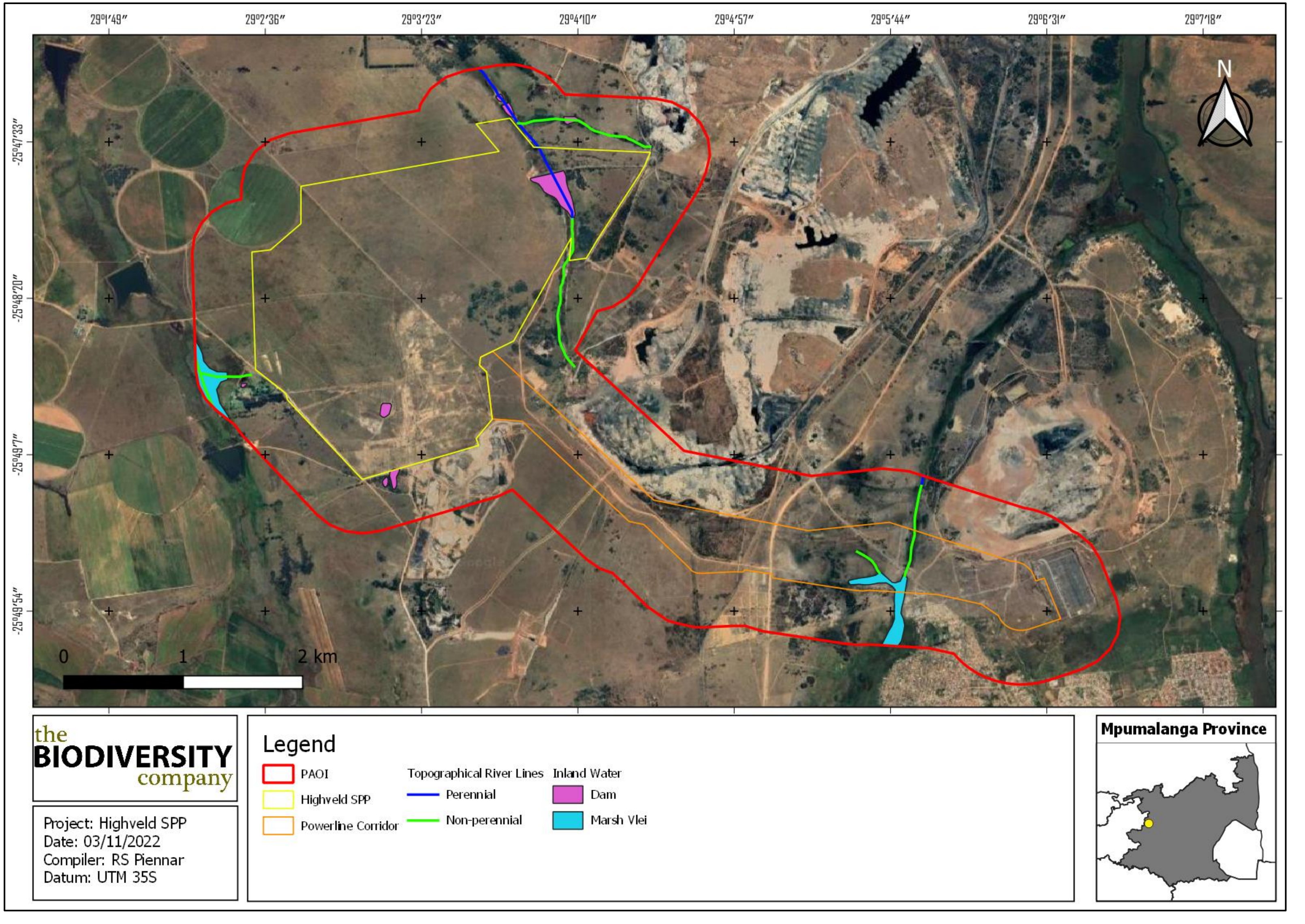

Figure 3-3 Topographical River line and inland water areas located within the PAOI

3.1.7 Terrain

The terrain of the PAOI has been analysed to determine potential areas where water is more likely to accumulate (due to convex topographical features, preferential pathways, or more gentle slopes).

3.1.7.1 Digital Elevation Model (DEM)

A Digital Elevation Model (DEM) has been created to identify lower laying regions as well as potential convex topographical features which could point towards preferential flow paths. The PAOI ranges from 1 413 to 1 540 metres above sea level (MASL). The lower laying areas (generally represented in dark blue) represent the area that will have the highest potential to be characterised as wetlands (see Figure 3-4).

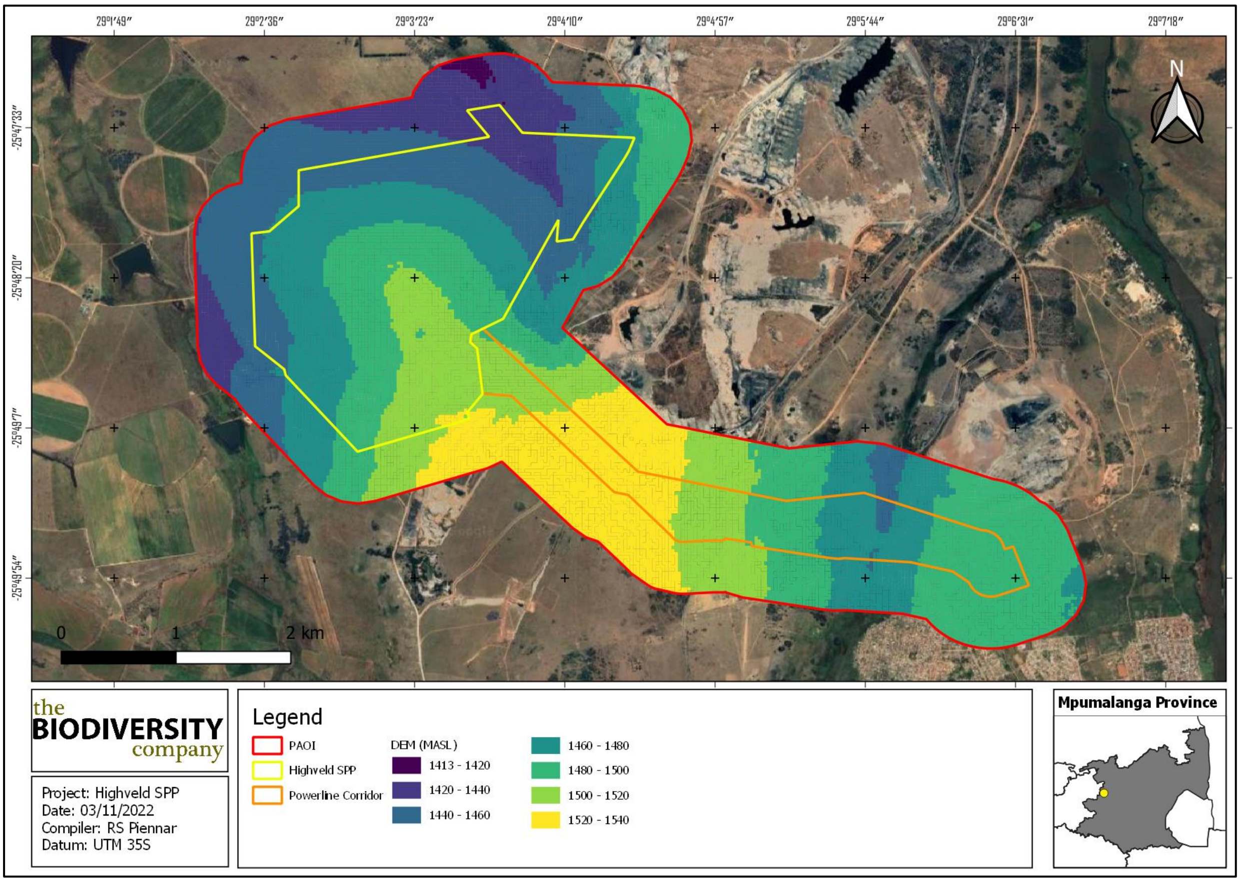

Figure 3-4 Digital Elevation Model of the PAOI

4 Field Assessment

4.1 Delineation and Description

During the site visit, nine HGM units were identified within the PAOI (see Figure 4-2). The wetland areas were delineated in accordance with the DWAF (2005) guidelines (see Figure 4-1 and Figure 4-2). HGM units have been classified as three channelled valley bottoms, three unchanneled valley bottoms and three hillslope seep wetlands. Multiple artificial wetlands, namely dams and drainage features were identified to the within the PAOI. According to Ollis *et al* (2013) a dam is classified as '*an artificial body of water formed by the unnatural accumulation of water behind an artificial barrier that has been constructed across a river channel or an unchannelled valley bottom wetland'*. Although these systems do not classify as a natural wetland system it is important to note where the dams are for any planned development in the area. The delineation of the wetland systems and functional assessment have been completed for the unchanneled valley bottom wetlands in which the dams are located.

