F-6 *AQUATIC*

AQUATIC BIODIVERSITY SPECIALIST SCOPING REPORT INPUTS:

Scoping and Environmental Impact Assessment (EIA) Processes for the Proposed Development of the Impumelelo Gridline, near Secunda, Province of Mpumalanga

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1 December 2022

Executive Summary

This report serves as the Aquatic Biodiversity Assessment Scoping Report input that was prepared as part of the Scoping and Basic Assessment (BA) Processfor the proposed 132kV Impumelelo Gridline, near Secunda Mpumalanga Province.

The terms of reference for the current study were as follows:

- Delineate the wetland and riparian areas to inform the placement of infrastructure,
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Compile a baseline description of the aquatic environment potentially impacted by the development as specified in GN320, March 2020,
- Undertake functional and integrity assessment of wetlands and riparian areas as specified in General Notice 267 of 24 March 2017,
- Undertake an impact assessment as specified in the NEMA 2014 regulations, as amended and GN320, March 2020;
- Undertake a Risk Assessment as specified in General Notice 267 of 24 March 2017;
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al.,* 2015; and
- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site as specified in GN320, March 2020.

The proposed project will be applied for under a Special Purpose Vehicle (SPV), and the Project Applicant is therefore Impumelelo Wind (Pty) Ltd. The project summary is listed below.

Facility Name	Impumelelo Wind Energy Facility
Applicant	Impumelelo Wind (Pty) Ltd (Registration Number: 2022/601923/07
Municipalities	The project is located in the Dipaleseng local Municipality of the Gert Sibande District Municipality
Affected Farms1	Refer to Table 4
Powerline corridor length	Approx.~34km (To be confirmed prior to construction)
Powerline assessment corridors width	500m (250m either side of center line)
Powerline servitude	32m per 132kV powerline Option 1 (~33km) Option 2 (~`34km)
Powerline pylons:	Monopole or Lattice pylons, or a combination of both where required
Powerline pylon height:	Maximum 40m height
Temporary laydown or staging area:	Typical area 220m x 100m = 22000m². Laydown area could increase to 30000m² for concrete towers, should they be required.
Site access	R547 and R23
Height of substation fencing	Up to 3 m high Galvanised steel

The study area comprises of two powerline and substation options. Option 1 (including Substation Option 1) and Option 2 (including Substation Option 2) follows the same route from the same Zandfontein Substation towards the Sasol Impomolelo Mine where the route diverges around the mine respectively. Substation Option 1 is located closer to the Sasol mine compared to Substation Option 2.

[1] Based on the current conceptual layout.

Thus Option 1 approximately 33.3 Km while Option 2 is approximately 33.7 km. It should be noted that both the powerline options follows existing roads, conveyer belts and other previously built powerlines for the majority of the route, this greatly reduces potential impacts due to access roads and previously vegetation clearing. Both route options cross a similar amount of wetlands although the substation of option 2 encroaches on a small seepage wetland and is thus not a suitable location. Furthermore, a wetland does fall within 100 m (and thus within the DWS 500 m regulated areas) from substation option 1 although option 1 follow an existing gravel road for a longer distance compared to option 2. Based on these findings Option 1 is the preferred option although ideally the substation should ideally be reconsidered to be moved possibly across the road in an existing agricultural land, thereby reducing potential impacts. The following wetlands were recorded within the powerline corridor and the substation corridor areas:

- 1 Depressional Pan Wetland;
- 1 Seepage Wetland;
- 3 Floodplain Wetlands;
- 9 Channelled Valley Bottom Wetlan; and
- 11 Unchannelled Valley Bottom Wetlands.

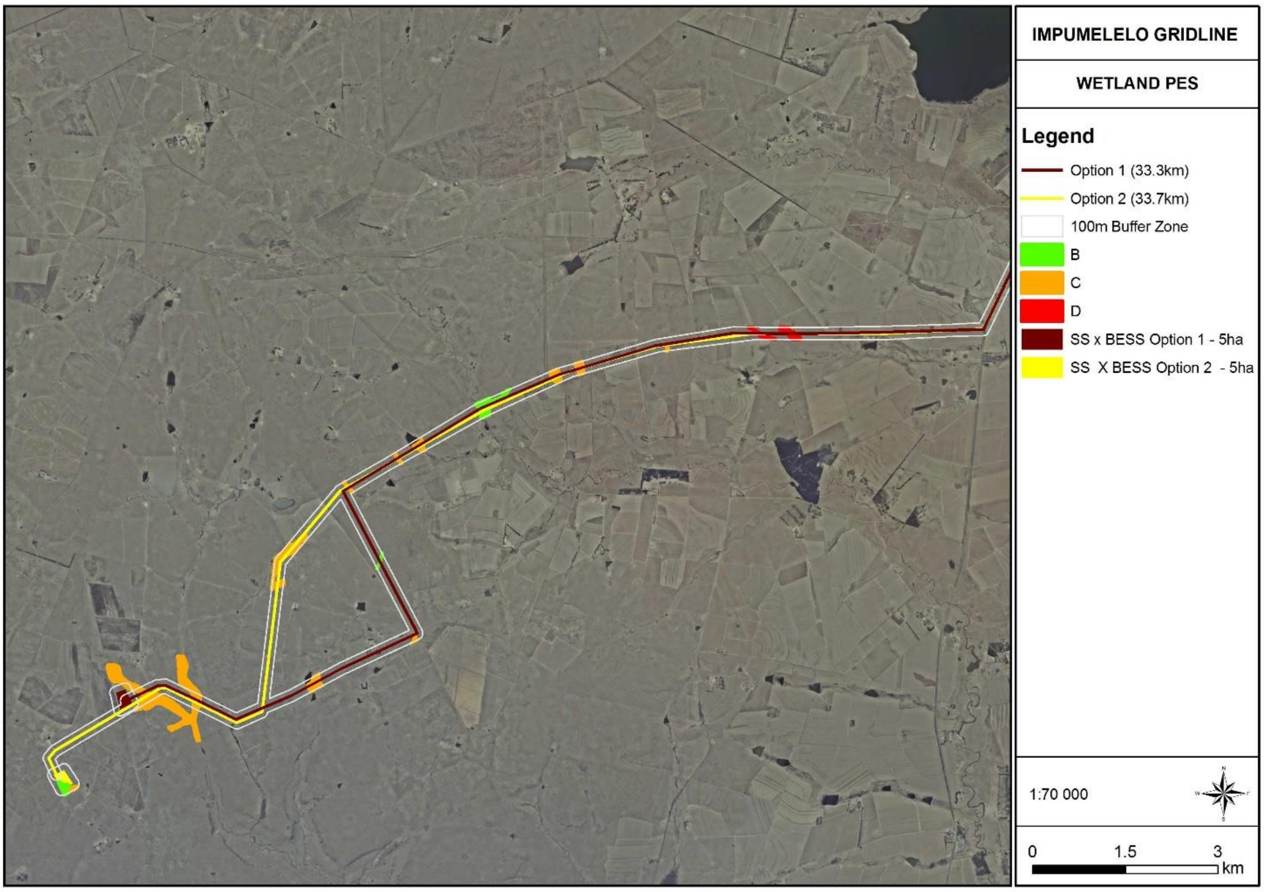
The main rivers associated with these wetlands include: Ouhoutspruit-, Wolwespruit-, Kaalspruit-, Xspruit- and Watervalspruit Rivers. These all drain southward into the Watervalspruit River before flowing into the important Vaal River.

Buffer zones were calculated for the wetland HGM Units following Macfarlane *et al.*, (2015):

- Floodplain Wetlands - 43 m;
- Channelled Valley Bottom Wetlands – 50 m;
- Depressional Pan – 70 m;
- Unchannelled Valley Bottom Wetlands – 42 m; and
- Seepage Wetland – 21 m.

The figure below presents the wetland units together with their calculated buffer zones and DWS regulated area and the Present Ecological Status of wetlands.


IMPUMELELO GRIDLINE
WETLAND PES
Legend
Option 1 (33.3km)
Option 2 (33.7km)
100m Buffer Zone
B
C
D
SS x BESS Option 1 - 5ha
SS X BESS Option 2 - 5ha
1:70 000
0
1.5
3
km


IMPUMELELO GRIDLINE
WETLAND PES
Legend
Option 1 (33.3km)
Option 2 (33.7km)
100m Buffer Zone
B
C
D
SS x BESS Option 1 - 5ha
SS X BESS Option 2 - 5ha
1:70 000
0
1.5
3
km

A summary of the findings of this report relevant to the application is provided in the table below.

The wetland classification and integrity scores are summarised in the table below.

	Quaternary Catchment and WMA areas	Important Rivers possibly affected
	C12F and C12D, #5: Vaal Major.	The main rivers associated with these wetlands include: Ouhoutspruit-, Wolwespruit-, Kaalspruit-, Xspruit- and Watervalspruit Rivers. These all drain southward into the Watervalspruit River before flowing into the important Vaal River.

Watercourse classification & Integrity scores

#	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)
1	Floodplain	B -Largely Natural with few modifications.	High
2	Floodplain	B -Largely Natural with few modifications.	High
3	Floodplain	B -Largely Natural with few modifications.	High
1	Seepage	B -Largely Natural with few modifications.	High
1	Depressional Pan	B -Largely Natural with few modifications.	High
1	Channelled Valley Bottom	C- Moderately Modified.	High
2	Channelled Valley Bottom	C- Moderately Modified.	High
3	Channelled Valley Bottom	C- Moderately Modified.	High
4	Channelled Valley Bottom	C- Moderately Modified.	Moderate
5	Channelled Valley Bottom	C- Moderately Modified.	Moderate
6	Channelled Valley Bottom	C- Moderately Modified.	Moderate
7	Channelled Valley Bottom	B -Largely Natural with few modifications.	High
8	Channelled Valley Bottom	C- Moderately Modified.	Moderate
9	Channelled Valley Bottom	D -Largely Modified.	Low
1	Channelled Valley Bottom	C- Moderately Modified.	Moderate
2	Channelled Valley Bottom	C- Moderately Modified.	Moderate
3	Unchannelled Valley Bottom	D -Largely Modified.	Low

	4	Unchannelled Valley Bottom	D -Largely Modified.	Low
	5	Unchannelled Valley Bottom	B -Largely Natural with few modifications.	Moderate
	6	Unchannelled Valley Bottom	D -Largely Modified.	Low
	7	Unchannelled Valley Bottom	C- Moderately Modified.	Moderate
	8	Unchannelled Valley Bottom	C- Moderately Modified.	Moderate
	9	Unchannelled Valley Bottom	B -Largely Natural with few modifications.	Moderate
	10	Unchannelled Valley Bottom	C- Moderately Modified.	Moderate
	11	Unchannelled Valley Bottom	C- Moderately Modified.	Moderate
Calculated Buffer zones: (Macfarlane *et al.*, 2015):	Floodplain - 43 m Seepage - 21 m Channelled Valley Bottom - 50 m Unchannelled Valley Bottom - 42 Depressional Pan – 70 m			
Aquatic assessment results	Due to high rainfall received in November 2022 results for the aquatic macroinvertebrates will be included in the EIA phase of the project			

Impact Assessment	The impact scores for the following aspects are relevant:		Without Mitigation	With Mitigation
	Changes to flow dynamics	Construction Phase	M	L
		Operation Phase	M	L
	Sedimentation	Construction Phase	M	L
		Operation Phase	M	L
	Establishment of alien plants	Construction Phase	M	L
		Operation Phase	M	L
	Pollution of watercourses	Construction Phase	M	L
		Operation Phase	M	L
	Loss of fringe vegetation and habitat	Construction Phase	M	L
		Operation Phase	M	L
	Loss of aquatic habitat	Construction Phase	M	L
		Operation Phase	M	L
Does the specialist support the development?	Provisionally yes. Given that the mitigation measures are adhered too and that the footprint does not encroach onto any wetland or wetland buffer zone. This statement will be re-examined after obtaining the findings of the aquatic assessment			
Recommendations	No development should occur within the described wetlands and associated buffer zones.			

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List of Abbreviations

AIS	Alien Invasive Species
ASPT	Average score per taxon
CBAs	Critical Biodiversity Areas
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DO	Dissolved Oxygen
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EIA	Environmental Impact Assessment
EIS	Ecological Integrity and Sensitivity
ES	Ecosystem Services
ESAs	Ecological Support Areas
ETS	Ecosystem Threat Status
EPL	Ecosystem Protection Level
FEPA	Freshwater Ecosystem Priority Areas
FSA	Fish Support Area
GSM	Gravel, Sand and Mud
GPS	Global Positioning System
IHAS	Integrated Habitat Assessment System
ISS	Iggdrasil Scientific Services
mamsl	Metres above mean sea level
MBSP	Mpumalanga Biodiversity Sector Plan
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act 107 of 1998
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act 36 of 1998
PES/C	Present Ecological State/Category
RHP	River Health Programme
REC	Recommended Ecological Category
RWQO	Receiving Water Quality Objective
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SAWQG	South African Water Quality Guideline
SEF	Solar Energy Facility
SQR	Sub Quaternary Reaches
SWSAs	Strategic Water Source Areas
SWSA-sw	Strategic Water Source Areas for surface water
SWSA-gw	Strategic Water Source Areas for groundwater
TDS	Total Dissolved Salts
TWQR	Target Water Quality Range
UFS	University of the Free State
UNISA	University of South Africa
UP	University of Pretoria
VEGRAI	Riparian Vegetation Response Assessment Index
WMA	Water Management Area
GRIDLINE	Wind Energy Facility

Glossary

Definitions	
Aquatic Ecosystems	Aquatic ecosystems are defined as the abiotic (physical and chemical) and biotic components, habitats and ecological processes contained within rivers and their riparian zones, reservoirs, lakes and wetlands and their fringing vegetation.
Aquatic Biomonitoring	Aquatic biomonitoring is the science of inferring the ecological condition of rivers and streams by examining the types of organisms that live there, such as invertebrates, algae, aquatic and non-aquatic vegetation, fish, or amphibians. The method is based on the principle that different aquatic organisms have different tolerances to pollutants, and that certain organisms will appear under conditions of pollution, while others will disappear. The assessment of biota in freshwater ecosystems is a widely recognised means of determining the condition, or 'health' of the ecosystem.
Benthic	Relating to or characteristic of the bottom of a water body, or the animals and plants that live there.
Bioaccumulation	The accumulation of a harmful substance in an organism that forms part of the food chain.
Biota	The animal and plant life of a particular region, habitat, or geological period.
Buffer	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area
Ecoregions	Regions that share similar ecological characteristics and are based on the understanding that ecosystems and their biota display regional patterns that mirror causal factors such as climate, soils, geology, physical land surface and vegetation.
FRAI	An assessment index based on the environmental intolerances and preferences of the reference fish assemblages and the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers.
Hydrophyte	any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats
Hydromorphic soil	soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils)
Macroinvertebrates	Invertebrates include all animals without backbones. In rivers this includes aquatic insects, larvae of insects with terrestrial (often flying) adult forms, as well as mussels, clams, snails and worms that are aquatic throughout their life cycle.
Seepage	A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows.
Sedges	Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.
Soil profile	the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991)
Spruit	A small tributary stream or watercourse that is usually non-perennial
Trophic level	The position an organism occupies on the food chain. Examples include omnivores, herbivores, insectivores, planktivores, and piscivores.
Vegetation	Plants of an area or region.
VEGRAI	A model which determines the response of vegetation to impacts in a way which can be defended by sound scientific methods.
Wetland:	"*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." (National Water Act; Act 36 of 1998).

Definitions	
Wetland delineation	the determination and marking of the boundary of a wetland on a map using the DWAF (2005) methodology. This assessment includes identification of suggested buffer zones and is usually done in conjunction with a wetland functional assessment. The impact of the proposed development, together with appropriate mitigation measures are included in impact assessment tables.

This report serves as the Aquatic Biodiversity Assessment Scoping Report input that was prepared as part of the Basic Assessment (BA) for the proposed 132kV Impumelelo Gridline, near Secunda in the Mpumalanga Province.

1. Introduction

1.1. Scope, Purpose and Objectives of this Specialist Report

Prior to commencing with the Aquatic Biodiversity and Species Specialist Assessment in accordance with the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity (Government Notice 320, dated 20 March 2020), a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).

The scope of the report is to provide aquatic input into the draft scoping report as required by 2014 NEMA EIA regulations, as amended.

1.2. Details of Specialist

This specialist assessment has been undertaken by a team of specialist lead by Lorainmari den Boogert of Iggdrasil Scientific Services. Lorainmari den Boogert is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 400003/13 in the field of Ecology and Botany. The wetland assessment was conducted by Antoinette Bootsma and Rudi Bezuidenhoudt. Antoinette (Professional, 400222/09, Ecology and Botany) and Rudi (Professional, 008867, Botany) are registered with SACNASP. Andre Strydom conducted the field surveys for the aquatic zoology and is a SASS5 registered practitioner with the Department of Water and Sanitation (DWS). Albie Steyn (Candidate, 125883, Zoological Science) a candidate Natural Scientist with SACNASP assisted with data formatting and reporting. A summary of the specialist's team and the relevant input is provided in Table 1 below. A curriculum vitae of the core team is included in Appendix A of this specialist assessment.

Table 1: Summary of the aquatic biodiversity team

Person	Highest Qualification	SACNASP or other information	Role
Lorainmari den Boogert	MSc. Geohydrology (UFS) MSc. Plant Science (UP)	Pr.Sci.Nat (400003/13) Botany and Ecology	Project Management Aquatic zoological reporting and overall report integration
Antoinette Bootsma	MSc. Environmental Science (UNISA)	Pr.Sci.Nat (400222/09) Botany and Ecology	Technical Review of wetland assessment
Rudi Bezuidenhoudt	BSc. Hons Botany (UNISA)	Pr.Sci.Nat (008867) Botany	Wetland fieldwork and reporting
Andre Strydom	B. Tech. Nature Conservation (UNISA)	SASS5 Accredited 2020	Aquatic Zoology field assessment and data input

Person	Highest Qualification	SACNASP or other information	Role
Albie Steyn	MSc Geohydrology (UFS)	Cand.Sci.Nat (125883) Zoological Science	Data input and reporting of aquatic zoological section

In addition, a signed specialist statement of independence is included in Appendix B of this specialist assessment.

1.3. Terms of Reference

The terms of reference for the current study were as follows:

- Delineate the wetland and riparian areas to inform the placement of infrastructure;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Compile a baseline description of the aquatic environment potentially impacted by the development as specified in GN320, March 2020,
- Undertake functional and integrity assessment of wetlands and riparian areas as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations, as amended and GN320, March 2020;
- Undertake a Risk Assessment as specified in General Notice 267 of 24 March 2017;
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al.,* 2015; and
- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site as specified in GN320, March 2020.

1.3.1. Scoping phase

The full terms of reference were covered in the Scoping phase.

1.3.2. EIA Phase

Any comments from the interested and affected parties will be reviewed and included in the EIA phase of the project.

2. Approach and Methodology

The wetland delineation method documented by the DWS in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), as well as the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al.*, 2013) was followed throughout the field survey. These guidelines describe the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms as well as the terrain unit indicator.

A handheld Garmin Montana 650 and/or a Samsung S10 smartphone was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey. Applications used on the smartphone includes GPX Viewer Pro and Google Earth.

Following a desktop assessment highlighting wetland areas to be groundtruthed in the field, soil and vegetation sampling on site informed a fine scale delineation. Functional and integrity assessments were conducted to indicate the baseline status of the watercourses identified. No wetland conditions were recorded on the site. The riparian habitat was assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) Kleynhans *et al*, 2008.

Aquatic biomonitoring is an integral component of ecological risk assessment, and is the science of determining the condition, or 'health' of an aquatic ecosystem by examining the organisms that live there, including their habitats, occurrence and composition. It is based on the principle that different aquatic organisms have different responses to stressors to their habitats, and that certain organisms will appear under conditions of stress, while others will disappear. Stressors include aspects such as increased or decreased flow (resulting from the abstraction of water, or the discharge of clean stormwater); changes in water quality (resulting from the discharge of stormwater or the introduction of contaminants through the discharge and disposal of effluents or seepage, and littering); bed and channel modification; changes in vegetation (resulting from the reduction of indigenous riparian plants and the presence of invasive alien plants and fauna).

A variety of aquatic organisms requires specific habitat types and habitat conditions for at least part of their life cycles. The availability and diversity of suitable habitats for aquatic biota will therefore determine the presence and species composition of the organisms living in the aquatic ecosystem. Habitat conditions for aquatic biota are influenced by drivers such as climate, geomorphology, and land use. The disturbance of the habitats of aquatic biota will result in stress to the aquatic population, which can affect the occurrence and species composition of the organisms living in the aquatic ecosystem (species response).
These relationships can be depicted as follows (adapted from Kleynhans and Louw, 2008) (Figure 1):

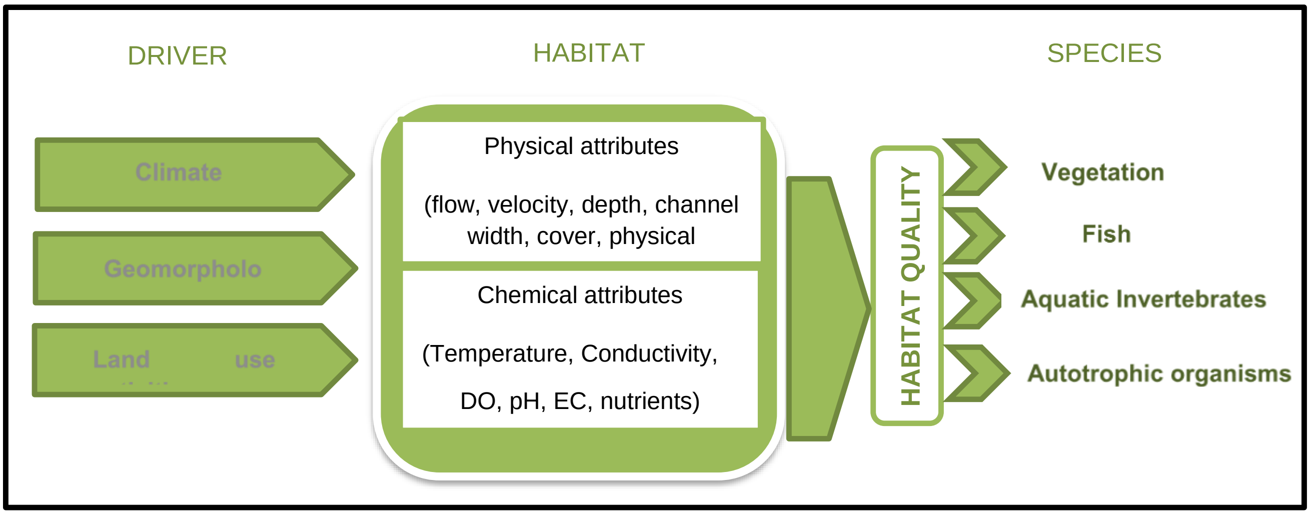


Figure 1: Relationships between ecosystem responses to drivers of change

Impacts on freshwater ecosystems can be measured by determining the presence or absence of certain indicator species of an aquatic ecosystem (riparian vegetation, fish, and invertebrates), and recording the species composition over time in order to determine changes in species composition, and to relate any observed changes to changes in the habitats of these species, taking cognisance of the drivers that influence the habitats in the first place. The occurrence and composition of species of flora and fauna in aquatic ecosystems therefore reflect both the present and history of the water resource at a particular site, allowing detection of disturbances that might otherwise be missed.

During a typical baseline survey at a specific location in an aquatic ecosystem, both the physical and chemical attributes of the aquatic habitat, as well as the species response of different types of aquatic biota, are therefore evaluated. Two aspects are of importance in this regard, namely the methods used for the evaluation of the physical and chemical attributes of the habitat, as well as for the determination of the species response of different types of aquatic biota at a specific survey site, and the selection of biomonitoring sampling points.

These aspects are discussed in more detail below.

Methods for Conducting aquatic zoological surveys

Because biological communities integrate the effects of physical and chemical changes to the environment in the long-term, different methods, typically based on assessment indices, are used as indicators of changes in habitat quality, as well as indicators of species responses (Ferreira and Graca, 2008).