Drainage features (or lines) were also identified for the eastern catchment the PAOI. These features are referred to as 'A' Section channels that convey surface runoff immediately after a storm event and are not associated with a baseflow (DWAF, 2005).

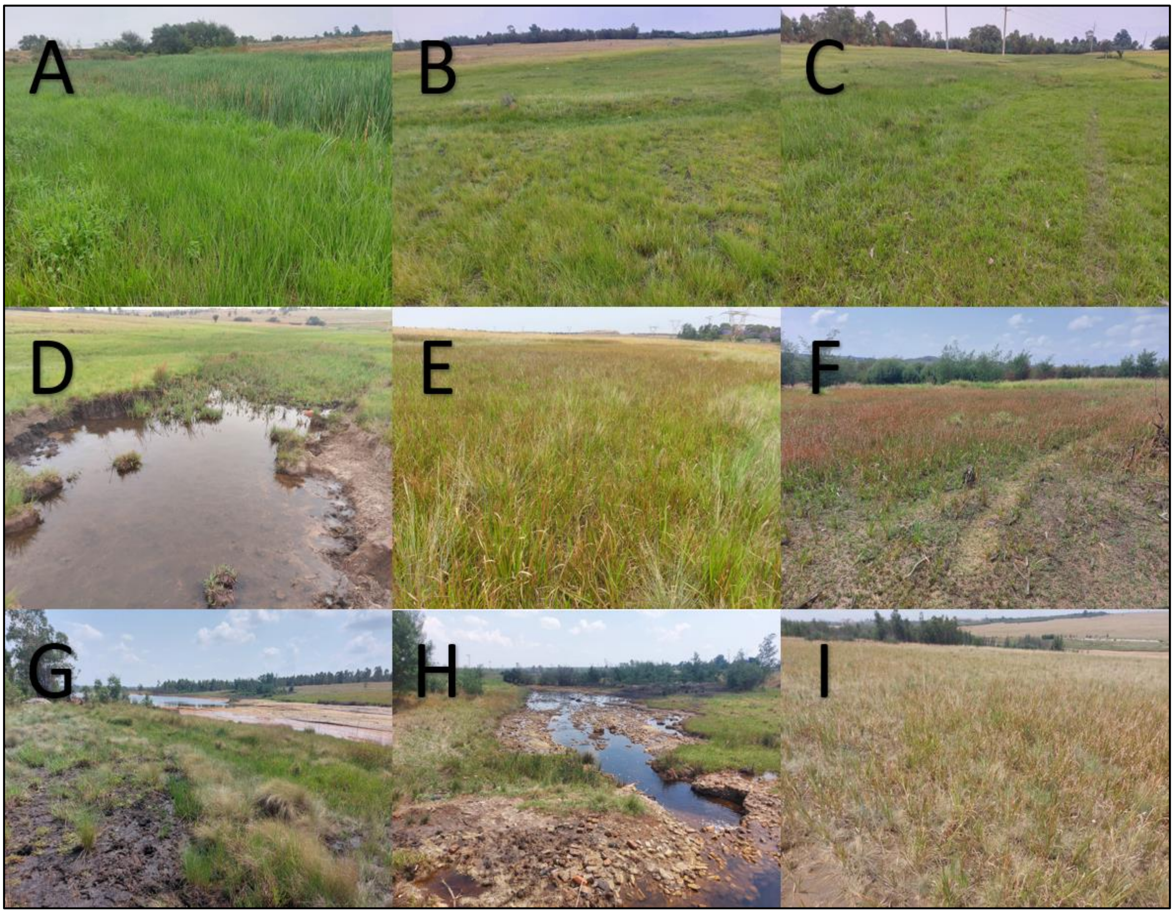

Figure 4-1 ***Photographical evidence of the different wetland types found within the project area of influence, A) Channelled valley bottom, B, C & D) Unchannelled valley bottom wetlands, E & F) Hillslope Seep, G & H) Channelled Valley bottom wetlands and I) Hillslope seep wetland.***

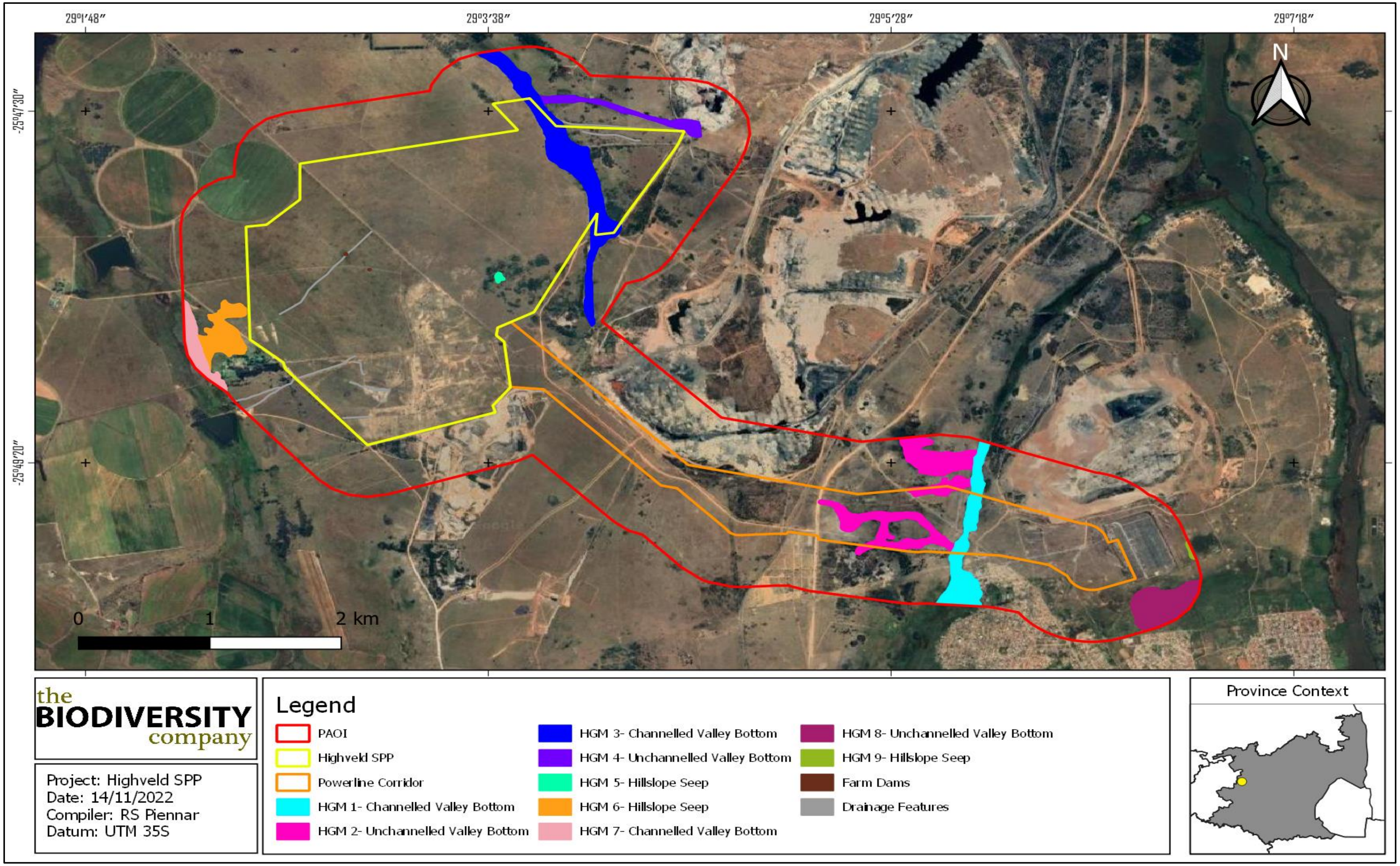

Figure 4-2 Delineation and location of the different HGM units identified within the PAOI

4.2 Unit Setting

Channelled valley bottom wetlands are typically found on valley floors with a clearly defined, finite stream channel and lacks floodplain features, referring specifically to meanders. Channelled valley bottom wetlands are known to undergo loss of sediment in cases where the wetlands' slope is steep and the deposition thereof in cases of low relief. Figure 4-3 presents a diagram of a typical channelled valley bottom, showing the dominant movement of water into, through and out of the system.

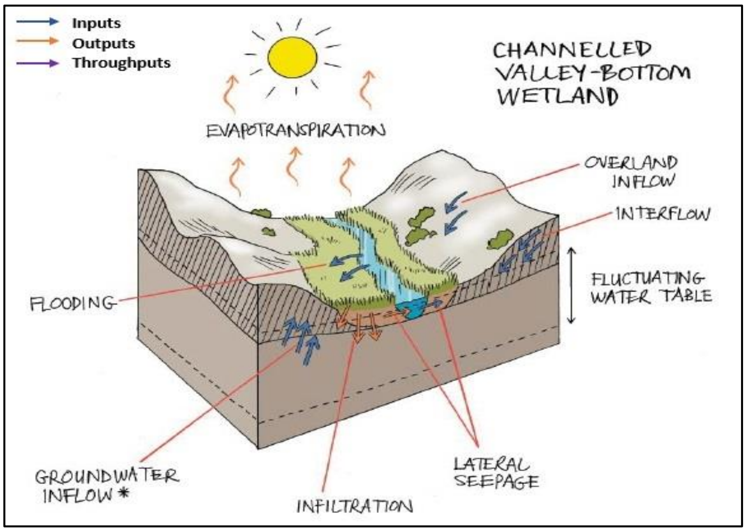

Figure 4-3 ***Amalgamated diagram of a typical channelled valley bottom, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)***

Unchannelled valley bottom wetlands are typically found on valley floors where the landscape does not allow high energy flows. Figure 4-4 presents a diagram of a typical unchannelled valley bottom wetland, showing the dominant movement of water into, through and out of the system.

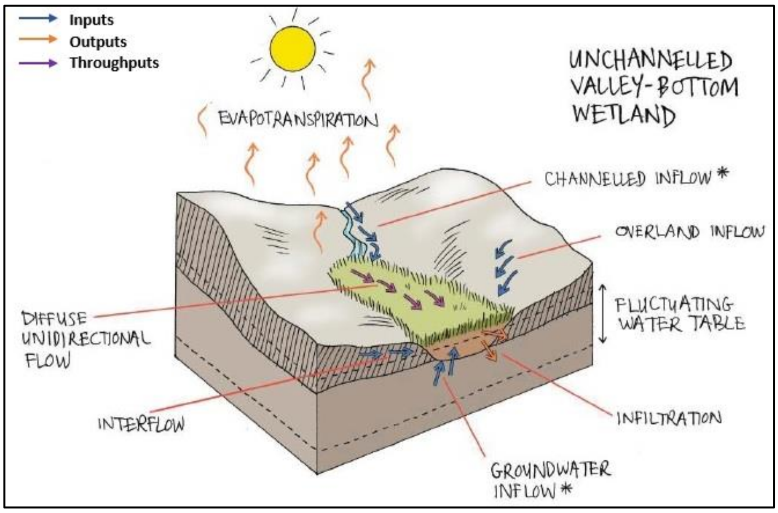

Figure 4-4 ***Amalgamated diagram of a typical unchannelled valley bottom, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)***

A typical hillslope seep is located within slopes, as mentioned in Figure 4-5. Isolated hillslope seeps are characterised by colluvial movement of material. These systems are fed by very diffuse sub-surface flows which seep out at very slow rates, ultimately ensuring that no direct surface water connects this wetland with other water courses within the valleys. Figure 4-5 illustrates a diagram of the hillslope seeps, showing the dominant movement of water into, through and out of the system.

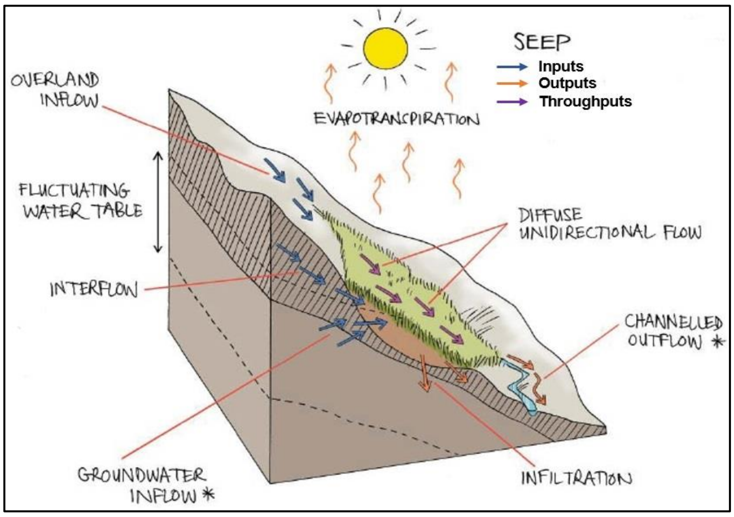

Figure 4-5 Amalgamated diagram of a typical hillslope seep, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

The DWAF (2005) manual separates the classification of watercourses into three (3) separate types of channels or sections defined by their position relative to the zone of saturation in the riparian area. The classification system separates channels into:

- those that do not have baseflow ('A' Sections);
- those that sometimes have baseflow ('B' Sections) or non-perennial; or
- those that always have baseflow ('C' Sections) or perennial.

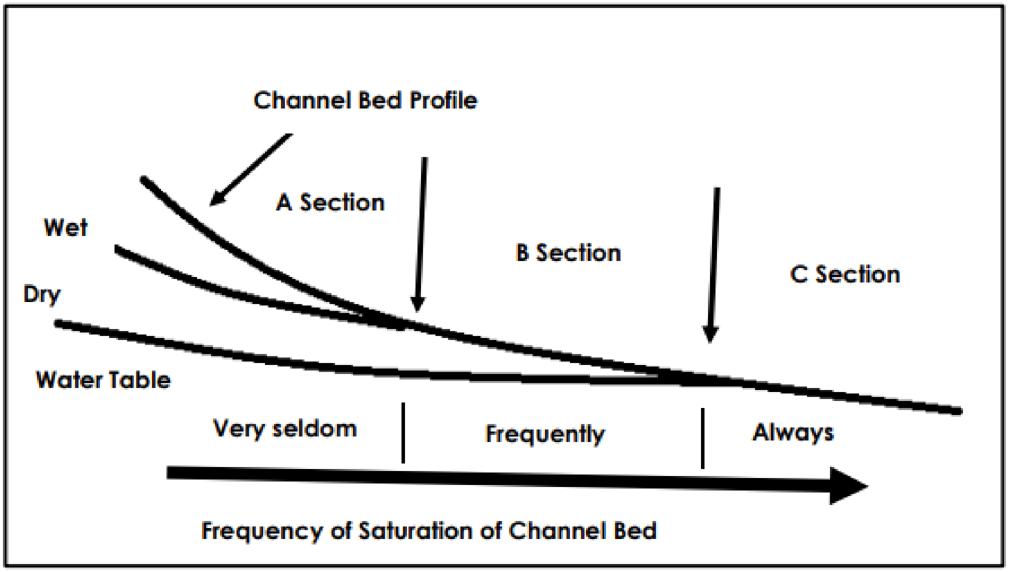

Figure 4-6 The watercourse classifications (DWAF, 2005)

4.3 General Functional Description

Channelled valley bottom wetlands tend to contribute less to sediment trapping and flood attenuation than other systems. Channelled valley bottom wetlands are well known to improve the assimilation of toxicants, nitrates and sulphates, especially in cases where sub-surface flows contribute to the system's water source (Kotze et al., 2009).

Unchanneled valley-bottoms are characterised by sediment deposition, a gentle gradient with streamflow generally being spread diffusely across the wetland, ultimately ensuring prolonged saturation levels and high levels of organic matter. The assimilation of toxicants, nitrates and phosphates are usually high for unchanneled valley-bottom wetlands, especially in cases where the valley is fed by sub-surface interflow from slopes. The shallow depths of surface water within this system adds to the degradation of toxic contaminants by means of sunlight penetration.