The current methods used for the evaluation of the physical and chemical attributes of the habitat at a specific biomonitoring survey site can be summarised as follows:

- Evaluation of the physical attributes of the aquatic habitat: The physical attributes of the instream and riparian habitat has a direct influence on the occurrence and composition the aquatic community. Physical habitat features such as colour, anthropogenic disturbances and riparian vegetation, as well as stream hydrology, average width and depth are established by means of and evaluated with the Integrated Habitat Assessment System (IHAS). IHAS was developed in 1998 by McMillan, and version 2 is the currently used assessment index; and
- Evaluation of the chemical attributes of the aquatic habitat: Although available water quality monitoring data on variables such as pH, salinity (EC or TDS) and nutrients will give an indication of the influence of these variables on the aquatic ecosystem, variables such as Temperature, Dissolved Oxygen (DO), and Turbidity need to be determined in situ, as these variables cannot be established away from the survey site.

The standardised, quantitative and replicable methods currently used for the species response of the different aquatic organisms at a specific survey site can be summarised as follows:

- The South African Scoring System, version 5 (SASS5) is a rapid bioassessment method used to identify changes in species composition of aquatic invertebrates (e.g. snails, crabs, worms, insect larvae, mussels, beetles). As most invertebrate species are fairly short-lived and have limited migration patterns or are not free-moving during their aquatic life phase, they are good indicators of localised conditions in a river over the short term and can be used to assess site-specific impacts (Dickens and Graham, 2002).

- Vegetation is a readily observable expression of the ecology and relationships as well as a series of interactions between biotic organisms and their abiotic environment, and thus provide a physical representation of the health of an ecosystem. Healthy riparian vegetation zones maintain channel form and serve as filters for light, nutrients and sediment. Changes in the structure and function of riparian vegetation commonly result from changes in the flow regime of a river, flooding, exploitation for firewood, mining, or use of the riparian zone for grazing or ploughing. The Riparian Vegetation Response Assessment Index (VEGRAI) is a model developed by the DWS for the qualitative assessment of the response of riparian vegetation to impacts (Kleynhans et al., 2007). It must be noted that there is a distinct difference between a VEGRAI and the evaluation of vegetation as part of the IHAS, as the IHAS merely records vegetation as one of the physical attributes of the aquatic habitat, while VEGRAI evaluates and assigns a rating to indicate species composition and diversity. As vegetation can undergo rapid changes, for example due to flooding, veld fires or overgrazing, the VEGRAI-method will record such changes in species composition, which will not be determined by the IHAS method.

- Fish are good indicators of long-term (several years) effects and broad habitat conditions, and changes in the available habitat conditions (Karr, 1981). This is because fish are “top of the food chain,” relatively long-lived and mostly highly mobile. Fish bio-accumulate the effects of anthropogenic activities on lower trophic levels; thus, fish assemblage structures are indicative of the integrated health of the aquatic ecosystem. Assemblages include a range of species that represent a variety of trophic levels (omnivores, herbivores, insectivores, planktivores, piscivores). The Fish Response Assessment Index (FRAI) is a rule-based model developed by the DWS based on the environmental intolerances and preferences of reference fish assemblages and the response of the species of the assemblage to particular groups of environmental determinants or drivers. Intolerance and preference attributes are categorized into metric groups with constituent metrics that relate to the environmental requirements and preferences of individual species. Changes in environmental conditions are related to fish stress and form the basis of ecological response interpretation. Reference conditions with regard to expected fish species and species compositions have been published for most of South Africa (Kleynhans, 2007).

- Acute (and short-chronic) toxicity testing is applied by exposing biota to water sources in order to determine the potential risk of such waters to the biota/biological integrity of the receiving water bodies. A risk category is determined based on the percentage of mortalities (or inhibition-stimulation) of the exposed biota. It is important to note that the hazard classification is based on the standardised battery of selected test biota and therefore represents the risk/hazard towards similar biota in the receiving aquatic environment. The toxicity hazard is therefore in terms of the aquatic biotic integrity and does in no way represent toxicology towards humans or other mammals.

- Diatom-based water quality indices have recently been evaluated and implemented in South Africa (Taylor, 2004; River Health Programme, 2005) for riverine ecosystems. De la Rey *et al.* (2004) and Taylor (2004) showed that diatom-based pollution indices may be good bio-indicators of water quality in aquatic ecosystems in South Africa by demonstrating a measurable relationship between water quality variables such as pH, electrical conductivity, phosphorus and nitrogen, and the structure of diatom communities as reflected by diatom index scores, allowing for conclusions to be drawn about water quality. Diatoms can also indicate whether heavy metals are present in aquatic systems. According to Luís *et al.* (2008) several studies on metal polluted waters have shown that diatoms respond to perturbations not only at the community but also at the individual level with alteration in cell wall morphology. In particular, size reduction and frustule deformations have been sometimes associated with high metal concentrations.

For the 2022 baseline aquatic assessment, the IHAS and the SASS5 methodologies were used to assess the biotic integrity of the study area. These were selected as due to budgetary constraints as well as the fact that the area is not situated in a National Freshwater Protected Area (NFEPA) and the desktop assessment did not indicate that a presence of sensitive fish taxa.

In order to ease the legibility of the report, details regarding the methods used in each phase of the watercourse assessment are presented in Appendix E.

Prior to the site visit the sampling points for the aquatic assessment were selected based on hydrology, the area of influence as well as current land use and site access. Two sets of data are required in order to interpret the results of biomonitoring surveys, namely data from a reference condition site, where habitat conditions are expected to be relatively undisturbed, and data from an affected condition site (or affected site), where the influences resulting from a land-use is expected to have created stressors in the habitats of the aquatic biota.

The site visit was conducted in the first week of February 2022 by the wetland specialist, Rudi Bezuidenhoudt. The aquatic specialist, Andre Strydom, conducted the site visit in 5th of January 2022, but not all sites could be sampled due to access issues. Due to layout changes, an additional site survey was conducted in November 2022. Rudi Bezuidenhoudt conducted the follow up wetland assessment in November 2022 but due to heavy rainfall the aquatic assessment could not be conducted. No access was available for the powerline section adjacent to the Sasol conveyer belt. The results of the aquatic assessment will be included in the final aquatic report.

Site selection for the aquatic assessment has been conducted and ten (10) sites have been provisionally identified for sampling. The feasibility of the sites will be determined during the site visit and the co-ordinates of the sampled sites will be included in the final aquatic report.

Impact assessment methodology used was supplied by the WSP and is in Appendix D.

Information Sources

Table 2 below list the main maps and databases used during the desktop phase of this assessment. Literature used is referred to in the reference list.

Table 2: Summary of the main information sources used during the desktop assessment

Data / Information	Source	Date	Type	Description
Environmental Potential Atlas	DFFE	1997	Report & Spatial	Geology and soils data used for to inform the wetland assessment was obtained from the Environmental Potential Atlas
National List of Threatened Terrestrial Ecosystems for South Africa (2011)	National Environmental Management: Biodiversity Act: (G 34809, GN 1002)	2011	Report & Spatial	National list of ecosystems that are threatened and in need of protection,
National Freshwater Ecosystems Priority Areas	CSIR	2011	Report & Spatial	National Freshwater Priority Areas classified for South Africa
Present Ecological State, Ecological Importance & Ecological Sensitivity	Department of Water and Sanitation	2014	Report & Spatial	A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa
Mpumalanga Biodiversity Sector Plan (MBSP)	Mpumalanga Tourism and Parks Agency	2014	Report & Spatial	MBSP is a spatial tool with land-use guidelines that forms part of a broader set of national biodiversity planning tools and initiatives that are provided for in national legislation and policies
Water Management Areas	National Water Act (G40279)	2016	Report	Description of the nine water management areas of South Africa
National Strategic Water Source Areas	Water Research Commission	2017	Report & Spatial	National Strategic Water Source Areas (SWSAs) for surface water (SWSA-sw) and groundwater (SWSA-gw) that have

Data / Information	Source	Date	Type	Description
				been delineated as part of a Water Research Commission (WRC) project (K5/2431).
Vegetation Map of South Africa, Lesotho and Swaziland	South African National Biodiversity Institute	2018	Report and Spatial data	The third and latest update to the original 2006 Vegetation Map of South Africa, Lesotho and Swaziland
National Biodiversity Assessment (NBA)	South African National Biodiversity Institute	2018	Report and Spatial	Latest assessment of South African biodiversity and ecosystems, including, vegetation types, wetlands and rivers.
South African National Protected Areas Database (SAPAD)	Department of Forestry Fisheries and the Environment	2020, Q2	Spatial	Spatial delineation of protected areas in South Africa. Updated quarterly
National EIA Screening Tool	Department of Forestry Fisheries and the Environment	2022, Q1	Spatial	Spatial database depicting aquatic biodiversity of the country as high or low sensitivity areas

2.1. Assumptions, Knowledge Gaps and Limitations

- The study focussed on the identification, delineation and functional assessment of wetlands found within/along the powerline and substation footprint area. Although all wetlands occurring within 500 m of the footprint were mapped at a desktop level in fulfilment of Regulation GN509 of the NWA, the field assessment was confined to only those areas to be impacted by the current operational and rehabilitation activities associated with the footprint, which was deemed sufficient for the purposes of this assessment.
- Whilst every effort was made to ensure that all wetland features potentially within the 500 m DWS Regulated Area were identified and delineated, less distinct features within these access-controlled areas may not have been identified.
- Sampling by its nature means that the entire study area cannot be assessed. In this case, the entirety of the study site could not be assessed due to time constraints and access restrictions. Therefore, the assessment findings are only applicable to the areas sampled and extrapolated to the rest of the study site. Some reliance was also made on a previous wetland assessment done in the area.
- Formal vegetation sampling was not done by the specialist. All vegetation information recorded was based on the onsite visual observations of the author. Furthermore, only dominant, and noteworthy plant species were recorded. Thus, the vegetation information provided has limitations for true botanical applications.
- The information provided by the client forms the basis of the planning and layouts discussed.

- It should be noted that at the time of the assessment, the exact location of the infrastructure was not available.
- All watercourses within 500 m of any developmental activities should be identified as per the DWS authorization regulations. In order to meet the timeframes and budget constraints for the project, watercourses within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Watercourses that fall outside of the site, but that fall within 100 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage.
- The specialist responsible for this study reserves the right to amend this report, recommendations and/or conclusions at any stage should any additional or otherwise significant information come to light.
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of the current assessment
- Floodline calculations fall outside the scope of the current assessment.
- A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study
- Species composition described for landscape units aimed at depicting characteristic species and did not include a survey for cryptic or rare species.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- Watercourses delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, while converting spatial data to final drawings, several steps in the process may affect the accuracy of areas delineated in the current report. It is therefore suggested that the no-go areas identified in the current report be pegged in the field in collaboration with the surveyor for precise boundaries. The scale at which maps and drawings are presented in the current report may become distorted should they be reproduced by for example photocopying and printing.
- The calculation of buffer zones does not consider climate change or future changes to watercourses resulting from increasing catchment transformation.
- Due to the amount of rainfall during the field work, several access roads were not driveable and access was thus limited in these areas during the initial fieldwork in March 2022.
- Due to the large extent of the study site several areas did not have access, and extrapolation was used here.
- The access road of the conveyer belt running parallel to the proposed powerline was locked and thus this section was inaccessible..

2.2. Consultation Processes Undertaken

The environmental department of Sasol Secunda Operations were consulted for historic reports related to biomonitoring as well as wetland delineation.

2.3. Description of Project Aspects relevant to the Aquatic Biodiversity Assessment

Although a project description was available at the time of writing, a site lay-out was not available. The project description was taken verbatim from Ennertag is as follows:

The proposed project will be applied for under a Special Purpose Vehicle (SPV), and the Project Applicant is therefore Impumelelo Wind (Pty) Ltd. The project summary is listed below (Table 3).

Table 3: Project Summary- Impumelelo Wind Energy Facility (GRIDLINE)

Facility Name	Impumelelo Wind Energy Facility
Applicant	Impumelelo Wind (Pty) Ltd (Registration Number: 2022/601923/07
Municipalities	The project is located in the Dipaleseng local Municipality of the Gert Sibande District Municipality
Affected Farms2	Refer to Table 4
Powerline corridor length	Approx.~34km (To be confirmed prior to construction)
Powerline assessment corridors width	500m (250m either side of center line)
Powerline servitude	32m per 132kV powerline Option 1 (~33km) Option 2 (~`34km)
Powerline pylons:	Monopole or Lattice pylons, or a combination of both where required
Powerline pylon height:	Maximum 40m height
Temporary laydown or staging area:	Typical area 220m x 100m = 22000m². Laydown area could increase to 30000m² for concrete towers, should they be required.
Site access	R547 and R23
Height of substation fencing	Up to 3 m high Galvanised steel

2.4. Components of A Typical Transmission Line System

The main components of a typical electrical transmission system include the following:

Transmission Structures

Transmission structures are the most visible components of the power transmission system. Their function is to inter alia, keep the high-voltage conductors separated from their surroundings and from each other. Some structure designs reflect the specific function of the structure, while others have come about as a result of technological progress.

Conductors

Conductors carry the power through and from the grid. Generally, several conductors per phase are strung from structure to structure. The number of conductors per phase depends on the performance of the line, typically, more than one conductor per phase is used when the operating voltage exceeds 132kV. Conductors are constructed primarily of aluminium, aluminium-alloy, steel or other types of materials as appropriate.

Substations

The very high voltages used for power transmission are converted at substations to lower voltages for further distribution and consumer use. Substations vary in size and configuration but may cover several hectares; they are cleared of vegetation and typically surfaced with gravel. They are fenced, and are normally reached by a permanent access road. In general, substations include a variety of indoor and outdoor electrical equipment such as switchgear, transformers, control and protection panels and batteries, and usually include other components such as control buildings, fencing, lighting etc.

For the substation to perform it needs sophisticated protection equipment to detect faults and abnormal conditions that may occur on the network. Action may consist for example, of automatically tripping a transmission line to cater for abnormal conditions such as lightning strikes, fires or trees falling on

[2] Based on the current conceptual layout.

transmission lines. This action is necessary for safety reasons in the event of an accident or to maintain electricity supply and limit the disruption caused.

Figure 2 provides an illustration of a typical substation layout.

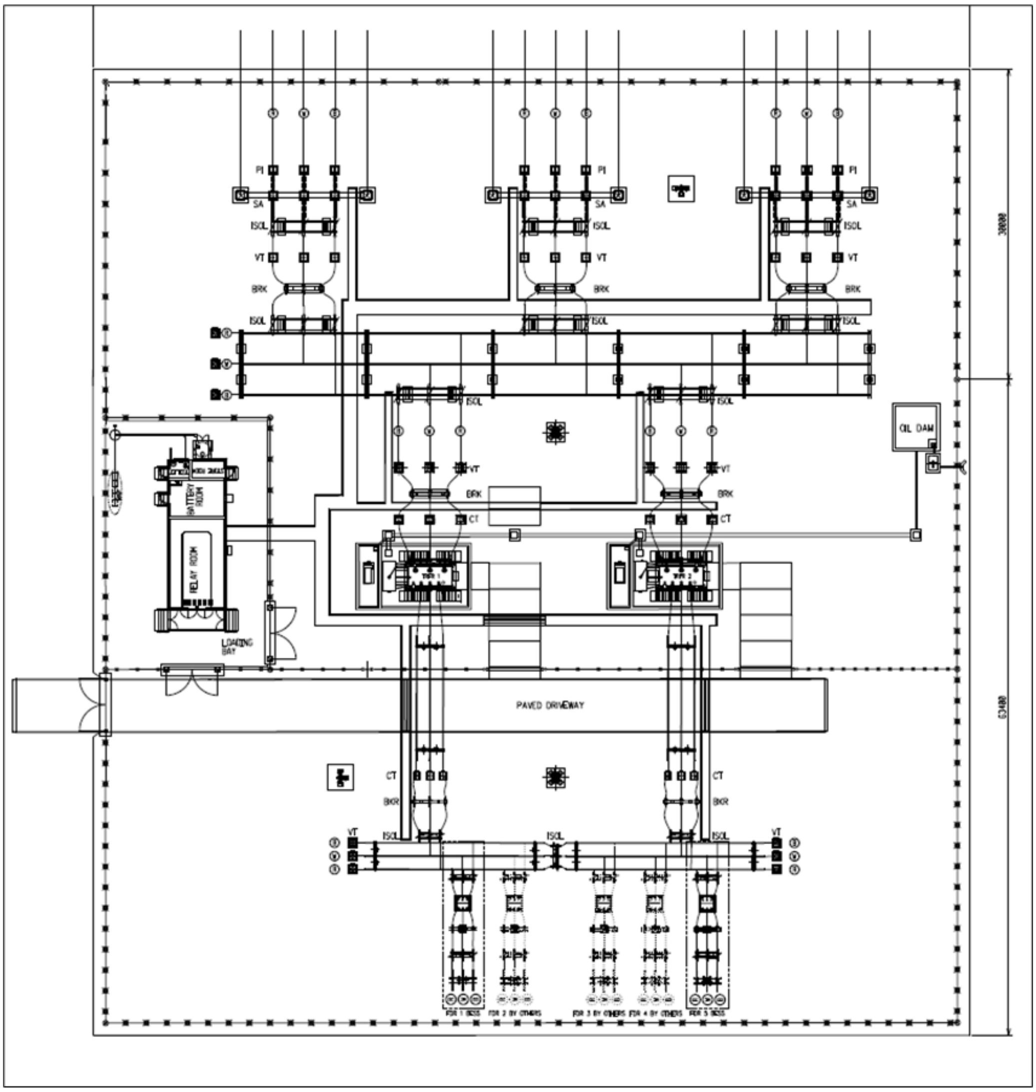


Figure 2: Typical Substation Layout

Transformers

Transformers are major items found in a transmission or distribution substation. There may be a number of different types of transformers in a substation such as power transformers, voltage transformers or current transformers.

A power transformer is a very simple device piece of electrical equipment where alternating current (AC) is led through a primary coil of wire, which produces an alternating magnetic field in the ring-shaped core of soft iron. This in turn creates a voltage in a secondary coil, from which the output current can be drawn. If the secondary coil has more turns than the primary coil, the output voltage is higher than the input voltage. This is a step-up transformer. A step-down transformer has more turns in the primary coil than in the secondary coil to reduce the voltage.

2.5. Project Infrastructure

The proposed project entails the construction of up to 132kV transmission line from the onsite substation to the Zandfontein Substation as per the following alternatives:

Gridline Alternative 1 (Preferred): The proposed powerline will be approximately ~33 km and will connect to the Impumelelo GRIDLINE to the Zandfontein Substation via the onsite substation located on portion 5/543 of Farm Platkop (preferred substation – Option 1). This alternative spans over existing road and farm boundaries.

The preferred pylon and powerline will be 132 kV Intermediate Self-Supporting single circuit or double circuit. The powerline will have a 500m (250m on either side of center line) assessment corridor to allow for micro-siting.

Gridline Alternative 2: The proposed powerline will be approximately ~34 km and will connect to the Impumelelo GRIDLINE to the Zandfontein Substation via the onsite substation located on portion 0/544 of Farm Mahemsfontein. This alternative spans across the GRIDLINE around the Carmona Substation thereafter following the existing road and farm boundaries.

The preferred pylon and powerline will be 132 kV Intermediate Self-Supporting single circuit or double circuit. The powerline will have a 500m (250m on either side of center line) assessment corridor to allow for micro-siting.

The proposed project will comprise the following key components:

- Establishment of the substation (with a footprint of approximately 5 ha) located on portion 5/543 of Farm Platkop (preferred).
- Standard substation electrical equipment, i.e., transformers, busbars, office area, operation and control room, workshop, and storage area, feeder bays, transformers, busbars, stringer strain beams, insulators, isolators, conductors, circuit breakers, lightning arrestors, relays, capacitor banks, batteries, wave trappers, switchyard, metering and indication instruments, equipment for carrier current, surge protection and outgoing feeders, as may be needed.
- The control building, telecommunication infrastructure, etc,
- All the access road infrastructure to and within the substation
- Associated infrastructure including but not limited to lighting, fencing, and buildings required for operation (ablutions, office, workshop and control room, security fencing and gating, parking area and storerooms).
- A 500m corridor along each of the proposed options (250m from the centre-lines) are included in the assessments.

2.6. Components of the Transmission Line

A brief overview of the physical/technical requirements of the project is as follows:

- 1 x up to 132kV transmission line (either single or double circuit) between the Alternative 1 substation (preferred Impumelelo GRIDLINE substation) and Zandfontein substation
- The preferred pylon and powerline will be 132 kV Intermediate Self-Supporting single circuit or double circuit.
- The assessment corridor for 1x up to 132kV transmission line is 500 m.
- The maximum height for an up to 132kV powerline structure is 40m.
- Minimum conductor clearance is between 8.1 and 12.6m.
- Span length between pylon structures is typically up to 250m apart, depending on complexity and slope of terrain.

The design of 132kV structure is currently unknown, the following options will be used to determine preferred design:

- Intermediate self-supporting monopole

- Inline or angle-strain self-supporting monopole
- Suspension self-supporting monopole
- Triple pole structure
- Steel lattice structure

The up to 132 kV structures will have a concrete foundation and the sizes may vary depending on design type up to 80m2 (10m by 8m), with depths reaching up to 3.5m typically in a rectangular 'pad' shape. The actual number of structures required will vary according to the final route alignment determined.

2.7. Clearance Requirements for Transmission Lines

For safety reasons, transmission lines require certain minimum clearance distances. These are as follows:

- The minimum vertical clearance distance between the ground and the transmission line is 6.7m.
- The minimum vertical clearance to any fixed structure that does not form part of the transmission line is 9.4m - 11m.
- The minimum distance between a 132kV transmission line and an existing road is 60m – 120m (depending on the type of road).
- Any farming activity can be practiced under the conductors provided that safe working clearances and building restrictions are adhered to.
- Minimum servitude to other parallel lines.

2.8. Proposed Associated Infrastructure

The proposed transmission integration project will require the following with respect to the permanent infrastructure:

- Where the transmission line crosses a fence between neighbouring landowners and there is no suitable gate in place, a suitable gate will be erected in consultation with the landowner. These gates are necessary in order to ensure access to the line for maintenance and repair purposes.
- Existing road infrastructure will be used as far as possible to provide access for construction vehicles during the construction of the line. Thereafter, the roads are used for inspection and maintenance purposes. Where appropriate roads may be upgraded to access transmission lines and substations. Where no roads exist, access roads may be created for maintenance and inspection purposes.
- Fibre Optic cable could be strung on the earth cable if required for telecommunication
- Associated infrastructure including but not limited to lighting, fencing, and buildings required for operation (ablutions, office, workshop and control room, security fencing and gating, parking area and storerooms).

2.9. Proposed Eskom Substations

Two alternative substation locations have been proposed for the Impumelelo GRIDLINE (Gridline Alternative 1 via the onsite substation located on portion 5/543 of Farm Platkop). It must be indicated that both substation alternatives are planned to be constructed on approximately 5 ha. Based on the plan, an IPP substation and an Eskom substation will be constructed for each of the alternatives. The substations will be constructed next to each other on area of 2.5ha each. Electricity generated from the Impumelelo GRIDLINE will be distributed through the IPP substation to the Eskom substation, from the Eskom substation electricity will be distributed by the proposed up to 132kV gridline transmission line into the Zandfontein Substation.

The substation will consist of a high voltage substation yard to allow for multiple up to 132kV feeder bays and transformers, control building telecommunication, and other substation components as required. Supporting infrastructure such as Control room, parking, oil spillage containment dam, fence, and other infrastructure will be constructed as part of the Eskom section substation see Figure 3 below for example of substation.

Figure 3: Example of Eskom substation

It should be noted that at the time of the assessment, the exact location of the pylons was not available.

3. Baseline Environmental Description

The proposed Impumelelo Gridline up to 132 kV is located in the Dipaleseng local Municipality of the Gert Sibande District Municipality approximately 19 km North-East of the Town of Greylingstad, located in the Mpumalanga Province (Figure 4).

The project is subject to a Basic Assessment process in terms of the 2014 NEMA EIA Regulations, as amended.