Unchanneled valley-bottoms are characterised by sediment deposition, a gentle gradient with streamflow generally being spread diffusely across the wetland, ultimately ensuring prolonged saturation levels and high levels of organic matter. The assimilation of toxicants, nitrates and phosphates are usually high for unchanneled valley-bottom wetlands, especially in cases where the valley is fed by sub-surface interflow from slopes. The shallow depths of surface water within this system adds to the degradation of toxic contaminants by means of sunlight penetration.

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

4.4 Ecological Functional Assessment

The ecosystem services provided by the wetland units identified on site were assessed and rated using the WET-EcoServices method (Kotze *et al.,* 2008). The average ecosystem service scores for the delineated systems are illustrated in Table 4-1 and Figure 4-7. The ecosystem services scores of the delineated wetlands ranges from low to high. Ecosystem services contributing to these scores include flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation, erosion control, and provision of cultivated foods.

Table 4-1 Average ecosystem service scores for delineated wetlands

High	Moderately High	Intermediate	Moderately Low	Low
HGM 1	HGM 4	HGM 3	HGM 5	HGM 8
HGM 2	HGM 6	HGM 9		
HGM 7				

HGM units 1, 2 and 7 scored the highest ecological services scores due to the high hydrophyte vegetation cover present within the HGM units. These HGM units were classified as being valley bottom wetlands where water will runoff to after heavy rains. The vegetation cover present inside these wetlands will help with flood attenuation and streamflow regulation. The vegetation also helps with sediment trapping and the assimilation of phosphates, nitrates and toxicants. These HGM units also play an important role in the provision of resources for both humans as well as charismatic species.

HGM 5 & 8 scored the lowest ecological services scores due to the lack of hydrophyte vegetation. HGM 8 underwent major sandmining activities which have removed most of the vegetation and hydromorphic soils from the wetland which in turn lower the wetland's function. HGM 5 is located on a hillslope and thus do not play any role in streamflow regulation, sediment trapping or flood attenuations. The HGM unit also does not have hydrophyte vegetation and thus his ecological function is very low.

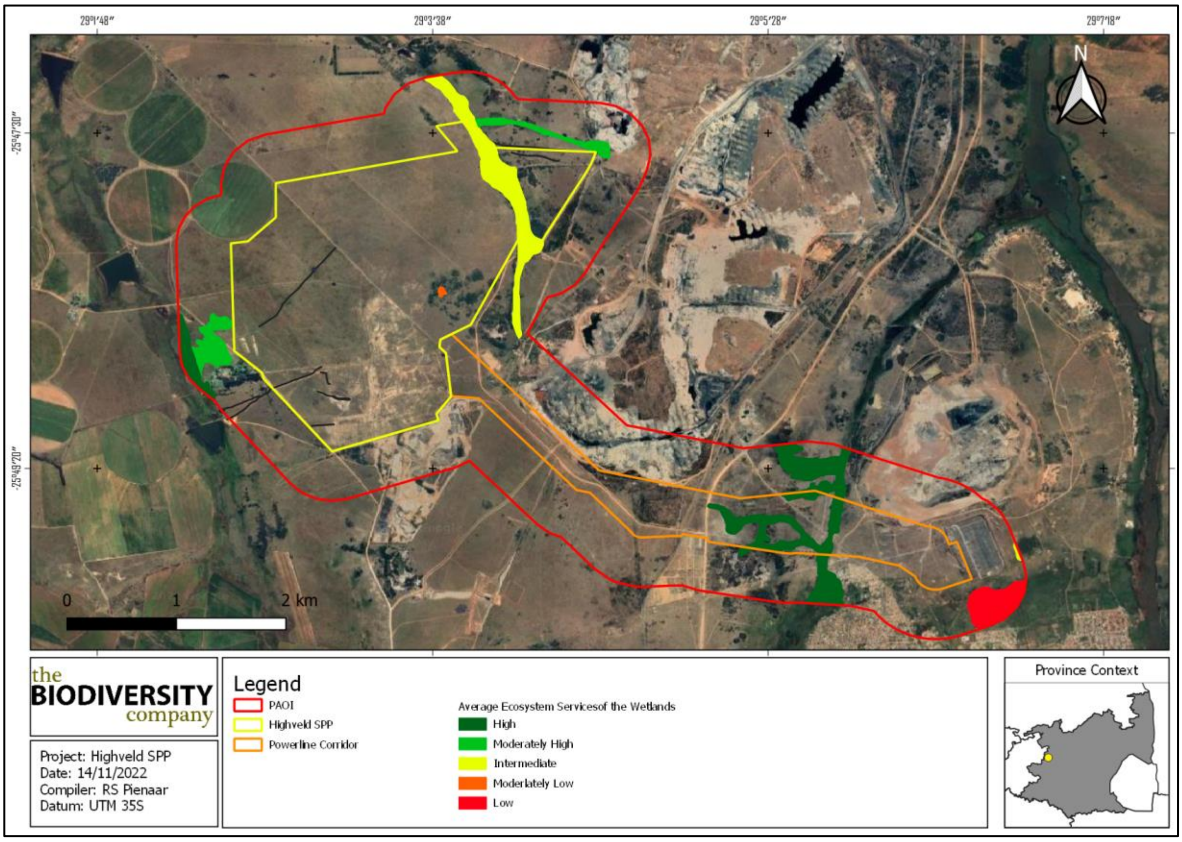

Figure 4-7 Average ecosystem services scores for the delineated wetlands

4.5 Ecological Health Assessment

The PES for the assessed HGM units is presented in Figure 4-9 and Table 4-2. The delineated wetland systems have been scored overall PES ratings ranging from moderately modified (class C) to seriously modified (class E), depending on the level of modification.

The findings from the PES assessment indicate significant disturbances to HGM 3, 5 and 8 that has been rated a seriously modified score. Five HGM units was classified as being largely modified (class D). Some notable modifications to the delineated wetlands include (see Figure 4-8);

- Sand mining;
- Salt and acid pollution;
- Removal of hydrophyte vegetation;
- Erosion;
- Alien invasive vegetation;
- Drainage channels;
- Dirt and tar roads;
- Fences through the wetlands;
- Dumping of waste; and
- Grazing of animals.

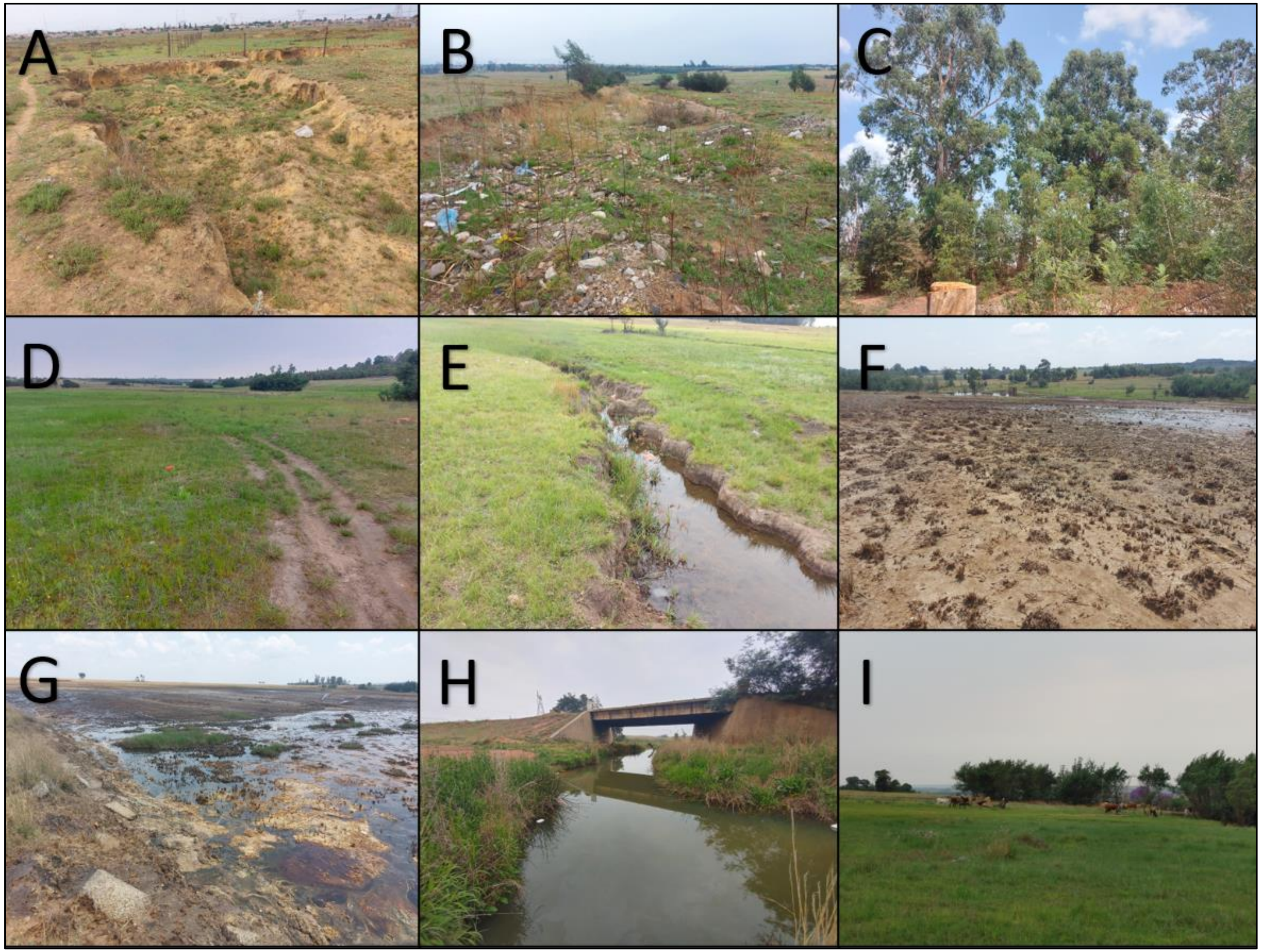

Figure 4-8 ***Examples of the different impacts on the wetlands within the PAOI, A) sand mining activities, B) Dumping of building and other rubbish, C) Alien invasives, D) Dirt Road through wetlands, E) Erosion inside of unchanneled valley bottoms, F) Removal of hydrophyte vegetation, G) Salt and acid pollution, H) Bridge inside the wetland, I) Grazing of cows inside the wetlands.***

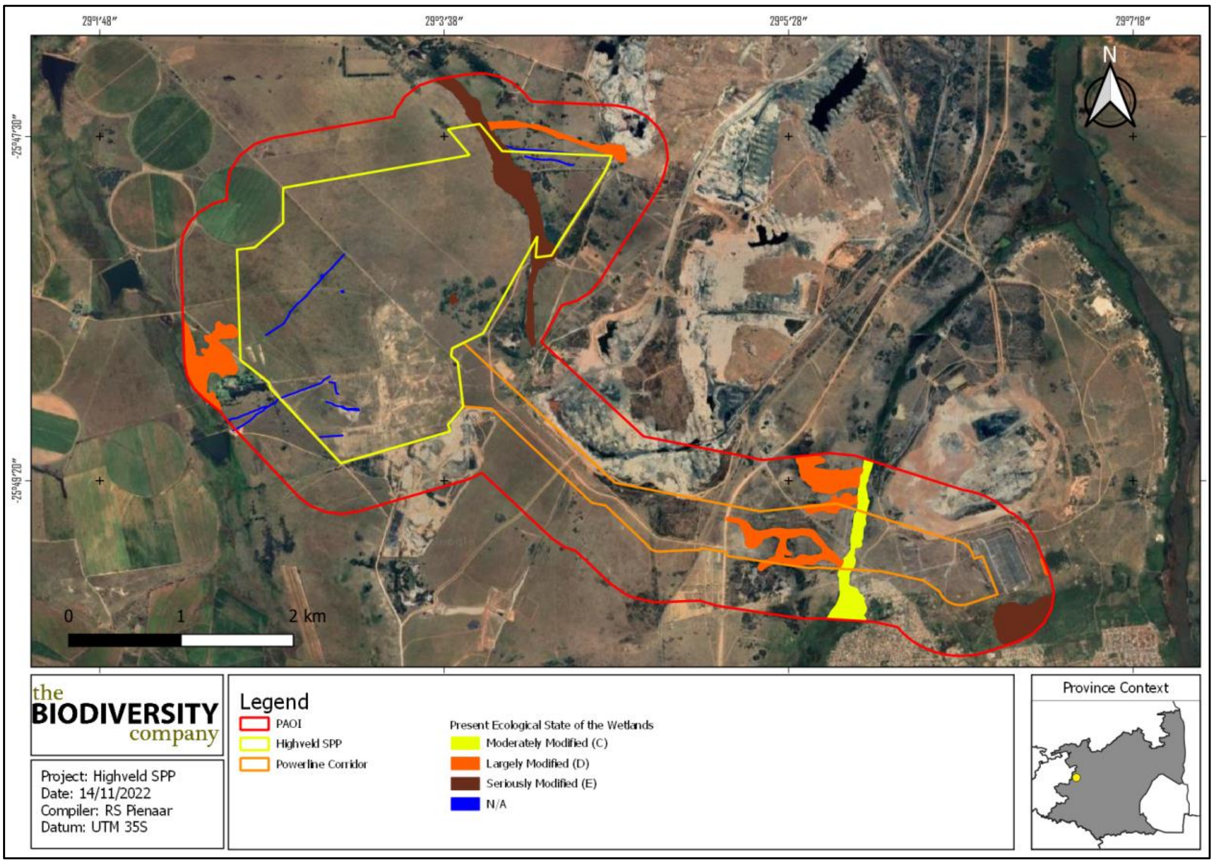

Figure 4-9 Overall present ecological state of delineated wetlands

Table 4-2 Summary of the scores for the wetland PES

Moderately Modified	Largely Modified (D)	Seriously Modified (E)
HGM 1	HGM 2	HGM 3
	HGM 4	HGM 5
	HGM 6	HGM 8
	HGM 7	

4.6 Importance & Sensitivity Assessment

The results of the ecological IS assessment are shown in Table 4-3. Various components pertaining to the protection status of a wetland are considered for the IS, including Strategic Water Source Areas (SWSA), the NFEPA wetland vegetation (wet veg) threat status and the protection status of the wetland. The IS for all the wetlands have been calculated to be "Moderate", which combines the relatively High threat status and the low protection levels of the wetland.

Table 4-3 The IS results for the delineated HGM units

HGM Type	NFEPA Wet Veg			NBA Wetlands			SWSA (Y/N)	Calculated IS
	Type	Ecosystem Threat Status	Ecosystem Protection Level	Wetland Condition	Ecosystem Threat Status 2018	Ecosystem Protection Level		
Channelled Valley Bottom	Mesic Highveld Grassland Group 4	Critical	Not Protected	D/E/F Largely Modified	Critical	Not Protected	N	Moderate

Unchannelled Valley Bottoms	Mesic Highveld Grassland Group 4	Critical	Not Protected	D/E/F Largely Modified	N/A	N/A	N	**Moderate**
Hillslope Seep	Mesic Highveld Grassland Group 4	Endangered	Not Protected	D/E/F Largely Modified	Critical	Poorly Protected	N	**Moderate**

4.7 Buffer Requirements

It is worth noting that the scientific buffer calculation (Macfarlane *et al*., 2014) was used to determine the size of the buffer zones relevant to the proposed project. A pre-mitigation buffer zone for the PV development of 30 m is recommended for the identified wetlands, which can be decreased to 15 m with the addition of all prescribed mitigation measures (see Table 4-4). The pre-mitigation buffer zone pertaining to the powerline were calculated at 24 m, which can be decreased to 15 m with the addition of all the prescribed mitigation measures.

Table 4-4 Pre- and post-mitigation buffer requirements

Aspect	Pre-Mitigation Buffer Size (m)	Post Mitigation Buffer Size (m)
PV development	30	15
Powerline	24	15

5 Risk Assessment

5.1 Potential Impacts

The impact assessment considered both direct and indirect impacts, if any, to the wetland systems. The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) will be considered for this component of the assessment (Figure 5-1). In accordance with the mitigation hierarchy, the preferred mitigatory measure is to avoid impacts by considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts. Figure 5-2 below indicates the different levels of risk associated with the PV area, and Figure 5-3 indicates the risk levels for the proposed powerline route.