The Impumelelo gridline up to 132 kV project area covers approximately 49 property portions. The details of the properties associated with the proposed Impumelelo GRIDLINE, including the 21-digit Surveyor General (SG) codes for the cadastral land parcels are outlined in the table below (Table 4)

Table 4: Property details associated with the proposed project

Portion No.	Farm No.	Farm Name
3	130	Zandfontein
2	130	Zandfontein
5	130	Zandfontein
8	130	Zandfontein
9	130	Zandfontein
0	279	Grootspruit
1	280	De Bank of Vaalbank
2	280	De Bank of Vaalbank
4	280	De Bank of Vaalbank
6	280	De Bank of Vaalbank
2	528	
3	528	Kafferfontein?
9	528	Kaalspruit
6	528	
7	528	Kaalspruit
16	323	Roodebank
0	542	
3	535	
4	535	Holgatsfontein
20	535	Holgatsfontein
18	535	Holgatsfontein
17	535	Holgatsfontein
19	535	Holgatsfontein
16	535	Holgatsfontein
15	535	
14	535	Holgatsfontein
3	535	Holgatsfontein
17	535	Holgatsfontein
0	529	
2	543	Platkop
4	543	Platkop
5	543	Platkop
9	543	Platkop
3	277	Sprinbokdraai
5	277	

Portion No.	Farm No.	Farm Name
2 (8)	277	Sprinbokdraai
5	277	Sprinbokdraai
20	323	Roodebank
3	130	
1	534	Wolvenfontein
18	534	Wolvenfontein
19	534	Wolvenfontein
20	534	Wolvenfontein
16	532	
0	544	Mahemsfontein
7	544	Mahemsfontein
8	544	Mahemsfontein
25	522	Hartbeestfontein
6	522	Hartbeestfontein

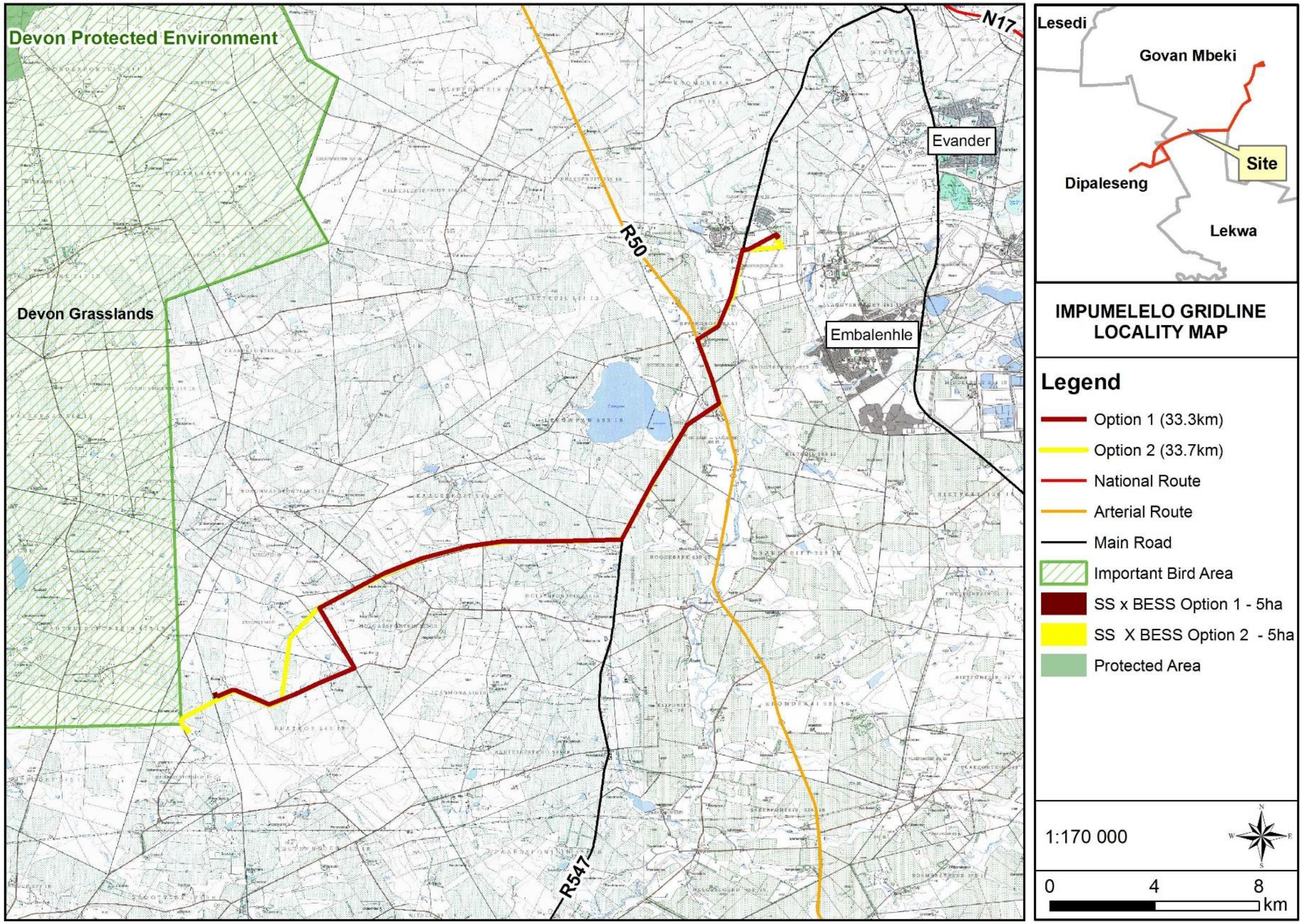


Figure 4: Locality Map of the proposed Impumelelo GRIDLINE

4.1. General Description

A review of available literature and spatial data formed the basis of a characterisation of the biophysical environment in its theoretically undisturbed state and consequently an analysis of the degree of impact to the ecology of the study site in its current state. Table 5 below provides a summary of the important aspects.

Table 5: Summary of the desktop analysis of the study site

Level of significance	Information or Source	Significance specific to the study site	Figure and Reference
International	RAMSAR	No World Heritage sites within 50km of site. The Blesbokspruit RAMSAR wetlands are approximately 100 km west of site.	(Ramsar)
National	Protected Areas	There are no protected areas in close proximity to the study site.	(South African Protected Areas Database)
	Threatened Ecosystems	The study site is situated within the Soweto Highveld Grassland which is Vulnerable.	(RSA, 2011)
	Water Management Area	#5: Vaal Major: rivers include the Wilge, Liebenbergsvlei, Mooi, Renoster, Vals, Sand, Vet, Harts, Molopo and Vaal. Quaternary catchment C12D & C12F.	(Figure 5, DWS)
	National Freshwater Priority Areas	The study site is situated within an upstream FEPA. Upstream FEPA's are areas in which human activities need to be managed to prevent damage to downstream FEPA's. The majority of the major and minor watercourses are listed as NBA (2018) watercourses	(Nel *et al.*, 2011)
	Strategic Water Resources Areas	Strategic Water Source Areas (SWSAs) surface and ground water areas have been identified for South Africa. Strategic Water areas. Strategic water areas are defined as follows: "Surface water SWSAs (SWSA-sw): Areas of land that supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size. Groundwater SWSAs(SWSA-gw): Are areas which combine areas with high groundwater availability as well as where this groundwater forms a nationally important resource". (Le Maitre, 2018)	(Le Maitre, 2018)

Level of significance	Information or Source	Significance specific to the study site	Figure and Reference
		The study site is not within a SWSA. One of the Upper Vaal SWSA-sw is situated to the north east of the site (15 km)	
	Vegetation	The study site overlays the Soweto Highveld Grassland (Gm8). Gently to moderately undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* and accompanied by a variety of other grasses such as *Elionurus muticus*, *Eragrostis racemosa, Heteropogon contortus and Tristachya leucothrix.* In places not disturbed, only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover.	(Mucina & Rutherford 2006, SANBI 2006-)
	National Biodiversity Assessment (NBA) 2018	Critically Endangered, Endangered and Vulnerable ecosystems are collectively referred to as threatened ecosystems and may be listed as such in terms of the Biodiversity Act. In terms of rivers the Grootspruit has a Present Ecological State (PES) of B-F indicating it is largely natural to critically modified. In terms of rivers the Ouhoutspruit has a Present Ecological State (PES) of C-F indicating it is moderately to critically modified. The majority of the spruits have a PES of C therefore it is expected that the Ouhoutspruit and Grootspruit and its tributaries will be moderately modified. The Ecosystem Threat Status (ETS) is Critically Endangered, and the Ecosystem Protection Level (EPL) for both the Ouhoutspruit and Grotspruit. The wetlands in and around the study site have been classified as Mesic Highveld Grassland Group 3 wetlands	(Figure 6, Skowno *et al.,* 2018, Van Deventer, *et al.,* 2019)
	PES 2014	The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) was determined per Sub Quaternary Reaches (SQR) for Secondary Catchments in South Africa. The SQRs within close proximity to the site are as follows: 1566(PES=D)(EI=Moderate)(ES=Moderate)- – Associated with the Waterval River 1576(PES=D)(EI=Moderate)(ES=High) – Associated with the Waterval River 1607(PES=C)(EI=Moderate)(ES=High) – Associated with the Xspruit River 1674(PES=C)(EI=Moderate)(ES=Moderate) – Associated with the Kaalspruit River 1688(PES=D)(EI=Moderate)(ES=Moderate) - – Associated with the Wolwespruit River	(DWS, 2014).

Level of significance	Information or Source	Significance specific to the study site	Figure and Reference
		1697(PES=C)(EI=Moderate)(ES=Moderate) – Associated with the Ouhoutspruit River 1752(PES=C)(EI=High)(ES=Moderate) – Associated with the Grootspruit River 1696(PES=C)(EI=Moderate)(ES=Moderate) Associated with the Grootspruit River A PES of C indicates the reach is moderately modified.	
Provincial	Mpumalanga Biodiversity Sector Plan (MBSP)	In 2014, the Mpumalanga Parks and Tourism Agency developed the MBSP. In essence the MBSP is a map guiding areas of conservation concern for the Mpumalanga Province. Two maps have been developed, namely one for terrestrial biodiversity, and the other for freshwater biodiversity. The MBSP maps the freshwater ecosystems of Mpumalanga into the following categories: • Critical Biodiversity Areas (CBAs) – areas of high biodiversity value, needed to meet biodiversity targets. These areas should be maintained in natural or near natural state; • Ecological Support Areas – these areas support CBAs, but are not essential for meeting conservation targets; • Other Natural Areas – these areas have natural characteristics but have not been earmarked as priority areas for conservation but perform a range of biological as well as ecological functions; • Heavily Modified Areas – Areas that have been impacted and have had a significant or complete loss of natural habitat and ecological function. Based on the terrestrial MBSP the majority of the site is classified as CBA Irreplaceable and development should ideally not occur in these regions. Some sections of agricultural land is classified as Heavily Modified while the remaining land is located on; CBA Optimal, ESA Landscape Corridor, ESA Local Corridor, Other natural Areas and Moderate Modified land. In terms of the freshwater assessment of the MBSP, the site includes mostly other natural areas and heavily modified areas.	(Figure 7, Lötter *et al.*, 2014))

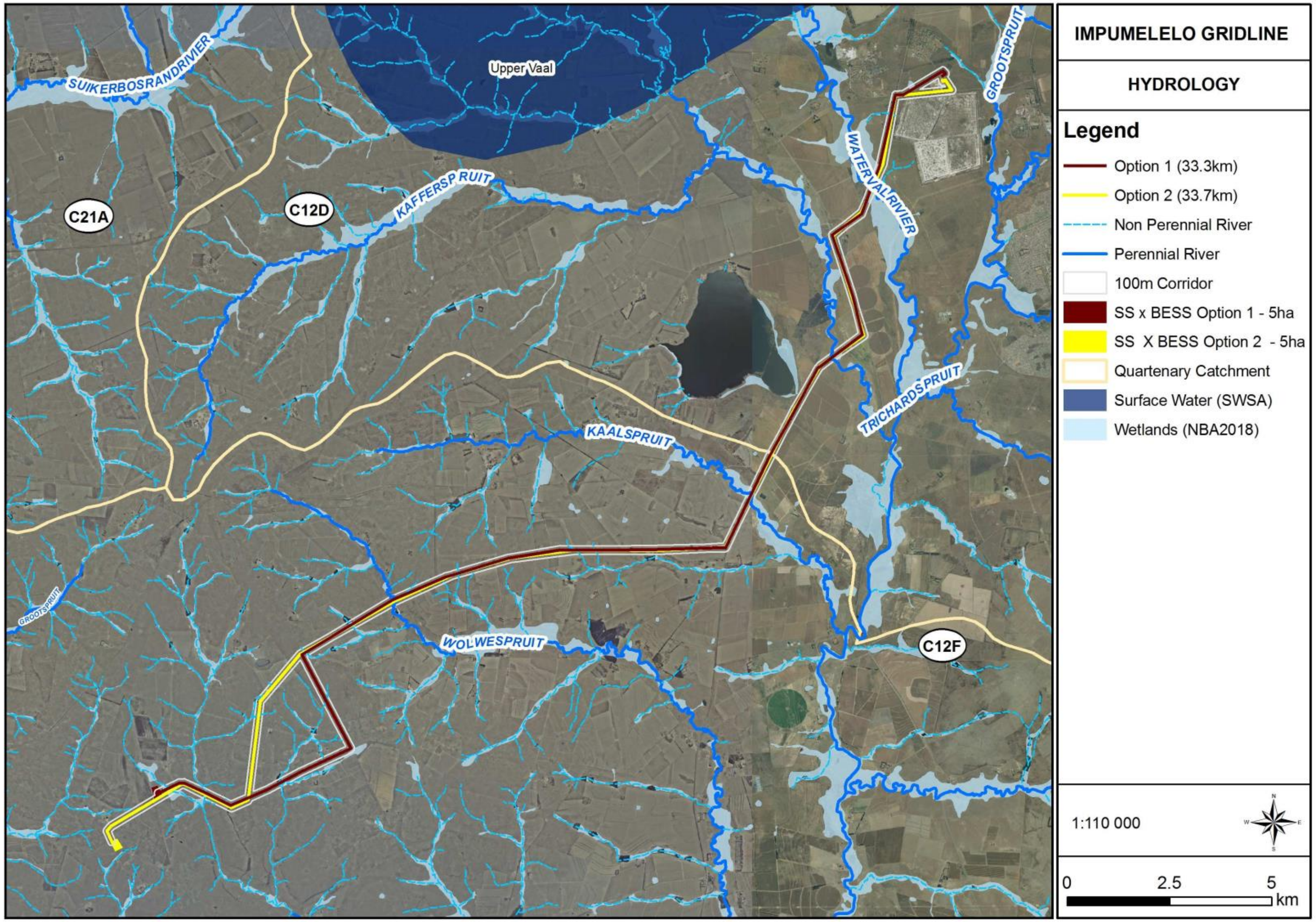


Figure 5: Hydrology of the study site and surrounds as per existing spatial layers

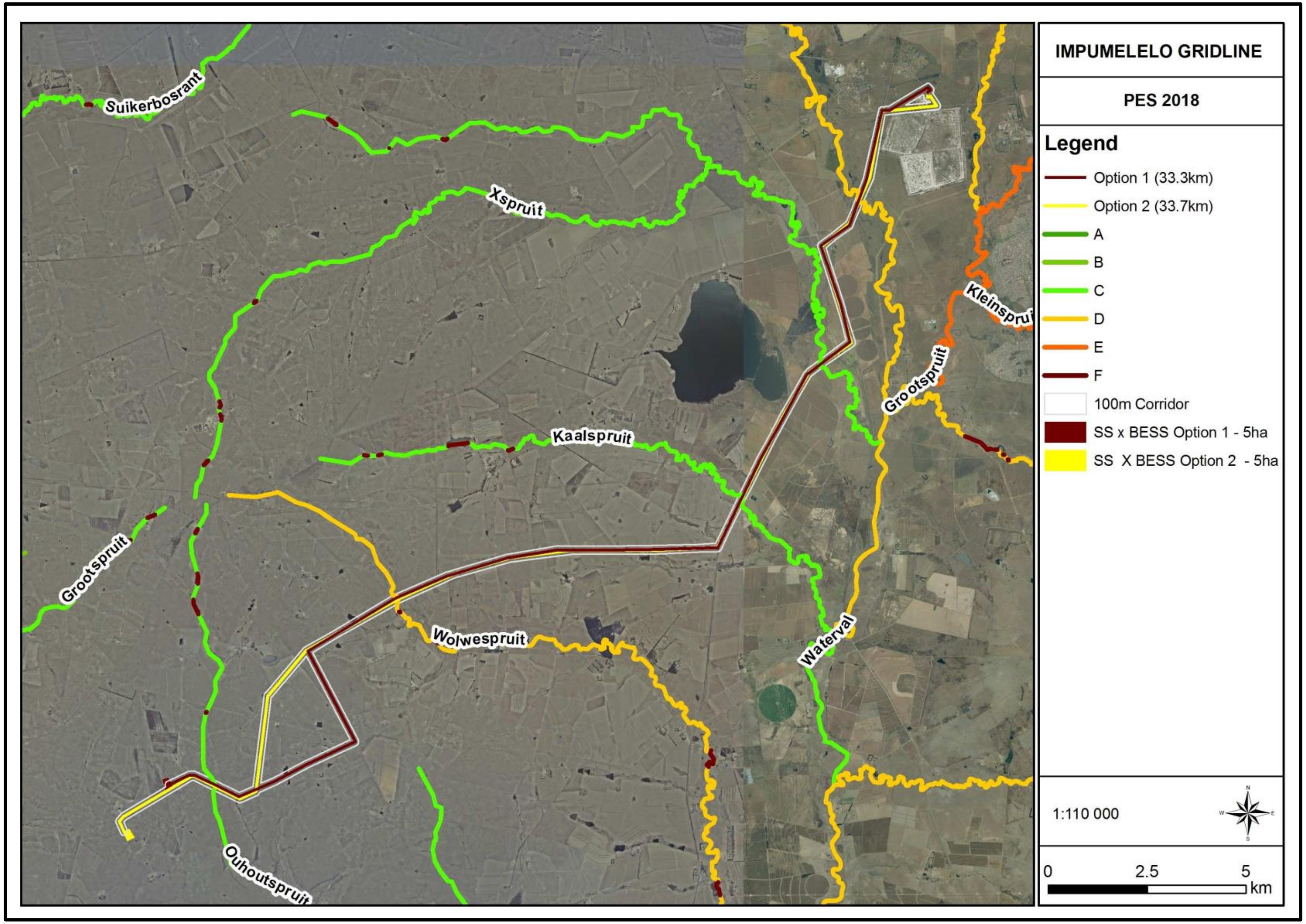


Figure 6: Present Ecological state of the rivers and streams surrounding the study site based on the 2018 National Biodiversity Assessment

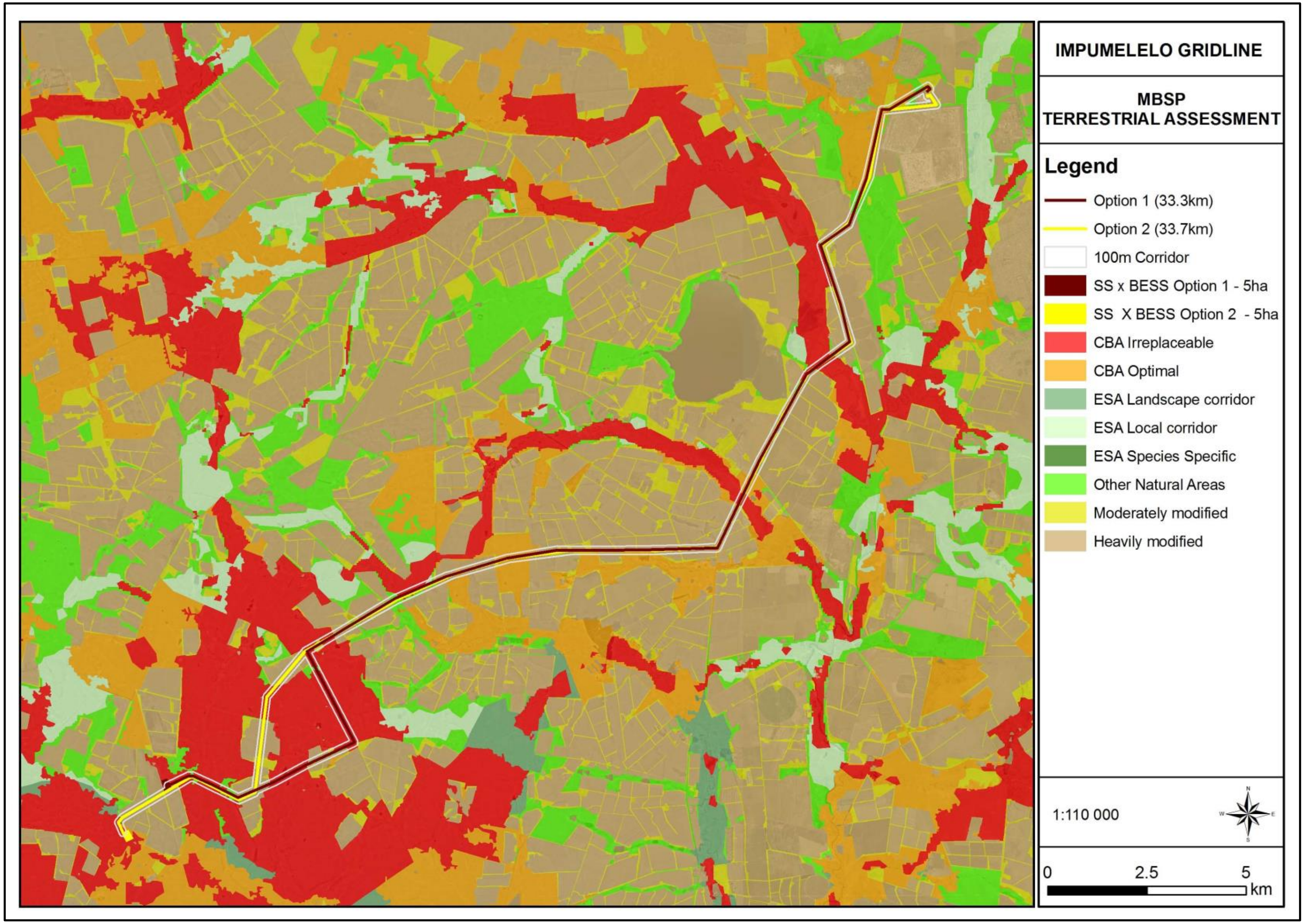


Figure 7: The proposed Impumelelo GRIDLINE site in relation to the MBSP terrestrial

In addition to the relevant international, national and provincial conservation importance of the aquatic ecosystems which could potentially be affected by the proposed development the following abiotic aspects are relevant to the study site (Table 5).

Table 6: A summary of abiotic aspects which informed the report

Abiotic Feature	Description	Figure and or reference
Climate	Summer-rainfall region (MAP 662 mm). Cool-temperate climate with thermic continentality (high extremes between maximum summer and minimum winter temperatures, frequent occurrence of frost, large thermic diurnal differences.	Mucina & Rutherford, 2006
Geology	The study site is underlain by Arenite and Dolorite	Figure 8, ENPAT
Soil	The majority of the study site is underlain by the soil/land type Ea20 - One or more of: vertic, melanic, red structured diagnostic horizons, undifferentiated. And Bb3 - Plinthic catena: dystrophic and/or mesotrophic; red soils widespread, upland duplex and margalitic soils rare	ENPAT
Hydrology and Drainage	Several wetlands and rivers are located on the study site and all drain into the Waterval River before flowing into the Vaal River.	Figure 5

Historical imagery of the study area indicates that the area was historically impacted by farming including agriculture and grazing (Figure 6). Additionally, a large increase in dams can be seen in recent years. Other additional changes that could have negatively impacted wetlands on the study site include an increase in transport infrastructure, increased farming footprint and the Mines. Current land-uses include agriculture and grazing livestock. In areas with high density grazing livestock a large density of Alien Invasive Species (AIS) were recorded. It should also be noted that numerous dams have been built in recent times, these dams can be seen to be artificial compared to historical imagery of 1960 (Figure 10). Although these areas where mapped as dams, they are considered to be artificial and was thus not assessed as natural wetlands.

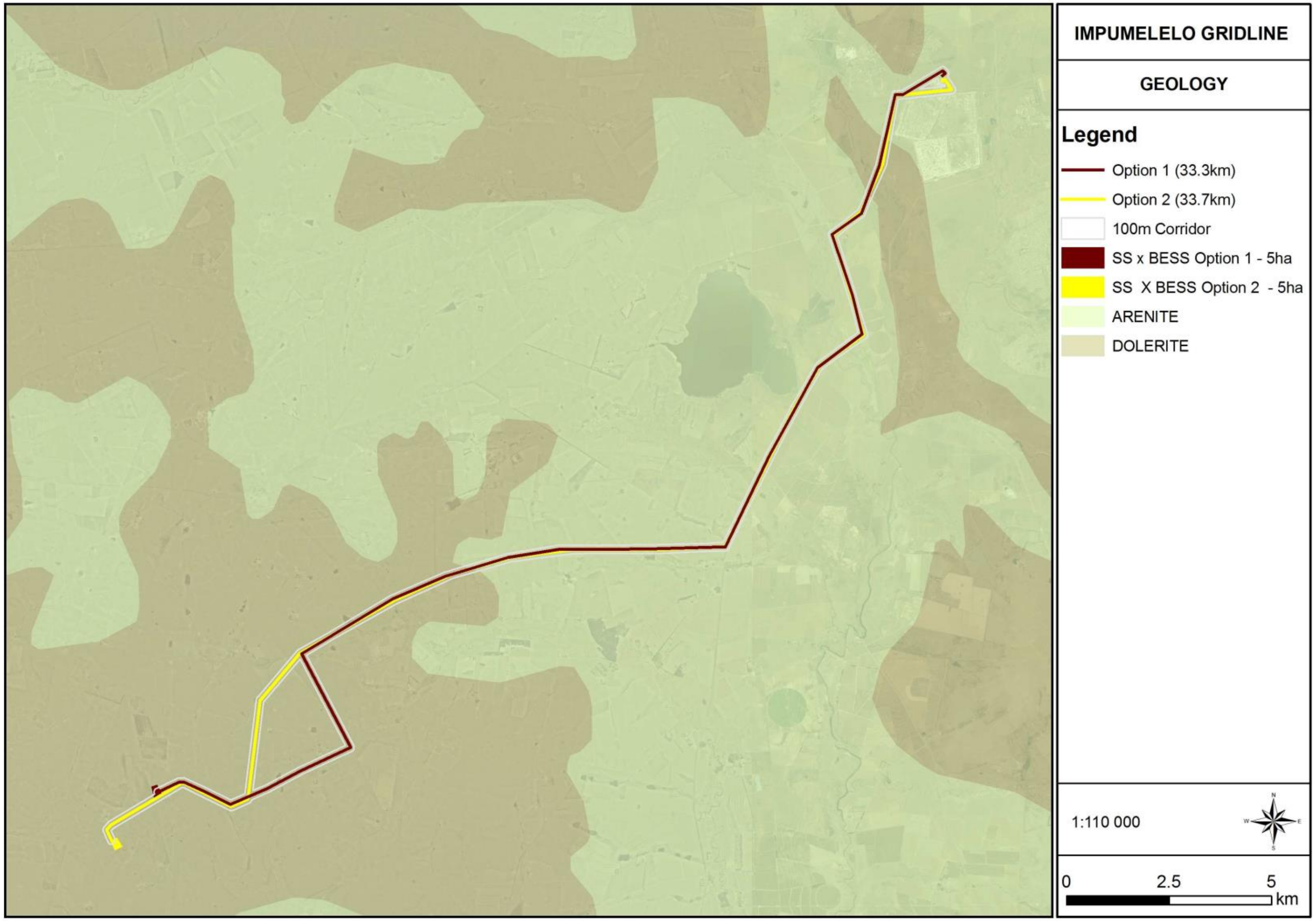


Figure 8: Geology of the proposed Impumelelo GRIDLINE site and proposed activities

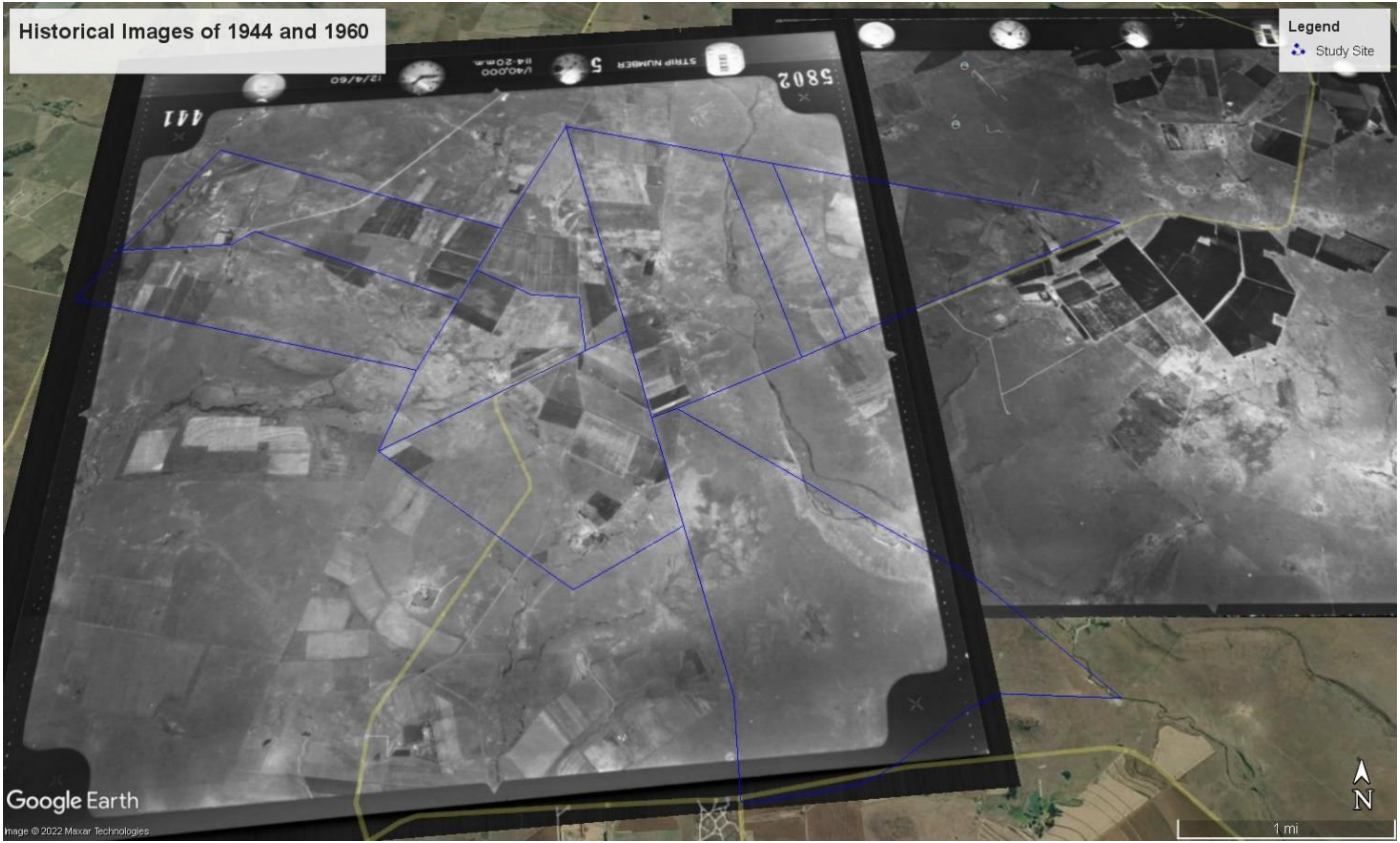


Figure 9: Historical image of 1944 (East) and 1960 (West) indicating prolonged farming activities on the study site

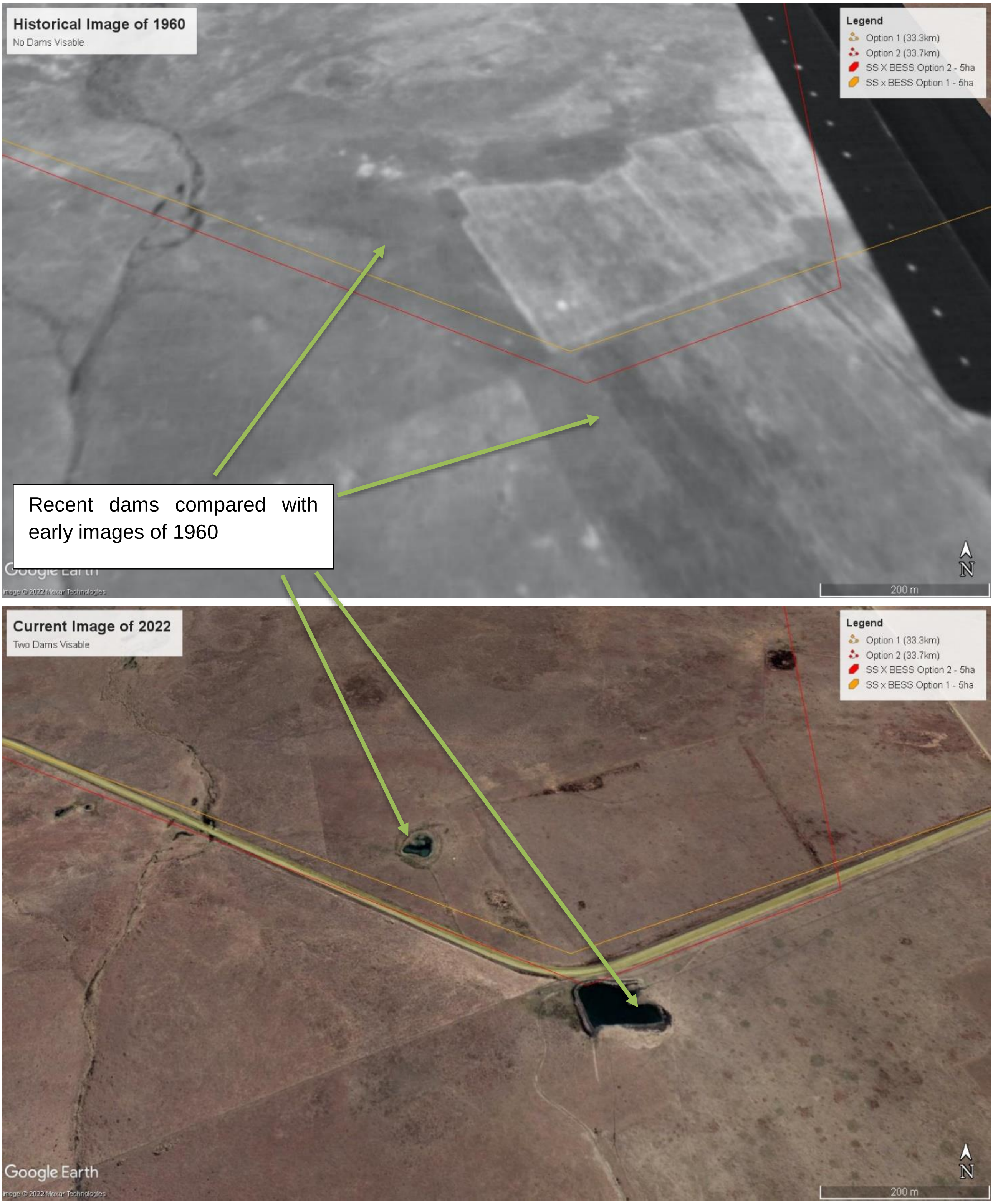


Figure 10: Aerial images of 1960 (Top) compared to recent images of 2022 (Bottom) indicates the presence of newly created artificial waterbodies.

4.2. Project Specific Description

This section describes the baseline aquatic environment surrounding the proposed Impumelelo Wind Facility based on the fieldwork conducted. The wetlands are classified as the following Hydrogeomorphic units which encompass three key elements (Kotze *et al*., 2005):

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
- Hydrodynamics - This refers to how water moves through the wetland.

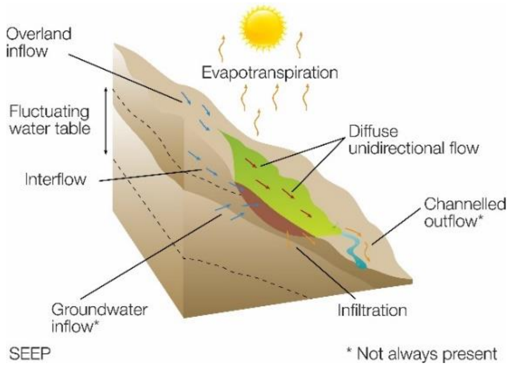
A summary of Levels 1 to 4 of the Classification System is presented in Table 11 below:

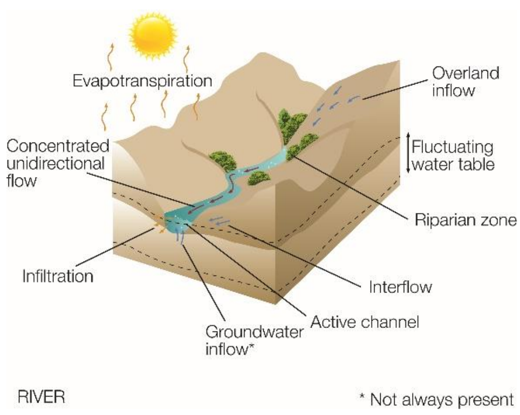
Table 7: Level 3 classification structure for Inland Systems

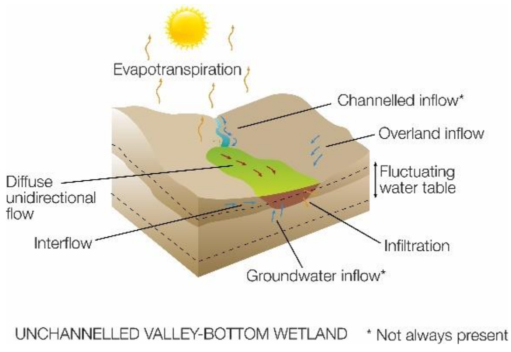
Wetland / Aquatic Ecosystem Context		
Level 1: System	Level 2: Regional Setting	Level 3: Landscape Unit
Inland Systems	DWA Level 1 Ecoregions Or NFEPA WetVeg Groups Or Other Special Framework	Valley Floor - gently sloping lowest surface of a valley, excluding mountain headwater zones.
		Slope - located on the side of a mountain, hill or valley that is steeper than lowland or upland floodplain zones.
		Plain - extensive area of low relief. Different from valley floors in that they do not lie between two side slopes, characteristic of lowland or upland floodplains.
		Bench (Hilltop / Saddle / Shelf) - an area of mostly level or nearly level high ground, including hilltops/crests, saddles and shelves/terraces/ledges.

Wetland / Aquatic Ecosystem Context		
Level 1: System	Level 2: Regional Setting	Level 3: Landscape Unit
Inland Systems	DWA Level 1 Ecoregions Or NFEPA WetVeg Groups Or Other Special Framework	Valley Floor - gently sloping lowest surface of a valley, excluding mountain headwater zones.
		Slope - located on the side of a mountain, hill or valley that is steeper than lowland or upland floodplain zones.
		Plain - extensive area of low relief. Different from valley floors in that they do not lie between two side slopes, characteristic of lowland or upland floodplains.
		Bench (Hilltop / Saddle / Shelf) - an area of mostly level or nearly level high ground, including hilltops/crests, saddles and shelves/terraces/ledges.

Functional Unit		
Level 4: Hydrogeomorphic (HGM) Unit		
HGM Type	Longitudinal Zonation / Landform / Outflow Drainage	Landform / Inflow Drainage
A	B	C

Seep: A wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.		Without Channel Inflow	Not Applicable

Floodplain: Linear fluvial, net depositional valley bottom surfaces which have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea) . The meandering channel flows within an unconfined depositional valley, and ox-bows or cut-off meanders evidence of meandering – are usually visible at the 1:10 000 scale (i.e. observable from 1:10 000 orthomaps).		Floodplain Flat	Not Applicable

Valley bottom without a channel Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line.		Not Applicable	Not Applicable

4.2.1. Watercourse classification and delineation

The study area comprises of two powerline and substation options as well as a 100 m corridor around the powerline. Option 1 (including Substation Option 1) and Option 2 (including Substation Option 2) follows the same route from the same Zandfontein Substation towards the Sasol Impomolelo Mine where the route diverges around the mine respectively. Substation Option 1 is located closer to the Sasol mine compared to Substation Option 2. Thus Option 1 approximately 33.3 Km while Option 2 is approximately 33.7 km. It should be noted that both the powerline options follows existing roads, conveyer belts and other previously built powerlines for the majority of the route, this greatly reduces potential impacts due to access roads and previously vegetation clearing. Both route options cross a similar amount of wetlands although the substation of option 2 encroaches on a small seepage wetland and is thus not a suitable location. Furthermore, a wetland does fall within 100 m (and thus within the DWS 500 m regulated areas) from substation option 1 although option 1 follow an existing gravel road for a longer distance compared to option 2. Based on these findings Option 1 is the preferred option although ideally the substation should ideally be reconsidered to be moved possibly across the road in an existing agricultural land, thereby reducing potential impacts. The following wetlands were recorded within the powerline corridor and the substation corridor areas:

- 1 Depressional Pan Wetland;
- 1 Seepage Wetland;
- 3 Floodplain Wetlands;
- 9 Channelled Valley Bottom Wetland; and
- 11 Unchannelled Valley Bottom Wetlands.

The main rivers associated with these wetlands include: Ouhoutspruit-, Wolwespruit-, Kaalspruit-, Xspruit- and Watervalspruit Rivers. These all drain southward into the Watervalspruit River before flowing into the important Vaal River.

Buffer zones were calculated for the wetland HGM Units following Macfarlane *et al.*, (2015):

- Floodplain Wetlands - 43 m;
- Channelled Valley Bottom Wetlands – 50 m;
- Depressional Pan – 70 m;
- Unchannelled Valley Bottom Wetlands – 42 m; and

- Seepage Wetland – 21 m.

Figure 11 and Figure 12 shows the delineated watercourses, together with their associated buffer zones and DWS regulated area relative to the study site. Sections 4.2.2 to 4.2.4 discuss the wetlands briefly.

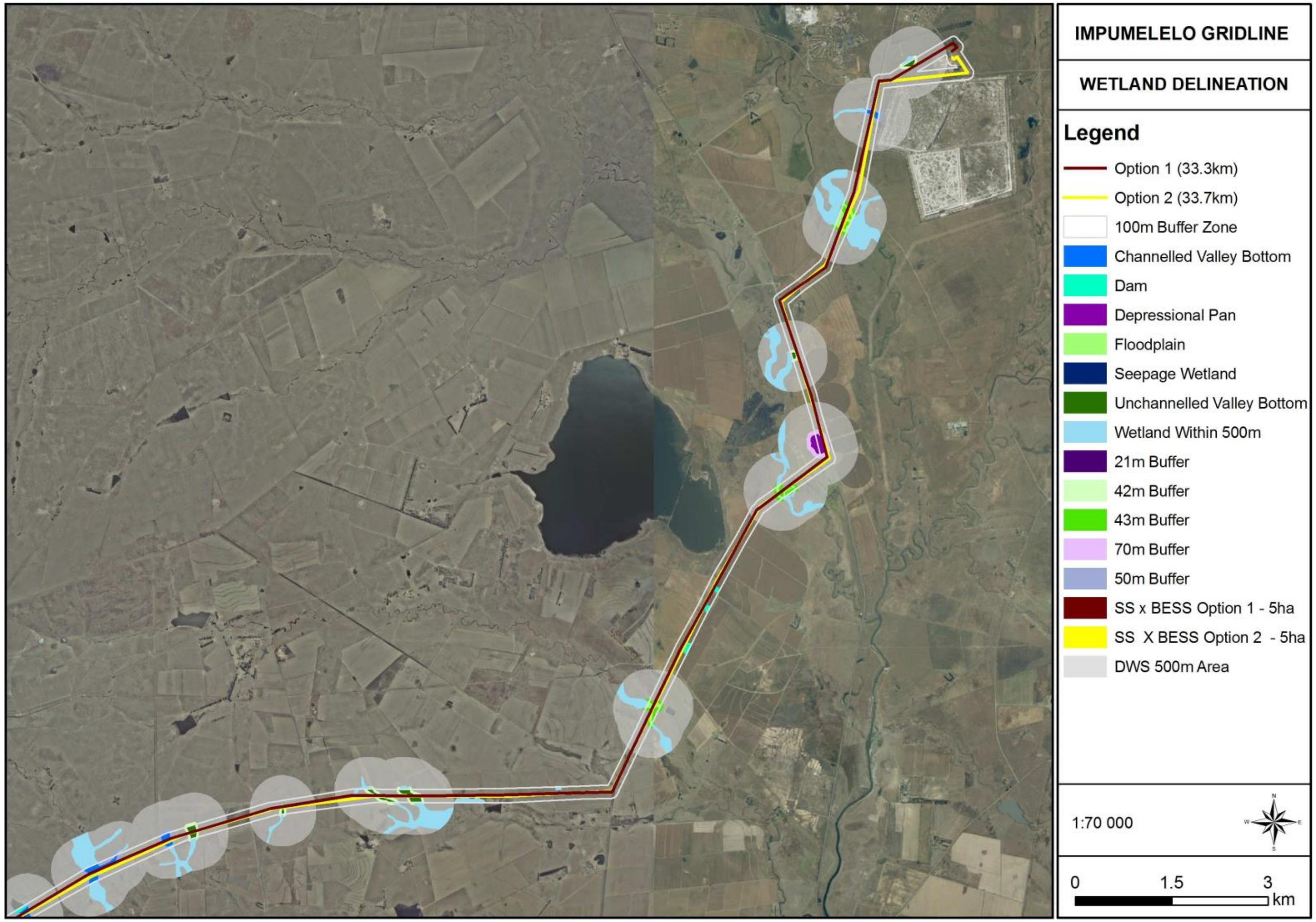


Figure 11: Delineated watercourses together with their calculated buffer zones and the 500 m DWS regulated area of the northern section of the study area.

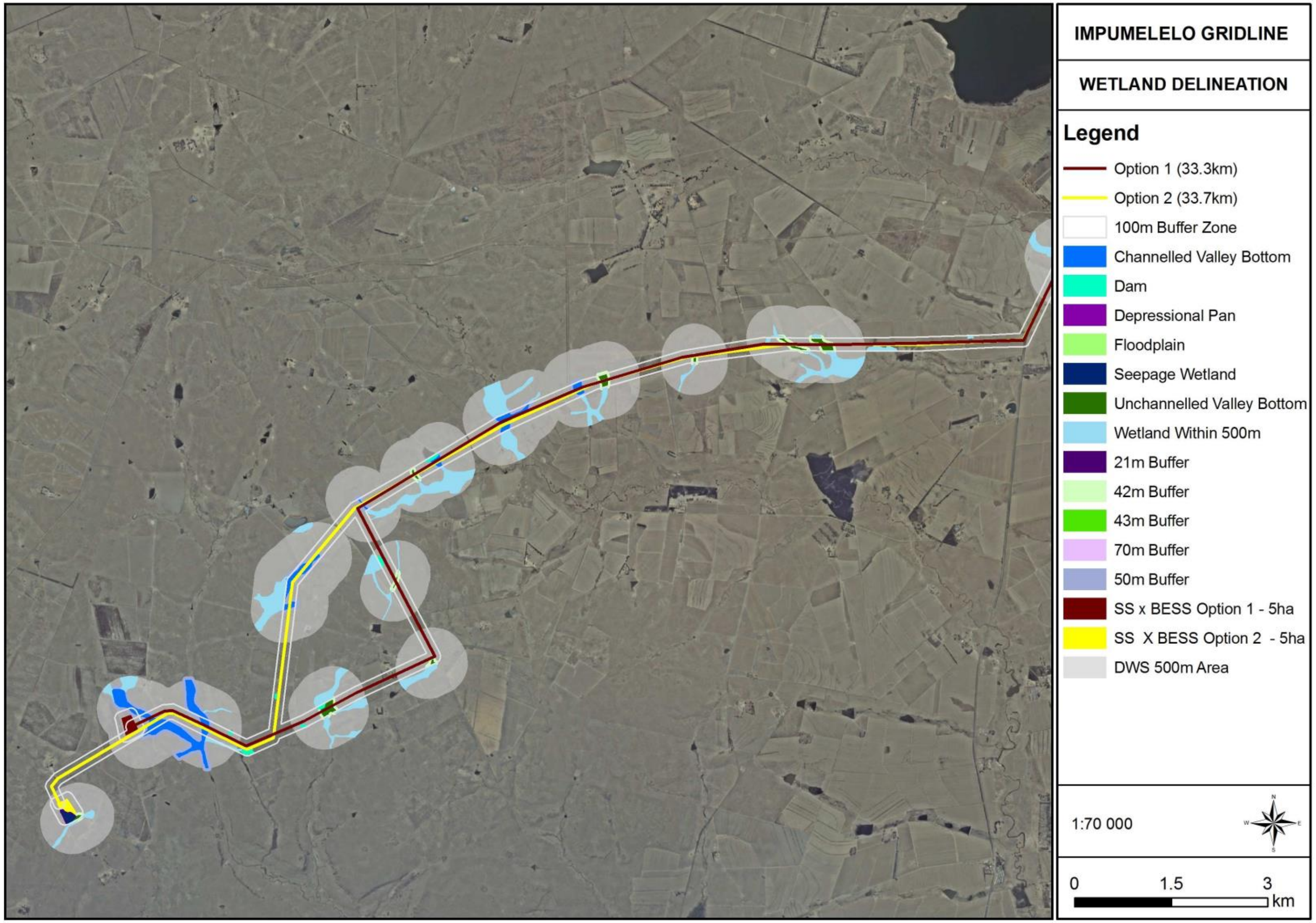


Figure 12: Delineated watercourses together with their calculated buffer zones and the 500 m DWS regulated area of the southern section of the study site

4.2.2. Watercourse Types

It is important to note that the majority of the study site is underlain by dolerite which is characterised by vertic soils with a high clay content. These clay soils form temporary wet areas when saturated. The site visit was conducted in a particularly wet season with above average rainfall and several areas of saturation were recorded. This resulted in robust vegetation growth similar in composition to the wetlands. Due to the high rainfall a few hydrophytic wetland species occurred in areas with poor drainage and prolonged saturation (such as roadsides and small depressions) that would not normally sustain wetland species. Furthermore, large section of the study site is dominated by agricultural fields of predominantly maize and the soil of these areas are mostly disturbed anthropogenic soils that do not indicate redoximoprhic features with great consistency. Vertic soils characteristic of the wetlands in the study area. Some alluvial deposits and sedimentation were recorded in the floodplain and some valley bottom wetlands. Overgrazing and agriculture has resulted in erosion, sedimentation and an increase in AIS in most of the wetlands recorded.