Two separate risk assessments were done for the project the first one being for the PV area and the second one for the powerline route. The risk assessment for the PV area where the risks are expected to be medium (pre-mitigation) due to the presence of natural wetlands and drainage features within the proposed development areas. For the PV area avoidance will not be achieved and the risk assessment will thus focus on the second step of the mitigation hierarchy namely minimisation of the impacts. Since direct impacts to the wetlands (and buffers) cannot be avoided, the risk assessment will consider both the direct and indirect risks posed to these systems as a result of the project. Table 5-1 illustrates various aspects that are expected to impact upon the delineated wetlands during the respective project phases.

If avoidance cannot be met when designing the PV layout a wetland compensation plan will need to be compiled in order to replace the ecosystem services provided by the wetland affected by the PV development.

The risk assessment for the powerline route where the pre-mitigation risk rating will be moderate due to the powerline traversing multiple wetlands. However, for the powerline avoidance can be possible by taking care of where the pylons of the powerlines will be located. Although the risks will be minimised with the placement of the pylons outside of the wetland buffers the lines will still be pulled through the wetlands and some direct as well as indirect impacts will occur on the wetlands. Table 5-2 illustrates various aspects that are expected to impact upon the delineated wetlands during the respective project phases.

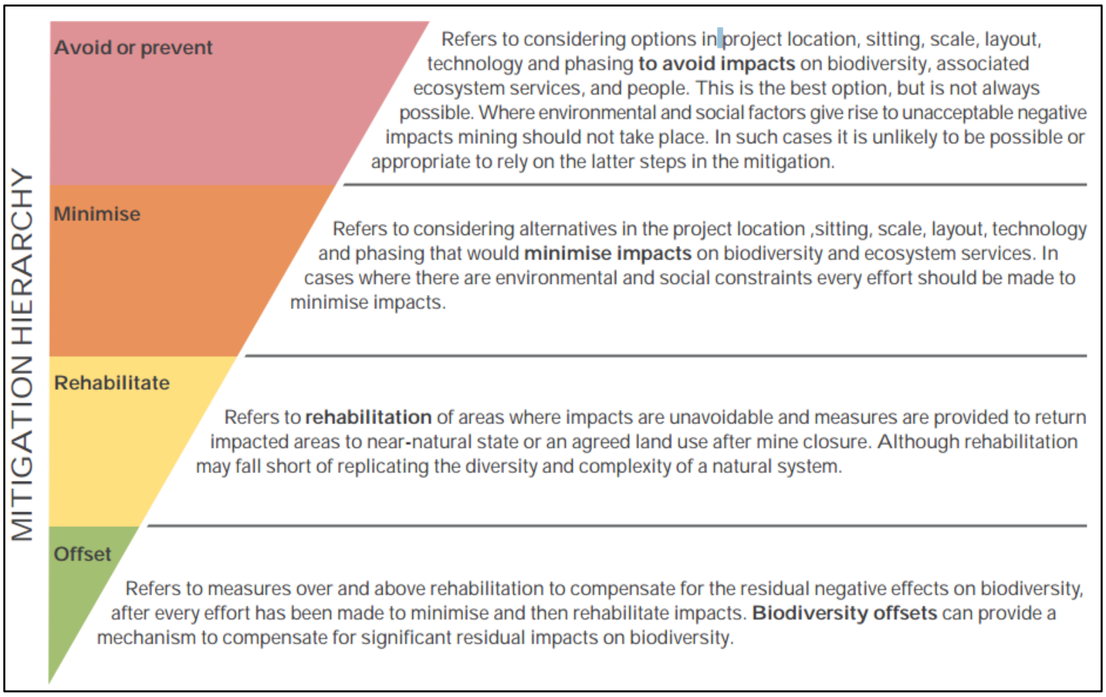

Figure 5-1 The mitigation hierarchy as described by the DEA (2013)