A large diversity of hydrophytic (water-loving) species were recorded in the wetlands. The dominant species include *Phragmites australis*, *Typha capensis*, *Themeda triandra, Paspalum diltatum, Eragrostis curvula, Leersia hexandra , Sporobolus africanus, Hypoxis spp,* and *Berkeya radula. Crinum bulbispernum* and *Erythrina zeyheri* were fairly common in the Floodplain and valley bottom wetlands especially in the second site visit in November.

Common sedges and forbs included: *Cyperus congestus, Cyperus esculnetis, Cyperus haematocephalus, Cyperus laevigatus, Cyperus longus, var. longus, Cyperus fastigiatus, Eleocharis spp. Rumex lanceolatus, Hypoxis obtuse, Berkheya sp, Typha capensis,, Kyllinga erecta,, Kyllinga melanosperma Phragmites australis, Schoenoplectus corymbosus, Senecio latifolius, Senecio coronatus Haplocarpha scaposa*, *Helichrysum nudifolium* var. *nudifolium*, *Helichrysum rugulosum, Schoenoplectus muricinux.*

The dominant alien species recorded included: *Solanum elaeagnifolium, Oenothera rosea, Plantego lanceolate, Senecio erubescens, Pennisetum clandestinum, Verbena bonariensis, Conyza canadensis, Pseudognaphalium luteo-album, Plantago lanceolate, Cosmos bipinnatus, Cirisium vulgare, Persicaria lapathifolia, Tagaets minuta, Bidens pilosa, Bidens bipinnata, Oxalis latifolia,* and *Trifolium repens.* Common woody AIS include: *Populus* x *canescens, Eucalyptus* spp*, Salix babylonica, Sesbania punicea, Tamarix ramosissima* and *Pinus* spp*.*

4.2.3. Watercourse Functional Assessment

The study site and surroundings are impacted by agriculture and grazing livestock as well as some mining, predominantly underground which has resulted in some watercourses with degraded water quality due to foreign material inputs and stormwater inputs both from farming and mining sectors. Additionally, some of the impacts recorded during the site visit include increased sedimentation, increased water input, large densities of AIS, foreign material input, agriculture, grazing animals, infrastructure such as roads. Loss of wetlands have also been noted in cultivated areas. Lastly, the hydrology and geomorphology has been impacted by a large increase in impoundments within watercourses. Notwithstanding, these watercourses provide habitat and breeding areas for wildlife observed in this area including several bird and amphibian species. The wetlands further function as ecological corridors between regions. Lastly, the watercourses provide several ecosystem services including cultural benefits, flood attenuation, streamflow regulation, water quality enhancement and carbon

Integrity Scores
The integrity and function scores calculated for the wetlands are presented in the section below. Table 8 presents a summary of the assessment methodologies applied to determine scores for the components of watercourse function and integrity. A summary of the integrity scores for each wetland is listed in Table 9 and shown in Figure 11, Figure 13 and Figure 15.

Table 8: Summary of the methodologies used to determine function and integrity scores for the watercourses associated with the study site.

Unchannelled Valley Bottom Wetland
WetHealth V2 (EC/PES) (Macfarlane et al., 2020)
Environmental Importance and Sensitivity category (EIS) (Kotze et al., 2020)
WetEcosystem Services V2 (ES) (Kotze et al., 2020)
Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)
Recommended Ecological Category (REC) Rountree et al., (2013)

Table 9: Summary of the scores of the wetland units

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.*, (2013)
1	Seepage	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - Moderate*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B
1	Depressional Pan	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - Moderate*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B
1, 2 and 3 (Same Wetland)	Channelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - High *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - Moderate*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B/C –Maintain at B/C
4	Channelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has	*Ecological Importance & Sensitivity* - Low	*Biodiversity maintenance importance* – Low	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local	C –Maintain at C

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
		taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	
5 & 6 (Same Wetland)	Channelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain at C
7	Channelled Valley Bottom	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - High *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - Moderate*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B
8	Channelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	*Ecological Importance & Sensitivity* -Moderate *Hydro-Functional Importance* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	C –Maintain at C

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
		Condition is likely to remain stable over the next 5 years	*Direct Human Benefits* - Moderate	*Provisioning and cultural services importance - Moderate*	They play a small role in moderating the quantity and quality of water in major rivers	
9	Channelled Valley Bottom	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Low *Hydro-Functional Importance* - Low *Direct Human Benefits* - Low	*Biodiversity maintenance importance* – Low *Regulating services importance* - Low *Provisioning and cultural services importance - Low*	Low/Marginal (D) - Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	D –Maintain at D
1	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain C
2	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in	C –Maintain C

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
		Condition is likely to remain stable over the next 5 years	*Direct Human Benefits* - Moderate		moderating the quantity and quality of water in major rivers	
3 & 4 (Same Wetland)	Unchannelled Valley Bottom	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Low *Hydro-Functional Importance* - Low *Direct Human Benefits* - Low	*Biodiversity maintenance importance* – Low *Regulating services importance* - Low *Provisioning and cultural services importance - Low*	Low/Marginal (D) - Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	D –Maintain at D
5	Unchannelled Valley Bottom	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain at C
6	Unchannelled Valley Bottom	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Low *Hydro-Functional Importance* - Low *Direct Human Benefits* - Low	*Biodiversity maintenance importance* – Low *Regulating services importance* - Low *Provisioning and cultural services importance - Low*	Low/Marginal (D) - Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in	D –Maintain at D

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
					moderating the quantity and quality of water in major rivers	
7	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain C
8	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain C
9	Unchannelled Valley Bottom	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* -Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in	C –Maintain at C

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
					moderating the quantity and quality of water in major rivers	
10	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - Moderate	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain C
11	Unchannelled Valley Bottom	C- Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - Moderate *Hydro-Functional Importance* - Moderate *Direct Human Benefits* - High	*Biodiversity maintenance importance* – Moderate *Regulating services importance* - Moderate *Provisioning and cultural services importance - Moderate*	Moderate (C) - Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	C –Maintain C
1	Floodplain	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - High *Direct Human Benefits* - High	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - High*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B

Wetland number	Wetland Type	WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Ecological Importance (EI) (Rountree & Kotze., 2013 and DWAF, 1999)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Recommended Ecological Category (REC) Rountree *et al.,* (2013)
2	Floodplain	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - High *Direct Human Benefits* - High	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - High*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B
3	Floodplain	B -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. Condition is likely to remain stable over the next 5 years	*Ecological Importance & Sensitivity* - High *Hydro-Functional Importance* - High *Direct Human Benefits* - High	*Biodiversity maintenance importance* – High *Regulating services importance* - High *Provisioning and cultural services importance - High*	High (B)- Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	B – Maintain at B

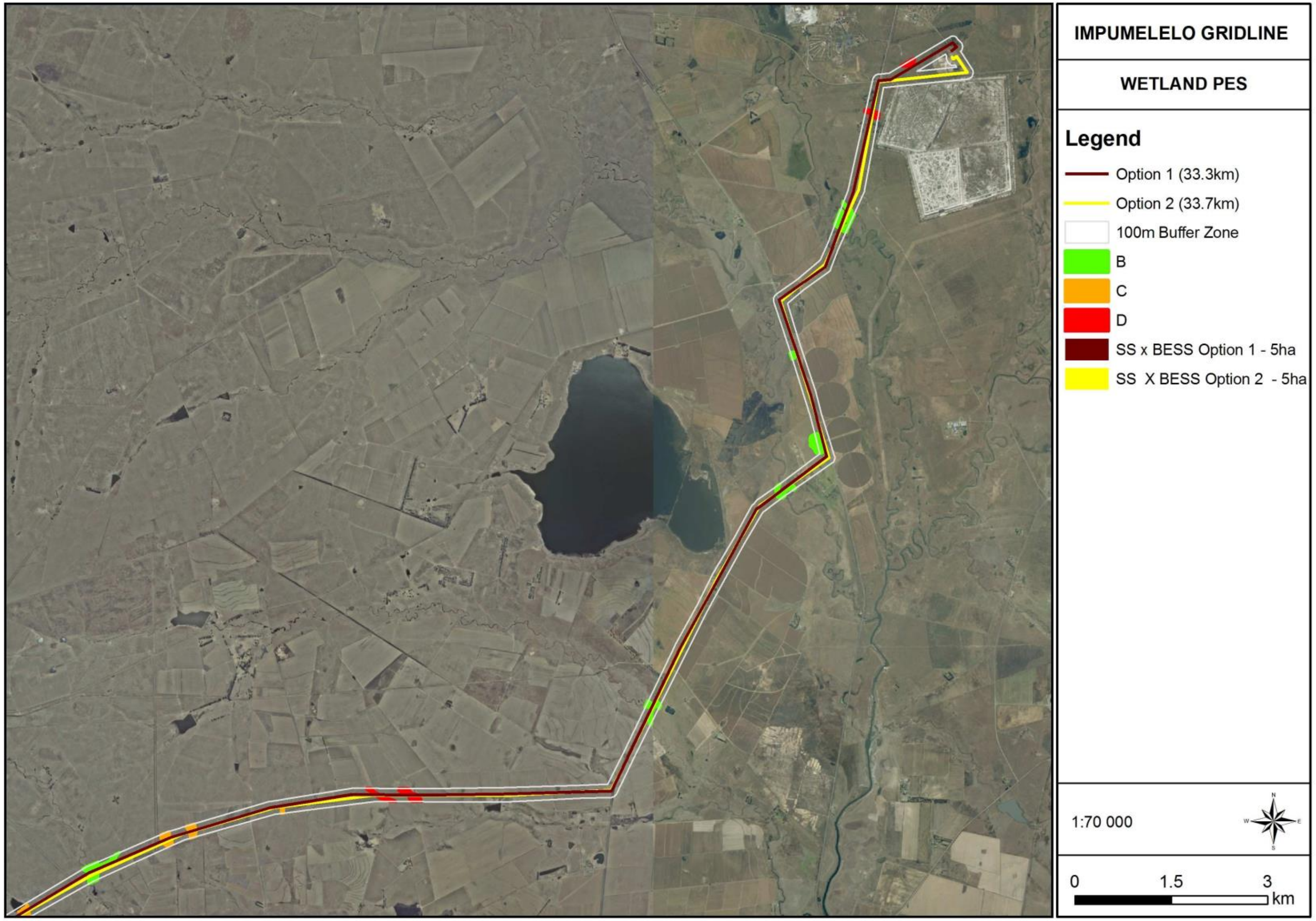
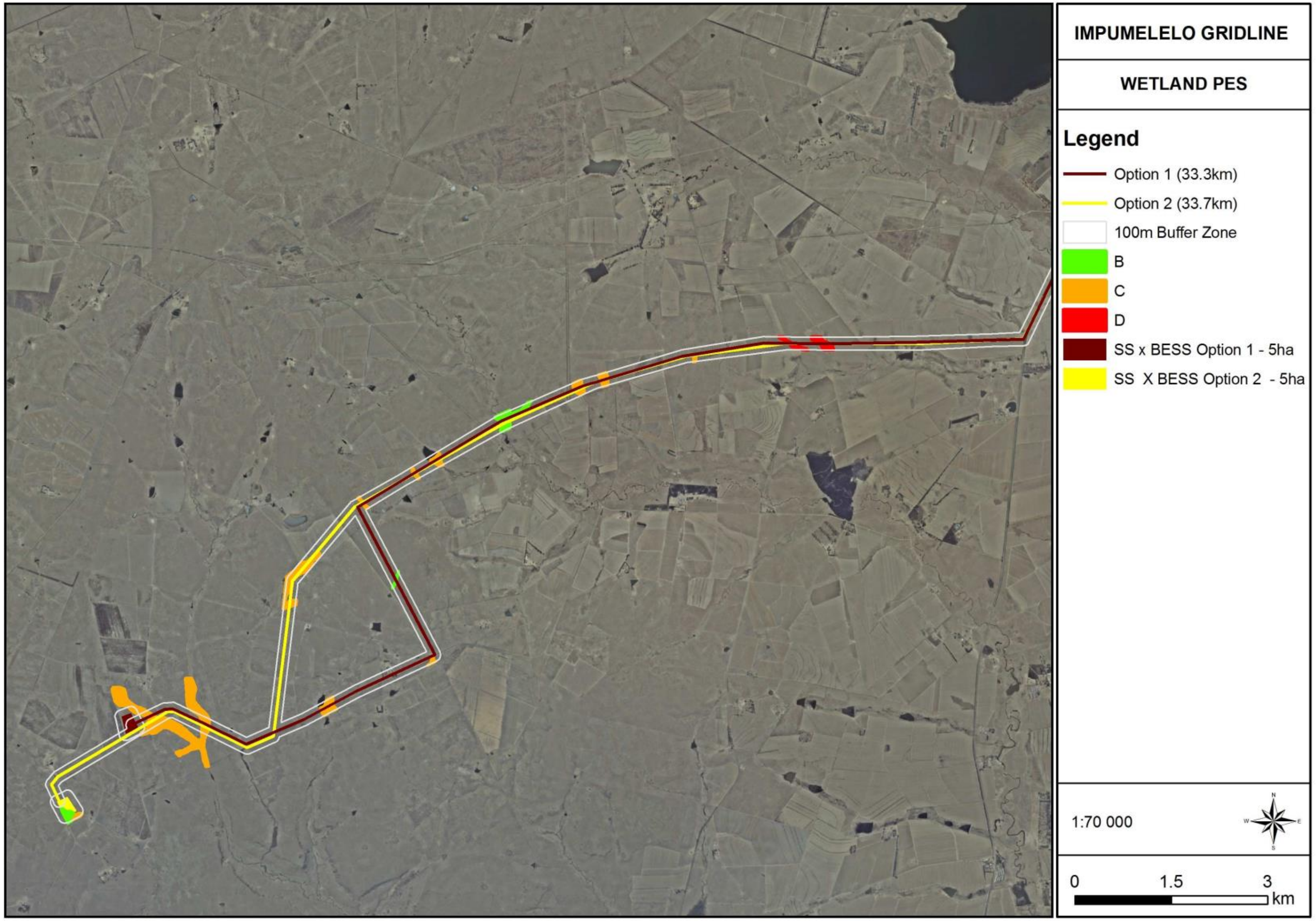


Figure 13: Present ecological state of each wetland unit in the proposed Impumelelo GRIDLINE of the northern section (Macfarlane et al., 2020)



igure 14: Present ecological state of each wetland unit in the proposed Impumelelo GRIDLINE of the southern section (Macfarlane et al., 2020)

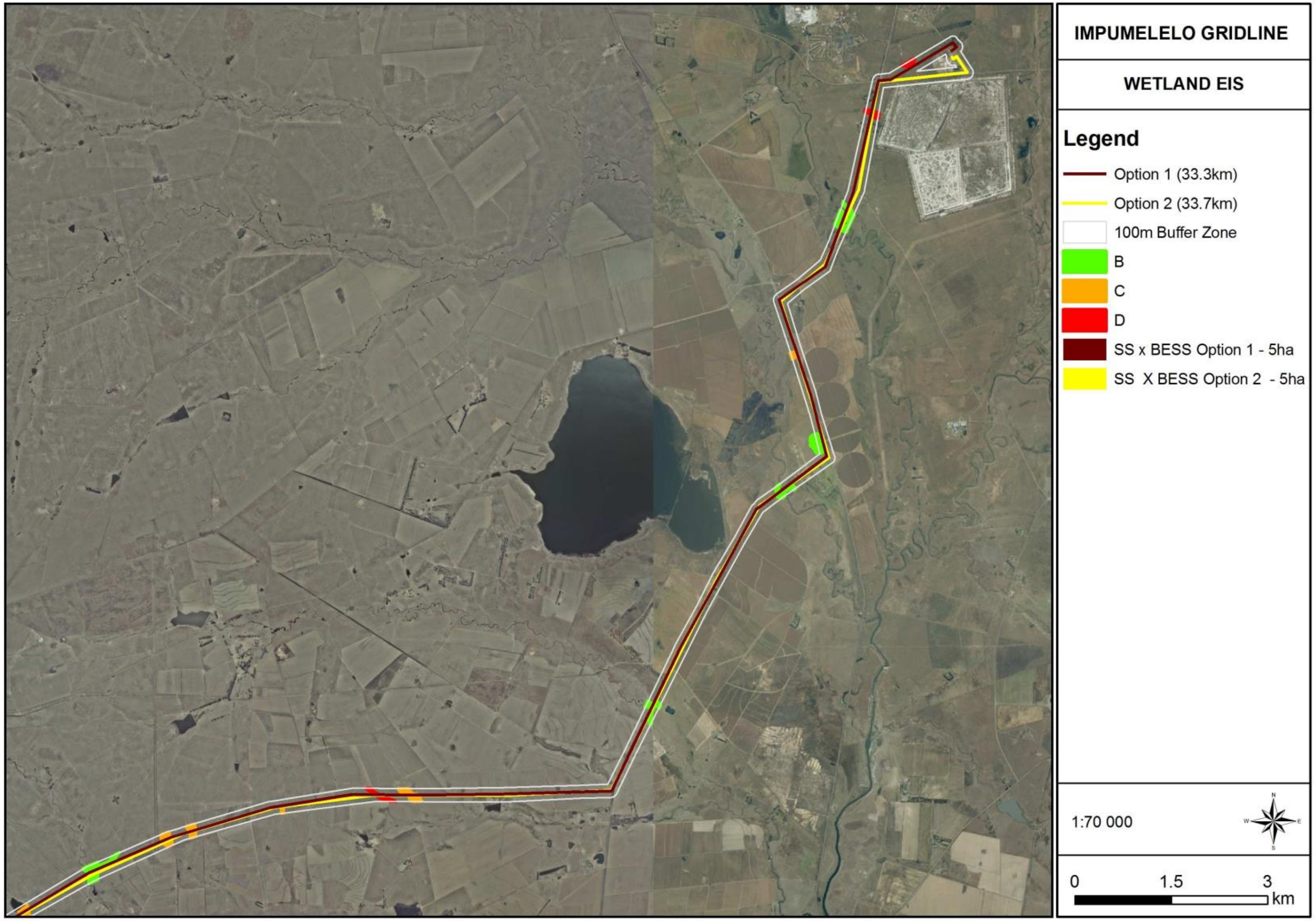


Figure 15: Environmental Importance and Sensitivity category (EIS) of the proposed Impumelelo GRIDLINE of the northern section (Kotze et al., 2020)

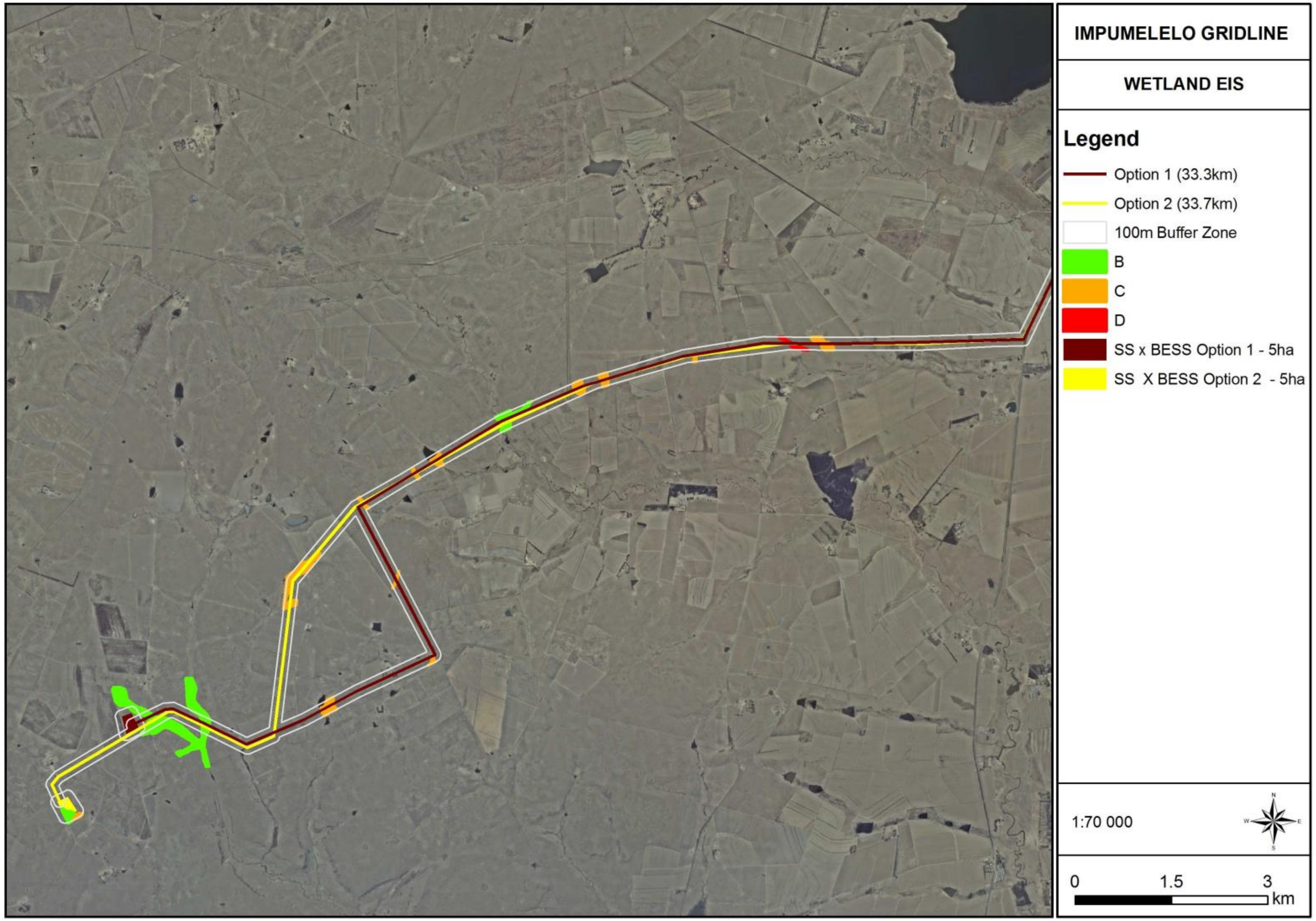


Figure 16: Environmental Importance and Sensitivity category (EIS) of the proposed Impumelelo GRIDLINE of the southern section (Kotze et al., 2020)

Figure 17: Characteristics of wetlands recorded on the study site.

4.2.4. Site Ecological Importance

Based on the Species Environmental Assessment Guideline (SANBI, 2020) watercourses and specialised habitats should be assessed based on their Site Ecological Importance (SEI). All the watercourses examine in this report should thus be regarded as having a High Sensitivity (Table 10):

Table 10: Ecological Importance of all wetland areas recorded on the study site

Habitat	Conservation Importance (CI)	Functional Integrity (FI)	Biodiversity Importance	Receptor Resilience	Site Ecological Importance
All Watercourses	High – Confirmed occurrence of watercourses within the development footprint	Medium – Some historical impacts and AIS recorded	Medium – Based on CI and FI	Very Low – Watercourses are not easily restored without significant rehabilitation. Many species are dependent on functional wetland habitat.	Based on BI – Medium and RR – Very Low = High

Existing impacts noted on watercourses during site visit

Development has several impacts on the surrounding environment and particularly on a wetland. It is assumed that all structures will remain outside of the wetland and calculated buffer zone boundaries. Changing the runoff characteristics of the catchment will result in runoff that may exacerbate bank instability and erosion already present in some watercourses.