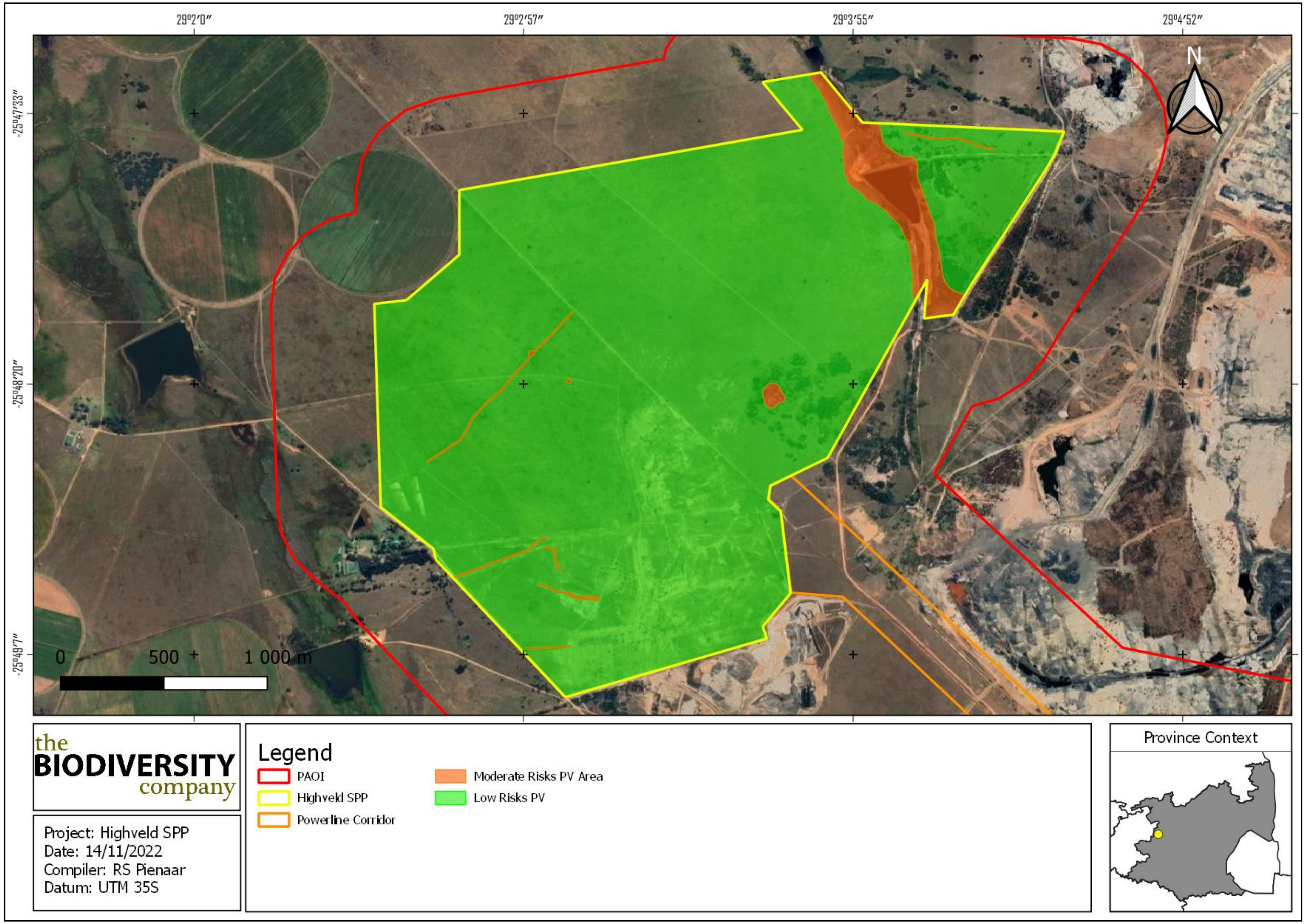

Figure 5-2 The identified risk areas within the PV Area

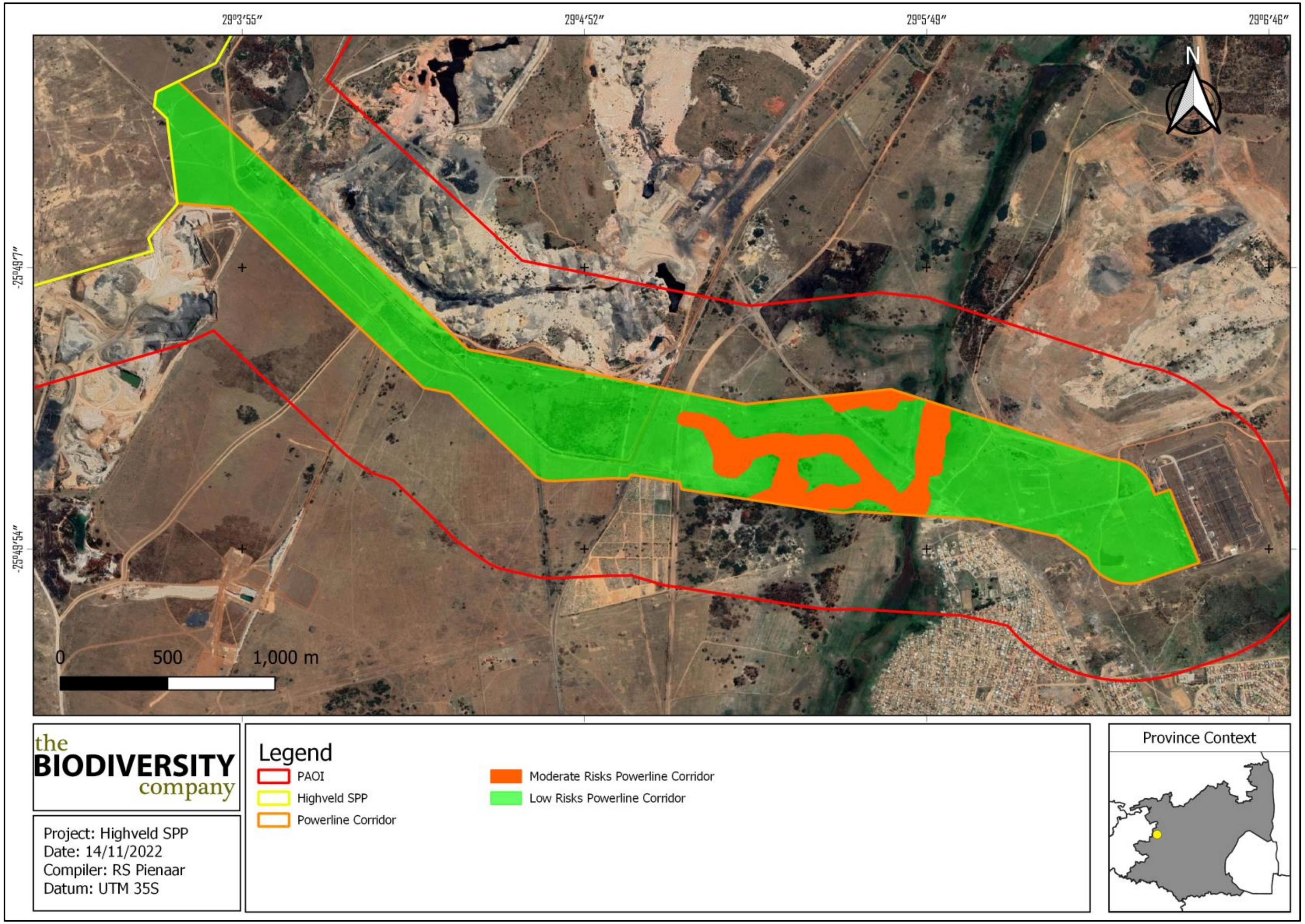

Figure 5-3 The identified risk area for the powerline corridor.

Table 5-1 DWS Risk Impact Matrix for PV area (Andrew Husted Pr Sci Nat 400213/11)

Activity	Aspect	Impact	Mitigation	Severity: Flow Regime	Severity: Water Quality	Severity: Habitat	Severity: Biota	Total	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Control Measures
Construction																			
Site clearing and preparation.	Wetland disturbance / loss.	Direct disturbance / degradation / loss to wetland soils or vegetation due to the construction of the solar facility.	Without	3	2	3	2	2.5	2	3	7.5	3	4	1	1	9	68	**M**	• Clearly demarcate the construction footprint and restrict all construction activities to within the proposed infrastructure area. • When clearing vegetation, allow for some vegetation cover as opposed to bare areas. • Minimize the disturbance footprint and the unnecessary clearing of vegetation outside of this area. • Use the wetland shapefiles to signpost the edge of the wetlands closest to site. Place the sign 25 m from the edge (this is the buffer zone). Label these areas as environmentally sensitive areas, keep out. • Educate staff and relevant contractors on the location and importance of the identified wetlands through toolbox talks and by including them in site inductions as well as the overall master plan. • All activities (including driving) must adhere to the 25 m buffer area. • Promptly remove / control all alien and invasive plant species that may emerge during construction (i.e. weedy annuals and other alien forbs) must be removed. • All alien vegetation along the transmission servitude should be managed in terms of the Regulation GNR.1048 of 25 May 1984 (as amended) issued in terms of the Conservation of Agricultural Resources Act, Act 43 of 1983. By this Eskom is obliged to control. • Landscape and re-vegetate all denuded areas as soon as possible.
			With	2	1	2	1	1.5	2	3	6.5	3	3	1	1	8	52	**L**	

				Severity															
Activity	**Aspect**	**Impact**	**Mitigation**	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Total**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Control Measures**
	Water runoff from construction site.	Increased erosion and sedimentation.	Without	3	3	2	2	2.5	2	3	7.5	3	3	1	2	9	68	M	• Limit construction activities near (< 50m) wetlands to winter (as much as possible) when rain is least likely to wash concrete and sand into the wetland. Activities in black turf soils can become messy during the height of the rainy season and construction activities should be minimised during these times to minimise unnecessary soil disturbances. • Ensure soil stockpiles and concrete / building sand are sufficiently safeguarded against rain wash. • No activities are permitted within the wetland and associated buffer areas. • Landscape and re-vegetate all unnecessarily denuded areas as soon as possible.
			With	2	2	1	1	1.5	2	2	5.5	3	2	1	1	7	39	L	
		Potential contamination of wetlands with machine oils and construction materials.	Without	1	3	2	2	2	1	2	5	3	3	1	2	9	45	L	• Make sure all excess consumables and building materials / rubble is removed from site and deposited at an appropriate waste facility. • Appropriately stockpile topsoil cleared from the project area. • Appropriately contain any generator diesel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) or construction materials on site (e.g. concrete) in such a way as to prevent them leaking and entering the wetlands. • No activities are permitted within the wetland and associated buffer areas.
			With	1	1	1	1	1	1	2	4	1	2	1	2	6	24	L	
Operation																			
Operation of the solar facility.	Hardened surfaces.	Potential for increased stormwater runoff leading to	Without	2	2	2	2	2	3	2	7	3	3	1	2	9	63	M	• Design and Implement an effective stormwater management plan. • Promote water infiltration into the ground beneath the solar panels.

Activity	Aspect	Impact	Mitigation	Severity: Flow Regime	Severity: Water Quality	Severity: Habitat	Severity: Biota	Total	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Control Measures
		Increased erosion and sedimentation.	With	1	1	1	1	1	2	2	5	1	2	1	1	5	25	L	• Release only clean water into the environment. • Stormwater leaving the site should not be concentrated in a single exit drain but spread across multiple drains around the site each fitted with energy dissipaters (e.g. slabs of concrete with rocks cemented in). • Re-vegetate denuded areas as soon as possible. • Regularly clear drains. • Minimise the extent of concreted / paved / gravel areas. • A covering of soil and grass (regularly cut and maintained) below the solar panels is ideal for infiltration. If not feasible then gravel is preferable over concrete or paving. • Avoid excessively compacting the ground beneath the solar panels.
	Contamination.	Potential for increased contaminants entering the wetland systems.	Without	2	3	2	2	2.3	3	2	7.3	3	3	1	2	9	65	M	• Where possible minimise the use surfactants to clean solar panels and herbicides to control vegetation beneath the panels. If surfactants and herbicides must be used do so well prior to any significant predicted rainfall events.
			With	1	1	1	1	1	2	2	5	1	2	1	1	5	25	L	
Closure																			
Decommissioning of the solar facility.	Rehabilitation.	Potential loss or degradation of nearby wetlands through inappropriate closure.	Without	2	2	3	2	2.3	2	3	7.3	3	3	1	1	8	58	M	• Develop and implement a rehabilitation and closure plan. • Appropriately rehabilitate the project area by ripping, landscaping and re-vegetating with locally indigenous species.
			With	1	1	1	1	1	2	2	5	1	2	1	1	5	25	L	

Table 5-2 DWS Risk Impact Matrix for the proposed powerline corridor (Andrew Husted Pr Sci Nat 400213/11)