GN 320 of 20220 prescribes the extent of potential impacts to wetlands that should be assessed. Table 5 summarises these potential impacts and includes a brief discussion for each aspect. The impact assessment matrix according to the NEMA 2014 regulations (as amended), are presented in Section 5.1. The DWS (2016) Risk Assessment matrix is presented Section 5.2 below.

Although the exact footprint infrastructure was not known at the time of compiling this report, it assumed that vegetation will be removed and that surface water will not be greatly impeded by these structures. Some of the impacts recorded including erosion, mining, agriculture and grazing is represented visually below (Figure 18).

Figure 18: Indicating some of the impacts recorded on site. Including mining, erosion, grazing and broken infrastructure

4.2.5. DWS 2016 Risk Assessment

An extract from the Risk Matrix spreadsheet presented in Table 14 below show that the expected risk score for the proposed transmission structures including substations, assuming that the structures will not be placed within a wetland/watercourse area or any buffer zones. The scores fall within the Low risk category. This category refers to risk and impact on watercourses that can be manages so as to have a low nett impact on the affected watercourses. This score is based on the assumption that the effective rehabilitation of disturbed watercourses on a site specific rehabilitation plan will be implemented and that monitoring will be undertaken to establish success of reestablishment of vegetation cover and water flow dynamics. An extract from the Risk Matrix spreadsheet is presented in Table 11 below.

The impact and risk assessment should be reviewed once the final layout has been determined. Furthermore, fauna and flora sensitivities and geohydrological parameters should be taken into consideration. Methods relevant to the calculation of impacts and risks are presented in Appendix D.

An extract from the Risk Matrix spreadsheet is presented in Table 11 below.

Table 11: The DWS (2016) risk assessment matrix for the proposed development. Risk is determined after considering all listed control / mitigation measures

RISK MATRIX (Based on DWS 2016 publication: Section 21 c and I water use Risk Assessment Protocol): Construction of Eskom powerline and Substations

NAME and REGISTRATION No of SACNASP Professional member: A Bootsma SACNASP # 400222/09

Phases	Activity	Aspect	Impact	Severity: Flow Regime	Severity: Physico & Chemical (Water Quality)	Severity: Habitat (Geomorph+Vegetation)	Severity: Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
C	Construction of Eskom 132kV Powerline and Substations	Establishment of Construction Site a	Loss of vegetation cover, compaction of soils, sedimentation, pollution and alien invasive plant establishment	1	2	3	2	2	1	2	5	1	2	5	2	10	50	L	80%	• Minimise the footprint of activities in the wetland and buffer zone by preventing unnecessary access of vehicles and personnel • Implement best practice and mitigation measures as specified in the rehabilitation plan • Establish the current aquatic baseline status and undertake regular biomonitoring to identify impacts to water quality resulting from the activity • Consider methods to reduce teh sediment load into the adjacent pan, for example filter sludge • Include a method statement for transportation of material on the access roads, with a focus on pollution control	N	Likely remain the same
		Establishment of Works Site		1	3	2	2	2	1	2	5	1	2	5	2	10	50	L	80%		N	
		Construction of a works platform, tower structures and pile		1	2	2	1	1.5	1	2	4.5	1	2	5	2	10	45	L	80%		N	
		Transporting machinery and construction material on the existing access road		1	2	2	1	1.5	1	2	4.5	1	2	5	2	10	45	L	80%		N	
O	Operation of the Eskom 132kV Powerline and Substations	Long term presence powerline and substations	Water quality impacts during maintenance activities	0	1	1	1	0.8	1	2	3.75	2	2	5	2	11	41.25	L	80%	• Maintenance activities should follow best practice	N	Likely remain the same
		Ad hoc repair and maintenance to structures		1	2	2	1	1.5	1	1	3.5	1	2	5	2	10	35	L	80%		N	

4.2.6. Baseline aquatic assessment results

Baseline aquatic assessment results will be included after sampling has occurred in the final aquatic assessment report.

4.3. Identification of Environmental Sensitivities

4.3.1. Sensitivities identified by the National Web-Based Environmental Screening Tool

Based on the National Web-Based Environmental Screening tool the majority of the watercourses and aquatic ecosystems surrounding the study site is classified as high in terms of aquatic biodiversity (Figure 19).

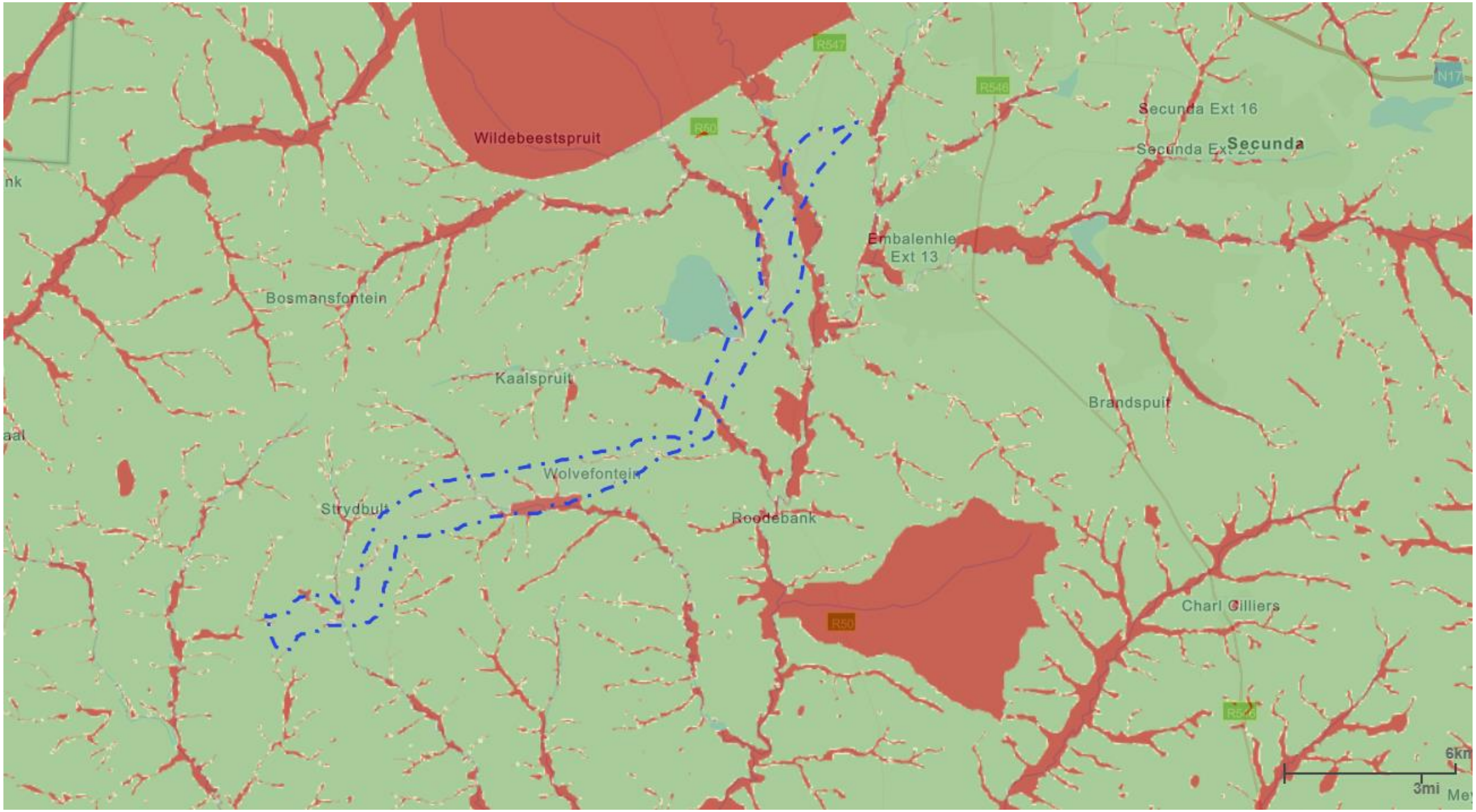


Figure 19: Results of the National Web Based Screening Tool in terms of Aquatic Biodiversity

In terms of the desktop assessment the study site has conservation significance both in terms of national as well as provincial conservation planning. The site verification assessment indicated that the proposed layout encroaches on the wetlands and their associated buffer areas.

The desktop assessment conducted by DWS indicated that the sub quaternary reaches surrounding the study site are largely natural (B) to moderately modified (C). The site verification indicated that the wetlands are moderately (C) to seriously modified (E) whilst the aquatic macroinvertebrates indicated that the aquatic ecosystems are largely (D) to seriously/critically (E/F) modified. Therefore, the wetland and aquatic ecosystems surrounding the study site do not conform to the desktop assessment and are more impacted than expected.

Based on the field assessments, the wetland delineation and buffer indicate that the current layout encroaches on the wetlands as well as their respective buffer areas. Although the wetland and aquatic ecosystems are impacted, they still fulfil important ecosystem services and also form part of national and provincial conservation targets. Ideally a walk down should be done on site once the location of each pylon is available to ensure the footprints remain outside of watercourses as far as possible.

4.3.2. Sensitivity Analysis Summary Statement

Although the wetland and aquatic ecosystems are impacted, they still fulfil important ecosystem services and also form part of national and provincial conservation targets. It is therefore recommended that the wetlands, aquatic ecosystems and the buffer areas as indicated in Figure 11 are considered of high sensitivity with the exception of one artificial wetland area scored as low.

4. Alternative Development Footprints

Two route options and substation areas were assessed . The two routes are very similar for the majority of the route with the exception of the southern section were the two option split to the different substation option. Option 2 is suggested due to the close nature of a tarred road adjacent to the site.

5. Issues, Risks and Impacts

6.1. Identification of Potential Impacts/Risks

Although the exact footprint infrastructure was not known at the time of compiling this report, it assumed that vegetation will be removed and that surface water will not be greatly impeded by these structures.

The largest impact is thought to be during the construction phase, the proposed construction timeframe is estimated to be 6-12 months, according to the information received. The major impacts are as follow:
Construction Phase:

a) Alteration in flow regime;
b) Changes in sediment regimes;
c) Introduction and spread of alien vegetation;
d) Loss and disturbance of riparian/watercourse habitat and vegetation;
e) Alteration in water quality due to pollution; and
f) Loss of aquatic biota.

Operational Phase:

a) Alteration in flow regime;
b) Changes in sediment regimes;
c) Introduction and spread of alien vegetation;

d) Loss and disturbance of riparian/watercourse habitat and vegetation;
e) Alteration in water quality due to pollution; and
f) Loss of aquatic biota.

Decommissioning Phase:

a) Alteration in flow regime;
b) Changes in sediment regimes;
c) Introduction and spread of alien vegetation;
d) Loss and disturbance of riparian/watercourse habitat and vegetation;
e) Alteration in water quality due to pollution; and
f) Loss of aquatic biota.

Cumulative Impacts:

a) Alteration in flow regime.

6. Impact Assessment

Currently the gridline layout does infringe on the wetlands as well as their respective buffer areas. Although the exact footprint of each pylon is not known, the layout does encroach on many wetlands. However, the majority of the proposed powerline is located adjacent to an existing road, and the impact is thus less compared to open land.

6.1. Potential Impacts during the Construction Phase

Changes in flow regime arises from the compaction of soil, the removal of vegetation and surface water redirection. Changes to hydrological function at a landscape level which can arise from changes to flood regimes (i.e. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes). The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary, seasonal, permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.). Changes to base flows i.e. too little/too much water in terms of characteristics and requirements of system). Fragmentation (i.e. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).

Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount). Construction and operational activities will result in earthworks and soil disturbance as well as the removal of natural vegetation. This could result in the loss of topsoil, sedimentation of the watercourse and increase the turbidity of the water. Possible sources of the impacts include:

- Earthwork activities during construction
- Clearing of surface vegetation will expose the soils, which in rainy events would wash through the watercourse, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate alien invasive trees can spread easily into these eroded soil.
- Disturbance of soil surface
- Disturbance of slopes through creation of roads and tracks adjacent to the watercourse
- Erosion (e.g. gully formation, bank collapse)

Changes in sediment regimes of the aquatic ecosystem and its sub -catchment by for example sand movement, meandering river mouth /estuary, changing flooding or sedimentation patterns.

The moving of soil and vegetation resulting in opportunistic invasions after disturbance. Invasions of alien plants can impact on hydrology, by reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system, alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plants can easily colonise and impact on downstream users.

Loss and disturbance of watercourse habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation.

Changes in water quality due to input of foreign materials i.e. due to increased sediment load, contamination by chemical and /or organic effluent, and /or eutrophication. During the construction phase a large amount of waste will be produced including sewerage, domestic waste, wash-water, used oils and grease, diesel or lubricant spills, etc. Waste generally contains pollutants and present a potential risk to the water and surrounding environment if not managed effectively. Oil and diesel spillages may occur during the construction phase which can contaminate surface water. Other potential contaminants (i.e. from chemical toilets, domestic waste, storage facilities, workshop facilities, etc.) can reduce surface water quality or result in discharge that exceeds the maximum concentrations permitted by the National Water Act. Changes to the water quality could result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality deterioration often leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure.

Aquatic biota can be lost due to the disturbance of the habitat and direct impacts on the watercourse/ rivers/ streams. This can be attributed to Loss and disturbance of biota due to direct development on the watercourse as well as changes in habitat including water quality, the water column, increased sediment, increased alien vegetation fire regime and habitat fragmentation.

The impact assessment was conducted using the impact assessment methodology provided as described in Appendix D.

CONSTRUCTION

Impact number	Aspect	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
					(M +	E +	R +	D) x	P =	S	Rating	(M +	E +	R +	D) x	P =	S	Rating
Impact 1:	*Changes in water flow regime*	Construction	Negative	Moderate	3	3	3	4	4	**52**	**N3**	2	2	3	4	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 2:	*Changes in sediment entering and exiting the system*	Construction	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 3:	*Introduction and spread of alien vegetation*	Construction	Negative	Moderate	3	3	3	3	3	**36**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 4:	*Loss and disturbance of watercourse habitat and fringe vegetation*	Construction	Negative	Moderate	3	2	3	4	3	**36**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 5:	*Changes in water quality due to pollution*	Construction	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 6:	*Loss of aquatic biota*	Construction	Negative	Moderate	3	3	3	3	3	**36**	**N3**	2	3	3	3	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						

6.2. Potential Impacts during the Operational Phase

During the operational phase the constructed powerline and substation as well as associated infrastructure as depicted in section 2.3 can potentially have an impact on the watercourses / aquatic ecosystems. The major mitigation measure for the operational phase will still be related to move the pylon and associated structures currently known to be located in a wetland or within the wetland buffer layout. The impacts expected in the operational phase are expected to be similar to the construction phase but not as severe in most instances.

The impacts are limited to:

a) Alteration in flow regime;
b) Changes in sediment regimes;
c) Introduction and spread of alien vegetation;
d) Loss and disturbance of riparian/watercourse habitat and vegetation;
e) Alteration in water quality due to pollution; and
f) Loss of aquatic biota.

A description of these have been provide in section 6.1.

Alteration in flow regime is possible during the operational phase due to the increase in hardened surfaces.
Changes in sediment is still likely especially in the early phase
The impact assessment was conducted using the impact assessment methodology provided as described in Appendix D.

Operational Phase

Impact number	Aspect	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
					(M+	E +	R +	D) x	P =	S	Rating	(M +	E +	R +	D) x	P =	S	Rating
Impact 1:	*Changes in water flow regime*	Operational	Negative	Moderate	3	3	3	4	4	**52**	**N3**	2	2	3	4	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 2:	*Changes in sediment entering and exiting the system*	Operational	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 3:	*Introduction and spread of alien vegetation*	Operational	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 4:	*Loss and disturbance of watercourse habitat and fringe vegetation*	Operational	Negative	Moderate	3	2	5	4	4	**56**	**N3**	2	2	3	3	3	**30**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 5:	*Changes in water quality due to pollution*	Operational	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 6:	*Loss of aquatic biota*	Operational	Negative	Moderate	3	2	3	5	3	**39**	**N3**	2	2	3	4	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						

6.3. Potential Impacts during the Decommissioning Phase

The proposed Gridline and substation will have a lifespan of have a life expectancy of more than 25 years. During the decommissioning phase it is envisaged that all infrastructure will be removed. . Should the mitigation measure of the removal of the layout from wetlands be followed, the impact will also be less during decommissioning. The major mitigation measure for the operational phase will still be related to remove the structures from any wetlands or buffer areas. The impacts expected in the decommissioning phase are expected to be similar to the construction phase.

The impacts are limited to:

a) Alteration in flow regime;
b) Changes in sediment regimes;
c) Introduction and spread of alien vegetation;
d) Loss and disturbance of riparian/watercourse habitat and vegetation;
e) Alteration in water quality due to pollution; and
f) Loss of aquatic biota.

A description of these have been provide in section 6.1.

The impact assessment was conducted using the impact assessment methodology provided as described in Appendix D.

Decommissioning Phase

Impact number	Aspect	Description Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
					(M +	E +	R +	D) x	P =	S	Rating	(M +	E +	R +	D) x	P =	S	Rating
Impact 1:	*Changes in water flow regime*	Decommissioning	Negative	Moderate	3	3	3	4	4	**52**	**N3**	2	2	3	4	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 2:	*Changes in sediment entering and exiting the system*	Decommissioning	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 3:	*Introduction and spread of alien vegetation*	Decommissioning	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 4:	*Loss and disturbance of watercourse habitat and fringe vegetation*	Decommissioning	Negative	Moderate	3	2	5	4	4	**56**	**N3**	2	2	3	3	3	**30**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 5:	*Changes in water quality due to pollution*	Decommissioning	Negative	Moderate	3	2	3	3	3	**33**	**N3**	2	2	3	3	2	**20**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						
Impact 6:	*Loss of aquatic biota*	Decommissioning	Negative	Moderate	3	2	3	5	3	**39**	**N3**	2	2	3	4	2	**22**	**N2**
				Significance	**N3 - Moderate**							**N2 - Low**						

6.1. Cumulative Impacts

In terms of drainage the Grootspruit, Ouhoutspruit watercourses, their tributaries which surround the GRIDLINE all ultimately drain into the Vaal River which is a very important and strategic water source of South Africa and all care should be taken to protect the Vaal River from further pollution and other impacts.

Cumulative impacts are assessed by adding anticipated impacts from this proposed development to existing and proposed developments with similar impacts in a 55 km radius. The existing and proposed developments (Figure 20) that were taken into consideration for cumulative impacts include:

- Grootvlei Solar PV project (In process): 75 MW
- Tutuka
- Forzando
- Mukondeleli
- Vhuvhili Solar

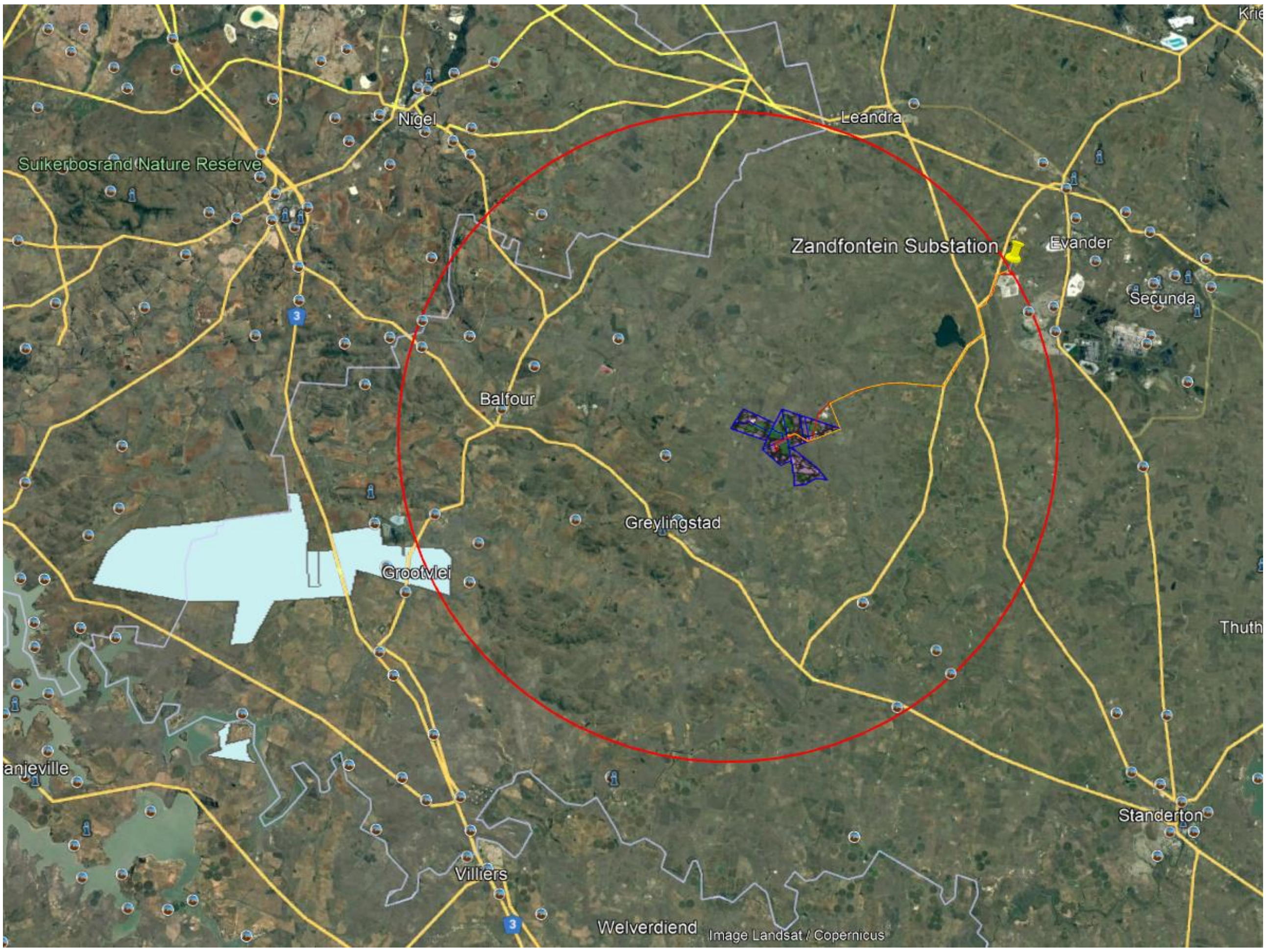


Figure 20: Projects considered within a 30 km radius of the proposed Impumelelo GRIDLINE site for the assessment of cumulative impacts

The grid solutions for the Impumelelo GRIDLINE are in design phase but will likely be shared. Research on SEF's environmental impact especially cumulative impacts are still limited (Rudman *et al.,* 2017).

On a landscape level the following are within the 30 km radius of the planned GRIDLINE:

Existing

- Agricultural activities;
- Roads;
- Sasol Secunda.

At a landscape level it is imperative that the GRIDLINE design is kept out of the wetlands as well as associated buffer area, as this will ensure that there is a degree of connectivity at a landscape level as the watercourses and tributaries of the Ouhoutspruit and Grootspruit also provide corridors for movement for fauna and insects.

During the construction phase it is likely that vegetative cover as well as disturbance of soil will increase the prevalence of erosion and subsequently the amount of sediment present in the catchment. It is also foreseen that during the construction phase the disturbance caused can increase the spread of alien invasive plant species. It is expected that during the operational phase the impact on hydrological regime will be higher due to the cumulative impacts of the GRIDLINE, SEF, grid solutions and supporting infrastructure.

In terms of aquatic biodiversity, the major cumulative impact is thought to be an increase in concentrated flows due to increase in runoff.

6.2. Mitigation Measures

The following mitigation measures as well as best practice measures and other specialist measures should e implemented to reduce potential risk.