Activity	Aspect	Impact	Mitigation Scenario	Severity				Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Control Measures
				Flow Regime	Water Quality	Habitat	Biota												
Construction																			
Clearing and preparation of powerline route including storage of equipment	Wetland vegetation deterioration and soil exposure.	Disturbance and degradation of wetland vegetation	Without	1	1	3	3	2	1	3	6	2	2	5	1	10	60	M	• Restrict the disturbance and clearance footprint to within 5 m on either side of the proposed powerline route (10 m disturbance corridor). • Avoid wetlands and buffers where feasible. Implement a rehabilitation plan for any disturbed wetlands. Cleared areas must be rehabilitated and stabilised to avoid impacts to adjacent wetland and buffer areas. • Although the prescribed post-mitigation buffer as per the national buffer determination tool is 15 m attempt wherever possible to maintain a 33 m buffer on the delineated wetlands to lower the potential for bird collisions which are highest near water resources. • Reduce the disturbance footprint and the unnecessary clearing of vegetation when traversing the identified drainage lines. • Make use of existing access routes as much as possible, before new routes are considered. Any selected “new” route must not encroach into the wetland areas.
			With	1	1	1	1	1	1	3	5	2	1	5	1	9	45	L	
		Increased bare surfaces, runoff and potential for erosion	Without	2	2	2	2	2	2	2	6	3	3	1	1	8	48	L	• Keep tower base excavation and soil heaps neat and tidy. • Limit construction activities in proximity (< 50 m) to wetlands to the dry season when storms are least likely to wash concrete and sand into wetlands. This is only where towers are within wetlands and buffer areas. • Ensure soil stockpiles and concrete / building sand are sufficiently safeguarded against rain wash. • Mixing of concrete must under no circumstances take place in any wetland or their buffers. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished. • Limit the placement of towers within wetlands and buffer areas where feasible. • Do not situate any of the construction material laydown areas within any wetland or buffer area. Try adhere to a 30 m buffer in these instances. • No machinery should be allowed to parked in any wetlands or buffer areas.
			With	1	1	1	1	1	2	2	5	3	1	1	1	6	30	L	

Activity	Aspect	Impact	Mitigation Scenario	Severity															Control Measures
				Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	
		Introduction and spread of alien and invasive vegetation	Without	1	1	3	3	2	1	2	5	3	3	5	1	12	60	M	• Promptly remove all alien and invasive plant species that may emerge during construction (i.e. weedy annuals and other alien forbs) must be removed. • Limit soil disturbance • The use of herbicides is not recommended in or near wetlands (opt for mechanical removal). • Appropriately stockpile topsoil cleared from the powerline footprint. • Clearly demarcate powerline construction footprint, and limit all activities to within this area. • Minimize unnecessary clearing of vegetation beyond the tower footprints and powerline corridors. • Lightly till any disturbed soil around the tower footprint to avoid compaction.
			With	1	1	2	1	1.25	1	2	4.25	3	1	1	1	6	26	L	
Excavation, levelling and installation of transmission towers.	Soil disturbance, sedimentation	Increased sediment loads to downstream reaches	Without	2	2	2	2	2	2	2	6	3	3	1	1	8	48	L	• See mitigation for increased bare surfaces, runoff and potential for erosion
			With	1	1	1	1	1	1	2	4	3	1	1	1	6	24	L	• Re-instate topsoil and lightly till transmission tower disturbance footprint.
		Contamination of wetlands with hydrocarbons due to leaks and spillages from machinery, equipment & vehicles as well as Contamination and eutrophication of wetland systems with human sewerage and litter.	Without	2	3	2	2	2.25	2	2	6.25	3	3	1	1	8	50	L	• Make sure all excess consumables and building materials / rubble is removed from site and deposited at an appropriate waste facility. • Appropriately contain any generator diesel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) or construction materials on site (e.g. concrete) in such a way as to prevent them leaking and entering wetland or buffer areas. • Mixing of concrete must under no circumstances take place within the wetland or buffer areas. • Check for oil leaks, keep a tidy operation, and promptly clean up any spills or litter. • Provide appropriate sanitation facilities for workers during construction and service them regularly. • The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected must be disposed of at a licensed disposal facility; • The Contractor must be in possession of an emergency spill kit that must be complete and available at all times on site; • Any possible contamination of topsoil by hydrocarbons must be avoided. Any contaminated soil must be treated in situ or
			With	1	3	1	1	1.5	2	2	5.5	3	1	1	1	6	33	L	

Activity	Aspect	Impact	Mitigation Scenario	Severity				Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Control Measures
				Flow Regime	Water Quality	Habitat	Biota												
																			be placed in containers and removed from the site for disposal in a licensed facility;
Operation																			
Routine operation and maintenance of power line route	Clearing of wetland vegetation beneath power line	Degradation of wetland vegetation wetland vegetation.	Without	1	1	1	3	1.5	2	1	4.5	3	1	5	1	10	45	L	• Clear vegetation in line with the 2010 Eskom Environmental Procedure Document entitled "Procedure for vegetation clearance and maintenance within overhead powerline servitudes". • Avoid the use of herbicides and diesel to treat stumps within the wetland and buffer areas. • Make use of existing access routes as much as possible, before new routes are considered. Any selected "new" route must not encroach into the wetland areas.
			With	1	1	1	23	6.5	2	1	9.5	3	1	5	1	10	95	L	
	Alien and Invasive species	Proliferation of alien and invasive species	Without	1	1	3	4	2.25	2	2	6.25	3	1	5	1	10	63	M	• In line with the 2010 Eskom Environmental Procedure Document entitled "*Procedure for vegetation clearance and maintenance within overhead powerline servitudes*" all alien vegetation along the transmission servitude should be managed in terms of the Regulation GNR.1048 of 25 May 1984 (as amended) issued in terms of the Conservation of Agricultural Resources Act, Act 43 of 1983. By this Eskom is obliged to control category 1, 2 and 3 plants to the extent necessary to prevent or to contain the occurrence, establishment, growth, multiplication, propagation, regeneration and spreading such plants within servitude areas.
			With	1	1	1	4	1.75	2	1	4.75	3	1	5	1	10	48	L	
Decommissioning																			
Removal of transmission towers and lines	Vehicle access	Degradation of wetland vegetation and proliferation of alien and invasive species	Without	2	2	2	3	2.25	1	2	5.25	3	1	5	1	10	53	L	• See mitigation for the impacts on direct loss, disturbance and degradation of wetlands and spread of alien and invasive plants. • Control should continue for a minimum of three years following decommissioning.
			With	1	1	2	3	1.75	1	2	4.75	3	1	5	1	10	48	L	
	Re-excavation of Transmission Towers	Increased bare surfaces, runoff and potential for erosion	Without	2	2	2	2	2	2	2	6	3	3	1	1	8	48	L	• See mitigation for increased bare surfaces, runoff and potential for erosion and increased sediment loads during construction
			With	1	1	1	1	1	2	2	5	3	1	1	1	6	30	L	

6 Conclusion and Recommendation

6.1 Baseline Ecology

During the site assessment, nine HGM units were identified and assessed within the project area of influence. These comprise of three channelled valley bottoms, three unchanneled valley bottom wetlands and three hillslope seep wetlands. The wetlands scored an overall PES scores ranging from C – "Moderately Modified" to E "Critically Modified" due to the modification to both the hydrology and vegetation of the wetlands through anthropogenic activities. The wetlands scored "Moderate" importance and sensitivity scores due to the high protection level of both the wetland vegetation and units. The average ecosystem service score was determined to range between "Low" and "High". A 15 m post mitigation buffer was assigned to the wetland systems for both the PV area as well as the powerline corridor.

6.2 Risk Assessment

Two risk assessments have been created for this project. The first risk assessment for the PV area showed that both direct and indirect impacts will occur on the wetlands. Thus, avoidance cannot be met and the focus was moved to minimising the impacts on the wetlands.

The second risk assessment was for the powerline corridor, the assessment showed that both direct and indirect impacts will occur on the wetlands, but with the correct placements of the pylons the avoidance can be met.

6.3 Specialist Recommendation

Based on the results and conclusions presented in this report, the specialist recommends that if all mitigation measures can be met with the designing of the PV area and the placement of the pylons, it is expected that the proposed activities will pose low residual risks on the wetlands and thus no fatal flaws were identified for the project. A General Authorisation (GN 509 of 2016) is required for the water use authorisation.

If the PV design cannot be altered in such a way that the wetland and their associated buffers cannot be avoided a wetland compensation plan should be compiled and a Water Use Licence (WUL) will be required.

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