Impact 1: Changes in water flow regime

Description	Construction and operational activities will result in earthworks and soil disturbance as well as the removal of natural vegetation. This could result in the loss of topsoil, sedimentation of the wetland and increase the turbidity of the water, particularly where pylons are constructed in or in close proximity to watercourses. Possible sources of impacts include: • Earthwork activities • Disturbance of soil surface including soil compaction • Disturbance of slopes through creation of roads and tracks adjacent to the watercourses • Creation of additional access roads
Mitigation Construction Phase:	• Pylons should be placed outside delineated watercourses and their associated buffer zones. • Prevent access of heavy vehicles and machinery in the wetlands or riparian areas • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out • Rehabilitation plans must be submitted and approved for rehabilitation of damage during the construction phase and that plan must be implemented immediately upon completion of construction. • Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. • Project engineers should compile a method statement, outlining the construction methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes • Only cross watercourses at designated points should this be necessary
Mitigation Operational Phase	• The pylon and substation Structure currently located either within a wetland or within the buffer of a wetland should be moved into nearby impacted areas like agricultural fields • Where development activities are located upslope from wetlands, effective stormwater management should be a priority during both construction and operational phase. This should be monitored as part of the EMP. • Effective culverts should be incorporated into the design of access roads.
Mitigation Decommissioning Phase	• Where structures are removed from nearby watercourses care should be taken not to disturb a larger footprint than needed. • Do not increase hardened surfaces and compaction of the soils after the removal of the solar panels and related infrastructure. • Rehabilitation of exposed soil surfaces should commence as soon as practical after completion of removal of removal of the solar panels and related infrastructure. • Culverts must remain in place and must not be removed if the given road is not removed during the decommissioning phase. • Vehicle movement should be restricted to designated decommissioning areas to prevent the increase in hardened surfaces and subsequent increase in runoff.

Impact 2: Changes in sediment entering and exiting the system

Description	Changes in sediment regimes of the aquatic ecosystem and its sub -catchment by for example sand movement, meandering river mouth /estuary, changing flooding or sedimentation patterns. Any activities that change the characteristics of the catchment of a watercourse will affect the way in which water enters into the watercourse. This has an effect on water flow volumes as well as energy. Possible sources of the impacts include: • Soil compaction through movement of heavy vehicles • Disturbance of slopes through creation of roads and tracks adjacent to the watercourse • Disturbance of vegetation cover through trampling • Creation of additional access roads • Any activities within the delineated watercourse
Mitigation Construction Phase:	• Where development is located upslope from wetlands, a temporary fence or demarcation must be erected around No-Go Areas outside the proposed works area prior to any construction taking place as part of the contractor planning phase when compiling work method statements to prevent access to the adjacent portions of the watercourse. • Where development is located upslope from wetlands, effective stormwater management including sediment barriers should be a priority during both construction and operational phase. This should be monitored as part of the EMP. • Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction/earthworks in that area. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Monitoring should be done to ensure that sediment pollution is timeously dressed. • Prevent access of heavy vehicles and machinery in the delineated watercourses • Rehabilitation plans must be submitted and approved for rehabilitation of damage during construction phase and that plan must be implemented immediately upon completion of construction. • Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. • Implementation of best management practices
Mitigation Operational Phase:	• The powerline and substation currently located either within a wetland or within the buffer of a wetland should be moved into nearby impacted areas like agricultural fields • Where development is located upslope from wetlands, effective stormwater management including sediment barriers should be a priority during both construction and operational phase. This should be monitored as part of the EMP. • Monitoring should be done to ensure that sediment pollution is timeously dressed. •
Mitigation Decommissioning Phase	• Where structures are removed from nearby watercourses care should be taken not to disturb a larger footprint than needed. • Vehicle movement should be restricted to the minimum that is required for decommissioning. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to increased erosion risk. • Progressive rehabilitation must occur. Rehabilitation has to be take place as soon as decommissioning commences to prevent soil erosion. • Monitoring should be done to ensure that sediment pollution is timeously dressed.

Impact 3: Introduction and spread of alien vegetation

Description	The moving of soil and vegetation resulting in opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien

<table>
<tr><td></td><td>plants can impact on hydrology, by reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plans can easily colonise and impact on downstream users</td></tr>
<tr><td>Mitigation Construction Phase:</td><td>
The powerline and substation currently located either within a wetland or within the buffer of a wetland should be moved into nearby impacted areas like agricultural fields
Monitor the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate corrective action where invasive species are observed to establish.
Undertake an Alien Plant Control Plan which specifies actions and measurable targets
Alien invasive species that are identified within the construction footprint should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils
Category 1 species, according to the CARA legislation eg Solonum mauritianum should be targeted first, while the larger trees should be selectively thinned out to allow light to penetrate the canopy to facilitate the germination of indigenous species.
All cleared vegetation, especially trees, should be removed from the system to ensure the free flow of the stream without any obstacles which will exacerbate flooding events.
Appointment of alien plant working group / assign this duty to specific staff
Treatment methods should be in alignment with the National Working for Water Herbicide policy.
Acquire the necessary equipment for removal and control
Planned sequence of areas to be cleared of invasive plants
A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage
Ensure that contractors can identify the relevant plants and are aware of the removal procedures
Construction equipment must be cleaned prior to site access. This will prevent alien invasive seed from other sites to spread into disturbed soils
Manual removal methods are preferred to chemical control
Rehabilitate or revegetate disturbed areas.
</td></tr>
<tr><td>Mitigation Operational Phase:</td><td>
Monitor the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate corrective action where invasive species are observed to establish.
Undertake an Alien Plant Control Plan which specifies actions and measurable targets
Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction/earthworks in that area and returning it where possible afterwards.
Long-term monitoring for the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate corrective action where invasive species are observed to establish, as specified in the Alien Vegetation Management Plan.
</td></tr>
<tr><td>Mitigation Decommissioning Phase</td><td>
Monitor the establishment of alien invasive species within the areas affected by the decommissioning and take immediate corrective action where invasive species are observed to establish.
Undertake an Alien Plant Control Plan which specifies actions and measurable targets
Retain vegetation and soil in position for as long as possible, removing it immediately ahead of decommissioning /earthworks in that area and returning it where possible afterwards.
Rehabilitation must occur concurrently with decommissioning.
The mixture of vegetation seed must be used during rehabilitation. The mix must include: Annual and perennial species, pioneer species, species which are indigenous to the area to ensure there is no ecological imbalance in the area.
Long-term monitoring for the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate
</td></tr>
</table>

	corrective action where invasive species are observed to establish, as specified in the Alien Vegetation Management Plan.

Impact 4: Loss and disturbance of watercourse habitat and fringe vegetation

Description	Loss and disturbance of watercourse habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation.
Mitigation Construction Phase:	• The Powerline and substation currently located either within a wetland or within the buffer of a wetland should be moved into nearby impacted areas like agricultural fields • Monitor the establishment of alien invasive species within the areas affected by the construction and take immediate corrective action where invasive species are observed to establish. • Monitor rehabilitation and the occurrence of erosion twice during the rainy season for at least two years and take immediate corrective action where needed.
Mitigation Operational Phase:	• Monitor the establishment of alien invasive species within the areas affected by the construction and take immediate corrective action where invasive species are observed to establish. • Monitor rehabilitation and the occurrence of erosion twice during the rainy season for at least two years and take immediate corrective action where needed. • Operational activities should not take place within watercourses or buffer zones, nor should edge effects impact on these areas. • Operational activities should not impact on rehabilitated or naturally vegetated areas.
Mitigation Decommissioning Phase	• Where structures are removed from nearby watercourses care should be taken not to disturb a larger footprint than needed. • Vehicle movement should eb restricted to the minimum that is required for decommissioning. • Rehabilitation of decommissioned areas must commence concurrently with decommissioning. • Monitor the establishment of alien invasive species within the areas affected by the decommissioning and take immediate corrective action where invasive species are observed to establish. • Monitor rehabilitation and the occurrence of erosion twice during the rainy season for at least two years and take immediate corrective action where needed. • Decommissioning activities should not impact on rehabilitated or naturally vegetated areas.

Impact 5: Changes in water quality due to pollution

Description	Changes in water quality due to input of foreign materials e.g. due to increased sediment load, contamination by chemical and /or organic effluent, and /or eutrophication. Construction and operational activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the watercourses and a reduction in watercourse function
Mitigation Construction Phase:	• Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone. • Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation and to prevent contaminated runoff into the watercourse. • The development footprint must be fenced off from the watercourses and no related impacts may be allowed into the watercourse i.e. water runoff from cleaning of equipment, vehicle access etc. • Maintenance of construction vehicles/equipment should not take place within the watercourse or watercourse buffer.

	• Ensure that no operational activities impact on the watercourse or buffer area. This includes edge effects. • Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse. • Regular independent water quality monitoring should form part of operational procedures in order to identify pollution. • Treatment of pollution identified should be prioritized according to best practice guidelines. • Develop norms and standards for the treatment of spills such as oil or hydraulic fluid. Ensure that the required equipment is available on hand to contain any spills. • Appoint a reliable contractor for the removal of refuse during the construction phase.
Mitigation Operational Phase:	• Amend designs to exclude wetlands as well as buffer areas. • Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone. • Maintenance of construction vehicles/equipment should not take place within the watercourse or watercourse buffer. • Ensure that no operational activities impact on the watercourse or buffer area. This includes edge effects. • Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse. • Regular independent water quality monitoring should form part of operational procedures in order to identify pollution. • Treatment of pollution identified should be prioritized according to best practice guidelines. • Develop norms and practices for the treatment of spills such as oil or hydraulic fluid. Ensure that the required equipment is available on hand to contain any spills. • Appoint a reliable contractor for the removal of refuse during the operational phase.
Mitigation Decommissioning Phase	• Where structures are removed from nearby watercourses care should be taken not to disturb a larger footprint than needed. • Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone. • Maintenance of construction vehicles/equipment should not take place within the watercourse or watercourse buffer. • Ensure that no decommissioning activities impact on the watercourse or buffer area. This includes edge effects. • Control of waste discharges and do not allow dirty water from decommissioning activities to enter the watercourse. • Regular independent water quality monitoring should form part of decommissioning procedures in order to identify pollution. • Treatment of pollution identified should be prioritized according to best practice guidelines. • Develop norms and practices for the treatment of spills such as oil or hydraulic fluid. Ensure that the required equipment is available on hand to contain any spills. • Appoint a reliable contractor for the removal of refuse during the operational phase

Impact 6: Loss of aquatic biota

Description	Loss and disturbance of watercourse habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation.
Mitigation Construction Phase:	• This impact is not easily mitigated. Further loss in diversity can be minimised by following the mitigation measures mentioned above • The Wind Energy Structure currently located either within a wetland or within the buffer of a wetland should be moved into nearby impacted areas like agricultural fields

Mitigation Operational Phase:	• This impact is not easily mitigated. Further loss in diversity can be minimised by following the mitigation measures mentioned above
Mitigation Decommissioning Phase	

Impact 7: Cumulative Impacts - Changes in water flow regime

Description	Cumulative impacts are assessed by adding anticipated impacts from this proposed development to existing and proposed developments with similar impacts in a 50 km radius. The existing and proposed developments that were taken into consideration for cumulative impacts include: Forzando Solar PV project (In process): 9.5 MW Tutuka Solar PV project (Approved): 66 MW Mukondeleli Solar Vhuvhili Solar Grootvlei Solar PV project (In process): 75 MW
Mitigation Construction Phase:	• As described in section 6 • Environmental specialist should be consulted in the planning phase to ensure footprint layout excludes sensitive or no-go areas. • The proposed Vhuvhilli SEF, Mukondeleli WEF and the associated grid solutions should avoid or limit the footprint within watercourses as well as associated buffer areas. • Access roads should be planned to use existing tracks or roads to limit stream crossings, • Monitoring of the aquatic biodiversity as well as watercourses should be conducted on a catchment level to address the cumulative impacts of the SEF, WEF and grid solution. • Ensure that connectivity in the landscape remains.
Mitigation Operational Phase:	• As described in section 6 • The proposed Vhuvhilli SEF, Mukondeleli WEF and the associated grid solutions should avoid or limit the footprint within watercourses as well as associated buffer areas. • Monitoring of the aquatic biodiversity as well as watercourses should be conducted on a catchment level to address the cumulative impacts of the proposed Vhuvhilli SEF, Mukondeleli WEF and the associated grid solution

7. Impact Assessment Summary

Based on the impacts rated in section 7 above it is summarised that the overall impact of the proposed Impumelelo GRIDLINE post mitigation will be low in both the construction as well as operational phases. Should all mitigation measures be adhered to it is also envisaged that the cumulative impacts in both the construction as well as operational phases are considered low (Table 12).

Table 12: Overall Impact Significance (Post Mitigation).

Phase	**Overall Impact Significance**
Construction	Low
Operational	Low
Decommissioning	Low
Nature of Impact	**Overall Impact Significance**
Cumulative - Construction	Low
Cumulative - Operational	Low

8. Legislative and Permit Requirements

It should also be noted that several plant species of conservation concern are known to occur in the area or have been recorded in the study site. Prior to the construction phase it is recommended that a botanist check the final Impumlelelo GRIDLINE layout footprint and determine if any of the plants will need to be relocated prior to construction. A permit will need to be obtained from the provincial authority prior to the removal or relocation of any of these species.

It is recommended that the terrestrial biodiversity report is also consulted to determine if any additional permits are required. In addition, should any of the alien vegetation, as listed as category 2 under The National Environmental Management: Biodiversity Act (NEMBA), 2004 (Act No. 10 of 2004): Alien and Invasive Species (AIS) Regulations, 2014 (as amended), not be removed a permit will be required for these to remain on site.

9. Conclusion

The study area comprises of two powerline and substation options. Option 1 (including Substation Option 1) and Option 2 (including Substation Option 2) follows the same route from the same Zandfontein Substation towards the Sasol Impomolelo Mine where the route diverges around the mine respectively. Substation Option 1 is located closer to the Sasol mine compared to Substation Option 2. Thus Option 1 approximately 33.3 Km while Option 2 is approximately 33.7 km. It should be noted that both the powerline options follows existing roads, conveyer belts and other previously built powerlines for the majority of the route, this greatly reduces potential impacts due to access roads and previously vegetation clearing. Both route options cross a similar amount of wetlands although the substation of option 2 encroaches on a small seepage wetland and is thus not a suitable location. Furthermore, a wetland does fall within 100 m (and thus within the DWS 500 m regulated areas) from substation option 1 although option 1 follow an existing gravel road for a longer distance compared to option 2. Based on these findings Option 1 is the preferred option although ideally the substation should ideally be reconsidered to be moved possibly across the road in an existing agricultural land, thereby reducing potential impacts. The following wetlands were recorded within the powerline corridor and the substation corridor areas:

- 1 Depressional Pan Wetland;
- 1 Seepage Wetland;
- 3 Floodplain Wetlands;
- 9 Channelled Valley Bottom Wetlan; and
- 11 Unchannelled Valley Bottom Wetlands.

The main rivers associated with these wetlands include: Ouhoutspruit-, Wolwespruit-, Kaalspruit-, Xspruit- and Watervalspruit Rivers. These all drain southward into the Watervalspruit River before flowing into the important Vaal River.

Buffer zones were calculated for the wetland HGM Units following Macfarlane *et al.*, (2015):

- Floodplain Wetlands - 43 m;
- Channelled Valley Bottom Wetlands – 50 m;
- Depressional Pan – 70 m;
- Unchannelled Valley Bottom Wetlands – 42 m; and
- Seepage Wetland – 21 m.

10. Professional Opinion

The majority of the proposed route is located directly adjacent to roads and the impact will thus be limited in extent. However, a walk down is suggested once the final position of the pylons is known to ensure they are not placed within watercourse of watercourse buffer zones. Ideally Aquatic Sampling should be undertaken as part of the proposed walk-down.

11. Recommendations

Alternative layouts should be considered where the current footprints encroach into wetlands or wetland buffer zones. It is recommended that monitoring in terms of wetland PES as well as biomonitoring be conducted to consider the cumulative impacts of the proposed Impumelelo GRIDLINE as well as the gridline solution (subject to separate applications). Monitoring should be conducted in both the construction and operational phases of the project. It is imperative that an AIS plant management plan be developed for the proposed Impumelelo GRIDLINE, prior to the construction phase. Clearing and/treatment of these species occurs prior to any construction activities which will curb the spread of AIS plants due to the disturbance events caused by construction.

12. References

Dallas, H.F. 2007. River Health Programme: South African Scoring System (SASS) data interpretation guidelines. *Report prepared for Institute of Natural Resources and Department of Water Affairs and Forestry.*

De la Rey, P.A., Taylor, J.C., Laas, A., Van Rensburg, L. & Vosloo, A. 2004. Determining the possible application value of diatoms as indicators of general water quality: A comparison with SASS 5. Water SA 30: 325-332.

Department of Water Affairs 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian areas.

Department of Water Affairs 2010. National Water Act, 1998 (Act No 36 of 1998) S21(c) & (i) Water Uses. Version: February 2010. Training Manual.

Department of Water Affairs and Forestry 1999. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0. Pretoria

Department of Water Affairs and Forestry 2008. Updated Manual for the identification and delineation of wetlands and riparian areas. Department of Water affairs and Forestry. Pretoria. South Africa Second Edition. September 2008.

Department of Water and Sanitation. 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: C2 Compiled by RQIS-RDM: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx accessed on [6 January 2021].

Department of Water Affairs and Sanitation 2016 Risk-based Water Use Authorisation Approach and Delegation Protocol for Section 21(c) and (i), Edition 02

Dickens, C.W.S. & Graham, P.M., 2002. The South African Scoring System (SASS) Version 5 Rapid Bioassessment Method for Rivers. African Journal of Aquatic Science 27: 1-10.

Digby Wells. 2015. Wetland Management and Offset Plan Vanchem Vanadium Products. Project Number VVP2685

Ewart-Smith J., Ollis D., Day J. and Malan H. 2006. National Wetland Inventory: Development of a Wetland Classification System for South Africa. Water Research Council project number K8/652

Kleynhans, C.J. 1999. A procedure for the determination of the determination of the ecological reserve for the purpose of the national water balance model for South African Rivers. Institute for Water Quality Studies Department of Water Affairs and Forestry, Pretoria.

Kleynhans, C. J. 2007. Module D: Fish Response Assessment Index (FRAI) in River Ecoclassification: Manual for Ecostatus Determination (Version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC report nr: TT330/08.

Kleynhans, C.J. & Louw, M.D.,2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. TT330/08. Water Research Commission. Pretoria.

Kleynhans, C.J. Mackenzie, J. & Louw, M.D., 2007. Riparian Vegetation Response Index in River EcoClassification: Manual for EcoStatus Determination (Version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC report nr: TT333/08. Water Research Commission. Pretoria.

Kotze D C, 1999. A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Kotze, D., Macfarlane, D. & Edwards, R. 2020. WET-EcoServices (Version 2): A technique for rapidly assessing ecosystem services supplied by wetlands and riparian areas. Final Report. WRC Project K5/2737.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L.B., Nel, J.L., Maherry, A. & Witthüser, K., 2018. Identification, Delineation and Importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater, WRC Report No TT 754/1/18, Water Research Commission, Pretoria, South Africa.

Lötter, M.C., Cadman, M.J. & Lechmere-Oertel, R.G. 2014. Mpumalanga biodiversity sector plan handbook. Mpumalanga Tourism and Parks Agency, Mbombela (Nelspruit).

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D, Koopman V, Goodman P & Goge C. 2008. WET-Health: A technique for rapidly assessing wetland health. Water Research Commission, Pretoria. WRC Rport TT340/08 February 2008

Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. 2020. WET-Health (Version 2.0): A Refined suite of tools for assessing the present ecological state of wetland ecosystems – Technical Guide. WRC Report No. TT 820/20.

Macfarlane D.M., Teixeira-Leite A., Goodman P., Bate G and Colvin C. 2015 Report on the Development of a Method and Model for Buffer Zone Determination. Water Research Commission project K5/1789. The Institute of Natural Resources and its Associates

Mcmilan, P.H., 1998. An Integrated Habitat Assessment System (IHAS v2) for the Rapid Biological Assessment of Rivers and Streams. A CSIR research project. Number ENV-P-I 98132 for the water resources management programme. CSIR.

Mucina L., & Rutherford M. C. 2006. Vegetation Map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute., Pretoria.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. & Nienaber, S. 2011. Technical Report for the Freshwater Ecosystem Priority Areas Project. WRC Report No. 1801/2/11. Water Research Commission, Pretoria.

Ollis, D., Snaddon, K., Job. N. & Mbona. N. 2013. Classification System for Wetland and Other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. Pretoria, South Africa: SANBI.

River Health Programme (RHP). 2005. State-of-Rivers Report: Monitoring and Managing the Ecological State of Rivers in the Crocodile (West) and Marico Water Management Area. Department of Water Affairs and Forestry, Pretoria, South Africa.

RSA (Republic of South Africa). 2011. National Environmental Management: Biodiversity Act (10/2004): National list of ecosystems that are threatened and in need of Protection. Government Gazette, South Africa 1002 (34809).

Rudman, J., Gauche, P. & Esler, K.J. 2017. Direct environmental impacts of solar power in two arid biomes: An initial investigation. South African Journal of Science, 113: 1-13.

SANBI, 2020. Draft Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Flora (3c) & Terrestrial Fauna (3d) Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 1.0.

Seaman M.T., Avenant M.F., Watson M., King J., Armour J., Barker C.H., Dollar E., du Preez P.J., Hughes D., Rossouw L., & van Tonder G. 2010. Developing a Method for Determining the Environmental water Requirements for Ephemeral Systems. Water Research Commission, Pretoria, Report No. TT459/10.

Schultze R.E. 1997. South African Atlas of Agrohydrology and Climatology. Water Research Commission, Pretoria, Report TT82/96

Skowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith-Adao, L.B., Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F. & Driver, A., 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria.pp. 1–214.

Taylor, J.C., 2004. The Application of Diatom-Based Pollution Indices in the Vaal Catchment. Unpublished M.Sc. thesis, North-West University, Potchefstroom Campus, Potchefstroom.

Thirion, C., 2007. Module E: Macroinvertebrate Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report. Water Research Commission. Pretoria.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K., 2019. South African National Biodiversity Assessment. 2018. Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

Wet-Earth 2020. Wetland Management Plan for Sasol Secunda Industrial Complex and Surroundings. Vendor No.40736. FINAL.

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  Department of Water Affairs, SA

Additional Courses

- Asteraceae ID course, by Paul Herman from SANBI's National Herbarium at the University of Pretoria, Department of Plant and Soil Sciences. 2018
- MIRAI (Macro invertebrate Response Assessment Index), Department of Water and Sanitation 2016
- Invasive Species and Herbicide Training, South African Green Industries Council (SAGIC) 2016
- A rapid method for water quality assessment, Nepid Consultants, Sabie 2011
- EIA water use authorisation and waste management activity licences, CBSS, Pretoria 2011
- Tools for wetland assessment, Rhodes University, Grahamstown 2011
- Inventory and survey methods for invasive plants, Online Course, Department of land resource of environmental Sciences, Montana State University, Bozeman, Montana. 2009

Conference Presentations

- **Course Presenter: Riparian Vegetation Assessment Methods for DWS** **2017**
  Department of Water and Sanitation, DWS, Roodeplaat
- **Conservation Planning in Urban Open Spaces** **2016**
  Botanical Society, Pretoria
- **The Vegetation ecology of Seringveld Conservancy, Cullinan South Africa** **2010**
  South African Association of Botanist's Annual Conference, Potchefstroom
- **A comparison between Ellenberg and Wamelink Biological indicator values** **2009**
  Wageninen Abiotic Research Group, Alterra Annual Conference, Wageningen, The Netherlands
- **The effect of the higher energy flow in the Ash River System, Bethlehem, SA** **2003**
  Stockholm International Youth Science Seminar, Sweden
- **The youth of South Africa would like to see underground water pollution addresses in light of the international summit for sustainable development** **2003**
  Water institute of South Africa, Annual Conference, Durban

Achievements

- Selected for the J.P. Morgan, Groundswell, Business Accelerator programme for an 18 month business mentorship
- Board member of the South African Botanical Society Pretoria Branch
- Selected for an exchange program to the University of Wageningen as part of my MSc studies.
- Overall Winner and gold medallist of the Eskom Expo for Young Scientist, representing south Africa in the Stockholm Sweden at the Stockholm international youth seminar
- Winner of the South Africa youth water prize of the department of water affairs and represented South Africa at the international youth water prize during world water week in Stockholm Sweden.

Membership & Associations

- South African Council of Natural Scientific Professions - Registered Professional Scientist (Pr.Sci.Nat: 400003/13),
- South African Association for Botanists,
- South African Botanical Society,
- South African Society for Aquatic Scientist,
- **Full project list and references available on request**

ANTOINETTE BOOTSMA nee van Wyk

ID Number	7604250013088
Name of Firm:	Limosella Consulting
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology

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EDUCATIONAL QUALIFICATIONS

- MSc Ecology, University of South Africa (2017) Awarded with distinction. Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management
- Short course in wetland soils, Terrasoil Science (2009)
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)

PUBLICATIONS

- A.A. Boostma, S. Elshehawi, A.P. Grootjans, P.L Grundling, S. Khosa. *In Press.* Ecohydrological analysis of the Matlabas Mountain mire, South Africa. Mires and Peat
- P.L. Grundling, A Lindstrom., M.L. Pretorius, A. Bootsma, N. Job, L. Delport, S. Elshahawi, A.P Grootjans, A. Grundling, S. Mitchell. 2015. Investigation of Peatland Characteristics and Processes as well as Understanding of their Contribution to the South African Wetland Ecological Infrastructure Water Research Comission KSA 2: K5/2346
- A.P. Grootjans, A.J.M Jansen , A, Snijdewind, P.C. de Hullu, H. Joosten, A. Bootsma and P.L. Grundling. (2014). In search of spring mires in Namibia: the Waterberg area revisited. Mires and Peat. Volume 15, Article 10, 1–11, http://www.mires-and-peat.net/, ISSN 1819-754X © 2015 International Mire Conservation Group and International Peat Society
- Haagner, A.S.H., van Wyk, A.A. & Wassenaar, T.D. 2006. *The biodiversity of herpetofauna of the Richards Bay Minerals leases.* CERU Technical Report 32. University of Pretoria.
- van Wyk, A.A., Wassenaar, T.D. 2006. *The biodiversity of epiphytic plants of the Richards Bay Minerals leases.* CERU Technical Report 33. University of Pretoria.
- Wassenaar, T.D., van Wyk, A.A., Haagner, A.S.H, & van Aarde, R.J.H. 2006. *Report on an Ecological Baseline Survey of Zulti South Lease for Richards Bay Minerals*. CERU Technical Report 29. University of Pretoria

KEY EXPERIENCE

The following projects provide an example of the application of wetland ecology on strategic as well as fine scale as well as its implementation into policies and guidelines. (This is not a complete list of projects completed, rather an extract to illustrate diversity);

- More than 90 external peer reviews as part of mentorship programs for companies including Gibb, Galago Environmental Consultants, Lidwala Consulting Engineers, Bokamoso Environmental Consultants, 2009 ongoing
- More than 300 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape 2007, ongoing
- Strategic wetland specialist input into the Open Space Management Framework for Kyalami and Ruimsig, City of Johannesburg, 2016
- Fine scale wetland specialist input into the ESKOM Bravo Integration Project 3, 4, 5 and Kyalami – Midrand Strengthening.
- Wetland/Riparian delineation and functional assessment for the proposed maintenance work of the rand water pipelines and valve chambers exposed due to erosion in Casteel A, B and C in Bushbuckridge Mpumalanga Province
- Wetland/Riparian delineation and functional assessment for the Proposed Citrus Orchard Establishment, South of Burgersfort (Limpopo Province) and North of Lydenburg (Mpumalanga Province).
- Scoping level assessment to inform a proposed railway line between Swaziland and Richards Bay. April 2013.
- Environmental Control Officer. Management of onsite audit of compliance during the construction of a pedestrian bridge in Zola Park, Soweto, Phase 1 and Phase 2. Commenced in 2010, ongoing.
- Fine scale wetland delineation and functional assessments in Lesotho and Kenya. 2008 and 2009;
- Analysis of wetland/riparian conditions potentially affected by 14 powerline rebuilds in Midrand, Gauteng, as well submission of a General Rehabilitation and Monitoring Plan. May 2013.
- Wetland specialist input into the Environmental Management Plan for the upgrade of the Firgrove Substation, Western Cape. April 2013
- An audit of the wetlands in the City of Johannesburg. Specialist studies as well as project management and integration of independent datasets into a final report. Commenced in August 2007
- Input into the wetland component of the Green Star SA rating system. April 2009;
- A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- As assessment of wetlands in southern Mozambique. This involved a detailed analysis of the vegetation composition and sensitivity associated with wetlands and swamp forest in order to inform the development layout of a proposed resort. May 2008.
- An assessment of three wetlands in the Highlands of Lesotho. This involved a detailed assessment of the value of the study sites in terms of functionality and rehabilitation opportunities. Integration of the specialist reports socio economic, aquatic, terrestrial and wetland ecology studies into a final synthesis. May 2007.

- Ecological studies on a strategic scale to inform an Environmental Management Framework for the Emakazeni Municipality and an Integrated Environmental Management Program for the Emalahleni Municipality. May and June 2007

RUDI BEZUIDENHOUDT

880831 5038 081
Limosella Consulting
Wetland Specialist
Pr.Sci.Nat (008867)
South African
Single
Afrikaans (mother tongue), English

EDUCATIONAL QUALIFICATIONS

 B.Sc. (Botany & Zoology), University of South Africa (2008 - 2012)

 B.Sc. (Hons) Botany, University of South Africa (2013 – 2015)

 M.sc Aquatic Ecology, University of Johannesburg (2017-)

 Introduction to wetlands, Gauteng Wetland Forum (2010)

 Biomimicry and Constructed Wetlands. Golder Associates and Water Research Commission (2011)

 Wetland Rehabilitation Principles, University of the Free State (2012)

 Tools for Wetland Assessment, Rhodes University (2011)

 Wetland Legislation, University of Free-State (2013)

 Understanding Environmental Impact Assessment, WESSA (2011)

 SASS 5, Groundtruth (2012)

 Wetland Operations and Diversity Management Master Class, Secolo Consulting Training Services (2015)

 Tree Identification, Braam van Wyk – University of Pretoria (2015)

 Wetland Buffer Legislation – Eco-Pulse & Water Research Commission (2015)

 Wetland Seminar, ARC-ISCW & IMCG (2011)

 Invasive Species Training, SAGIC (2016)

KEY EXPERIENCE

WETLAND SPECIALIST

This entails all aspects of scientific investigation associated with a consultancy that focuses on wetland specialist investigations. This includes the following:

- Approximately 200+ specialist investigations into wetland and riparian conditions on strategic, as well as fine scale levels in Gauteng, Limpopo, North-West Province Mpumalanga KwaZulu Natal, North-West Province, Western Cape, Eastern Cape & Northern Cape

- Ensuring the scientific integrity of wetland reports including peer review and publications.

Major Projects Involve:

 Numerous Eskom Powerline Projects some spanning more than one Province.

 Proposed New Kruger National Camp and Infrastructure (2016)

 Numerous Mining Projects

 Numerous Water infrastructure upgrades

 Numerous Residential and Housing Developments

BIODIVERSITY ACTION PLAN
This entails the gathering of data and compiling of a Biodiversity action plan.

WETLAND REHABILITATION
This entailed the management of wetland vegetation and rehabilitation related projects in terms of developing proposals, project management, technical investigation and quality control.

COURSES PRESENTED
 Riparian Vegetation Response Assessment Index (VEGRAI) Training presented to DWA (2017)

 Numerous Wetland Talks

WETLAND ECOLOGY
Experience in the delineation and functional assessment of wetlands and riparian areas in order to advise proposed development layouts, project management, report writing and quality control.

ENVIRONMENTAL CONTROL OFFICER:
Routine inspection of construction sites to ensure compliance with the City's environmental ordinances, the Environmental Management Program and other laws and by-laws associated with development at or near wetland or riparian areas.

- Soweto Zola Park 2011-2013
- Orange Farm Pipeline 2010-2011

WETLAND AUDIT:
Audit of Eskom Kusile power station to comply with the Kusile Section 21G Water Use Licence (Department of Water Affairs, Licence No. 04/B20F/BCFGIJ/41, 2011), the amended Water Use Licence (Department of water affairs and forestry, Ref. 27/2/2/B620/101/8, 2009) and the WUL checklist provided by Eskom.

- Kusile Powerstation 2012-2013.

INVASIVE SPECIES CONTROL PLAN

Libradene Filling Station, Boksburg, Gauteng

PUBLICATIONS
Bezuidenhoudt. R., De Klerk. A. R., Oberholster. P.J. (2017). Assessing the ecosystem processes of ecological infrastructure on post-coal mined land. COALTECH RESEARCH ASSOCIATION NPC. University of South Africa. Council for Scientific Industrial Research.

Employee Experience:
GIS Specialist – AfriGIS
January 2008 – August 2010
Tasks include:
 GIS Spatial layering
 Google Earth Street View Mapping
 Data Input

Wetland Specialist - Limosella Consulting
September 2010 – Ongoing
Tasks include:
 Wetland and Riparian delineation studies, opinions and functional assessments including data collection and analysis.

 Rehabilitation Reports

 Invasive species surveys and control plans

 Correspondence with stakeholders, clients, authorities and specialists.

 Presentations to stakeholders, clients and specialists.

 Project management.

 Planning and executing of fieldwork.

 Analysis of data.

 GIS spatial representation.

- Submission of technical reports containing management recommendations.
- General management of the research station and herbarium.
- Regular site visits.
- Attendance of monthly meetings
- Submission of monthly reports.

MEMBERSHIPS IN SOCIETIES

- Botanical Society of South African
- SAWS (South African Wetland Society) Founding member
- SACNASP (Reg. No. 500024/13)

ANDRÉ STRYDOM

Aquatic Ecologist

Specialisation

Aquatic biomonitoring, aquatic specialist biodiversity assessments, design of surface water monitoring programs, toxicity testing and nature reserve management.

Total years of environmental experience

13 years

Employment History

- 2019 - Present: Environmental and Aquatic Specialist (Enviro Elements)
- 2011 - 2018: Environmental Consultant and Laboratory manager
- 2016 – 2018: Aquatic Ecologist and Project Manager (Clean Stream Biological Services)
- 2013 - 2016: Fieldwork Manager (Clean Stream Biological Services) and
- 2013 - 2015: LaboratoryManager (Biotox Laboratory Services)
- 2011 - 2012: Junior Environmental Scientist (Clean Stream Biological services)
- 2007 - 2010: Assistant Reserve Manager (Doornkop Fish and Wildlife Reserve)

Professional Experience

- Conducting of aquatic and biodiversity specialist assessments.
- Acute and Chronic Toxicity testing of water and soil samples

Academic history

- 2014: B. Tech. Nature Conservation, University of South Africa
- 2006: National Diploma in Nature Conservation, Tshwane University of Technology2002: Matriculate, Nelspruit High School

General

- SASS5 Accredited
- Skippers licence, category R vessel (Power driven <9m)

Most relevant experience

- Aquatic baseline assessments for proposed new hydro power stations in Zambia.
- Aquatic biomonitoring on Orange River for Kakamas Hydro Power Station, South Africa.
- Aquatic Impact Assessment for proposed new alluvial diamond mine in Schmidtsdrif
- Aquatic Biomonitoring for one of a graphite mine in Northern Mozambique
- Aquatic Biomonitoring for Grootvlei Power Station
- Biomonitoring of the Leragane and Elands Rivers
- Biomonitoring of the Modder River
- Biomonitoring of the Seeikoei River
- Freshwater fish specialist study. In Environmental Impact Assessment: Mining Right application.

- Alluvial Diamond Mining at Rooipoort Private Nature Reserve
- Biomonitoring of the Hex River catchment in the vicinity of Anglo Platinum
- Biomonitoring of the Modderfonteinspruit in the area of Kelvin Power Station
- Biomonitoring of the Crocodile River in the Thabazimbi area
- Biomonitoring of receiving water bodies in the Rasimone Platinum mining area (Elands River catchment)
- Biomonitoring of the Bierspruit and Crocodile River in the vicinity of Northam.
- Biomonitoring of the Greensidespruit / Naauwpoortspruit catchments
- Biomonitoring of the Vaal River catchment (Vaal River & West Wits operations)
- Biomonitoring of the Luvuvhu and Mutale Rivers in the vicinity of Tsikondeni Mine
- Biodiversity assessment programme, Xstrata Eastern mines
- Biomonitoring of the Hex River catchment in the vicinity of Xstata Kroondal
- Biomonitoring of Selected Rivers (Receiving Water Bodies) in the Komati catchment
- Biomonitoring of the Olifants catchment, Mpumulanga
- Biomonitoring of the Bierspruit and Crocodile River in the vicinity of Thabazimbi
- Biomonitoring of the Klein-Olifants catchment, Mpumulanga
- Aquatic biomonitoring of Olifants River and Witbank Dam in the vicinity of Duvha Power

Prior to commencing with the specialist assessment in accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).

The details of the site sensitivity verification are noted below:

Date of Site Visit	1st to 4th of February 2022 and November 2022
Specialist Name	Rudi Bezuidenhout
Professional Registration Number	Pr.Sci.Nat (008867)
Specialist Affiliation / Company	Limosella Consulting

- Provide a description on how the site sensitivity verification was undertaken using the following means:

  (a) Desktop analysis, using satellite imagery as well as databases listed in Table 5 and Table 6 ;
  (b) National Web Based Screening Tool Results for aquatic ecosystems;
  (c) In field site inspection; and
  (d) Previous specialist reports wetland and aquatic on monitoring of wetlands and aquatic ecosystems for Sasol, Secunda.

It is important to note that a full assessment was conducted and not the site verification only as the aquatic ecosystems surrounding the proposed SEF based on the screening tool had a high sensitivity. The methods described in Appendix F were used during the site inspection. The outcome of the site verification indicated that wetlands were moderately to seriously modified and aquatics. The results of the site inspection are included in section 4.2 of this report.

The desktop assessment conducted by DWS indicated that the sub quaternary reaches surrounding the study site are moderately modified (C). The site verification indicated that the wetlands are largely natural (B) to seriously modified (E) whilst the aquatic macroinvertebrates indicated that the aquatic ecosystems are moderately (C) to seriously/critically (E/F) modified. Therefore, the wetland and aquatic ecosystems surrounding the study site do not conform to the desktop assessment and are more impacted than expected.

Although the wetland and aquatic ecosystems are impacted, they still fulfil important ecosystem services and also form part of national and provincial conservation targets and therefore are still considered as sensitive. The significance rating of high as assigned by the Screening Tool for Aquatic Biodiversity (Figure 18) is therefore supported by the specialist.

Impact Assessment Methodology

The Impact Assessment Methodology was supplied to the specialsit by WSP.

High-Level Screening of Impacts and Mitigation

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability; and, consequence (Table 13**,** Table 14**,** Table 15), where the latter is based on general consideration to the intensity, extent, and duration.

The scales and descriptors used for scoring probability and consequence are detailed in Table 13 and Table 14 respectively.

Table 13: Probability Scores and Descriptors

Score	Descriptor
4	Definite: The impact will occur regardless of any prevention measures
3	Highly Probable: It is most likely that the impact will occur
2	Probable: There is a good possibility that the impact will occur
1	Improbable: The possibility of the impact occurring is very low

Table 14: Consequence Score Descriptions

Score	Negative	Positive
4	Very severe: An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	Very beneficial: A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe: A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	Beneficial: A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe: A medium to long term impacts on the affected system(s) or party (ies) that could be mitigated.	Moderately beneficial: A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible: A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	Negligible: A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

Table 15: Significance Screening Tool

	Consequence Scale				
Probability Scale		1	2	3	4
	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	Low	Medium	Medium	High
	4	Medium	Medium	High	High

The nature of the impact must be characterised as to whether the impact is deemed to be positive (+ve) (i.e. beneficial) or negative (-ve) (i.e. harmful) to the receiving environment/receptor. For ease of reference, a colour reference system (Table 16) has been applied according to the nature and significance of the identified impacts.

Table 16: Impact Significance Colour Reference System to Indicate the Nature of the Impact

Negative Impacts (-ve)	Positive Impacts (+ve)
Negligible	Negligible
Very Low	Very Low
Low	Low
Medium	Medium
High	High

Assessment of Impacts and Mitigation

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.
The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[3], indirect[4], secondary[5] as well as cumulative[6] impacts.
A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[7] presented in Table 17
Impact Significance Colour Reference System to Indicate the Nature of the Impact

Table 17: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries

[3] Impacts that arise directly from activities that form an integral part of the Project.
[4] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[5] Secondary or induced impacts caused by a change in the Project environment.
[6] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[7] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	4 to 15	16 to 30	31 to 60	61 to 80	81 to 100
Environmental Significance Rating (Negative (-))	Very low	Low	Moderate	High	Very High
Environmental Significance Rating (Positive (+))	Very low	Low	Moderate	High	Very High

Impact Mitigation

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development’s actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.
The mitigation sequence/hierarchy is shown in Figure 21 below.

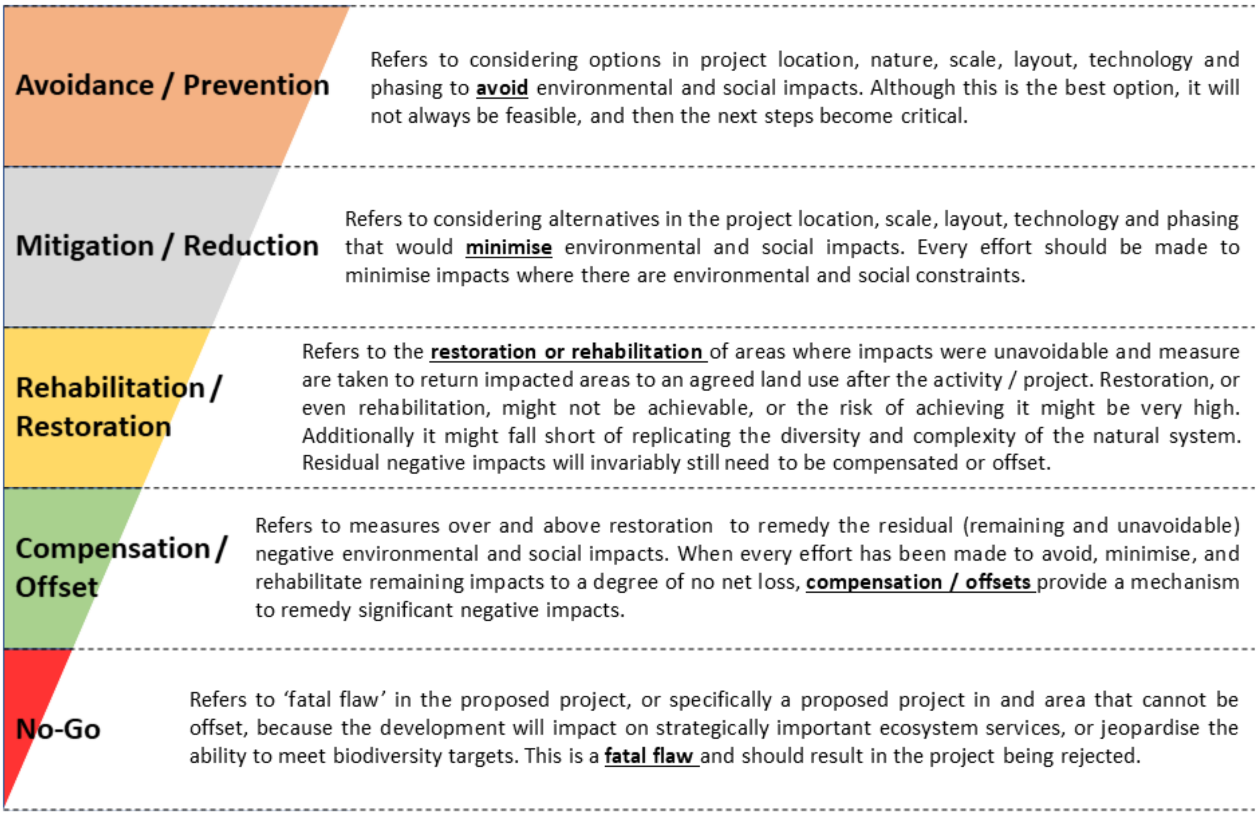


Figure 21: Mitigation Sequence/Hierarchy

Wetland and Riparian Delineation

Wetlands are delineated based on scientifically sound methods and utilizes a tool from the Department of Water and Sanitation 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005) as well as the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008). The delineation of the watercourses presented in this report is based on both desktop delineation and groundtruthing.

Desktop Delineation

A desktop assessment was conducted with wetland and riparian units potentially affected by the proposed activities identified using a range of tools, including:

- 1: 50 000 topographical maps;
- S A Water Resources;
- Recent, relevant aerial and satellite imagery, including Google Earth.

All areas suspected of being wetland and riparian habitat based on the visual signatures on the digital base maps were mapped using google earth.

Ground Truthing

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figure 22 & Figure 23):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes);
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation; and
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50 cm of the soil surface.

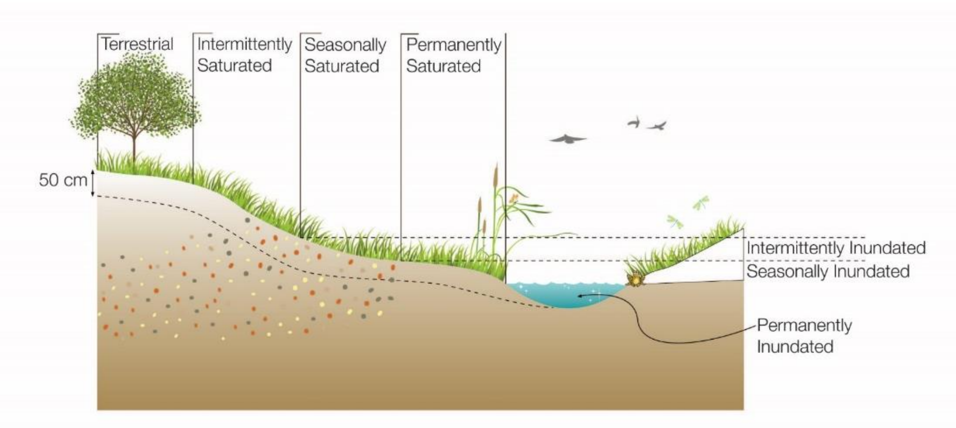


Figure 22: Typical cross section of a wetland (Ollis, 2013)

The Terrain Unit Indicator

The terrain unit indicator (Figure 23) is an important guide for identifying the parts of the landscape where wetlands might possibly occur. Some wetlands occur on slopes higher up in the catchment where groundwater discharge is taking place through seeps. An area with soil wetness and/or vegetation indicators, but not displaying any of the topographical indicators should therefore not be excluded from being classified as a wetland. The type of wetland which occurs on a specific topographical area in the landscape is described using the Hydrogeomorphic classification which separates wetlands into 'HGM' units. The classification of Ollis, *et al*. (2013) is used, where wetlands are classified on Level 4 as either Rivers, Floodplain wetlands, Valley-bottom wetlands, Depressions, Seeps, or Flats (Figure 24).

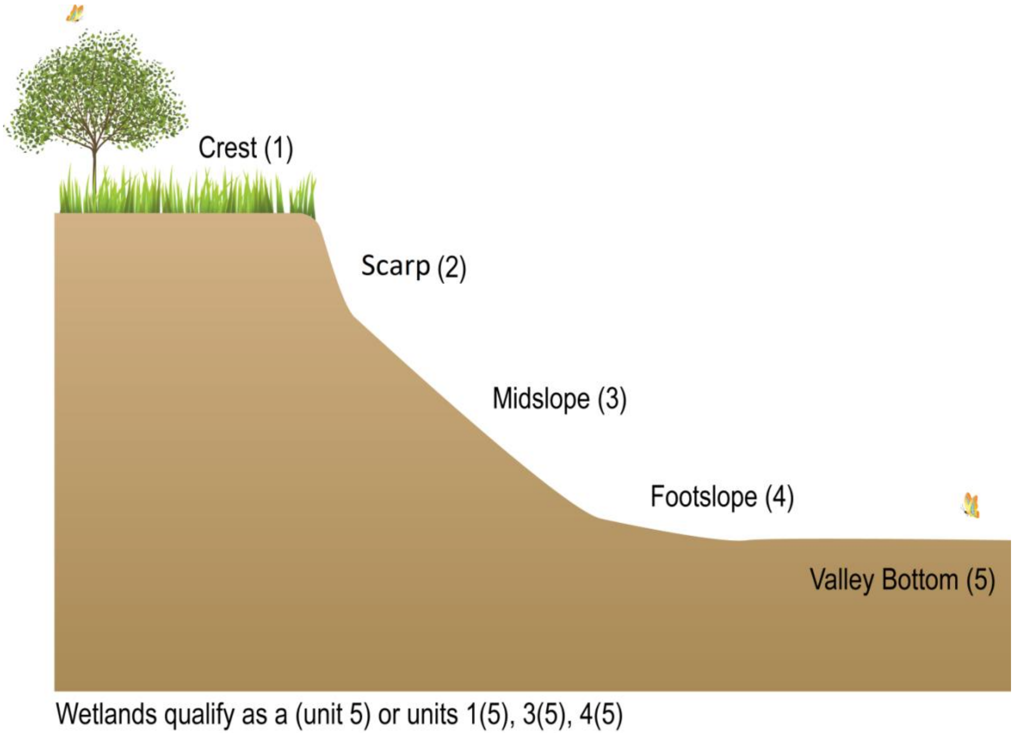


Figure 23: Terrain units (DWAF, 2005).

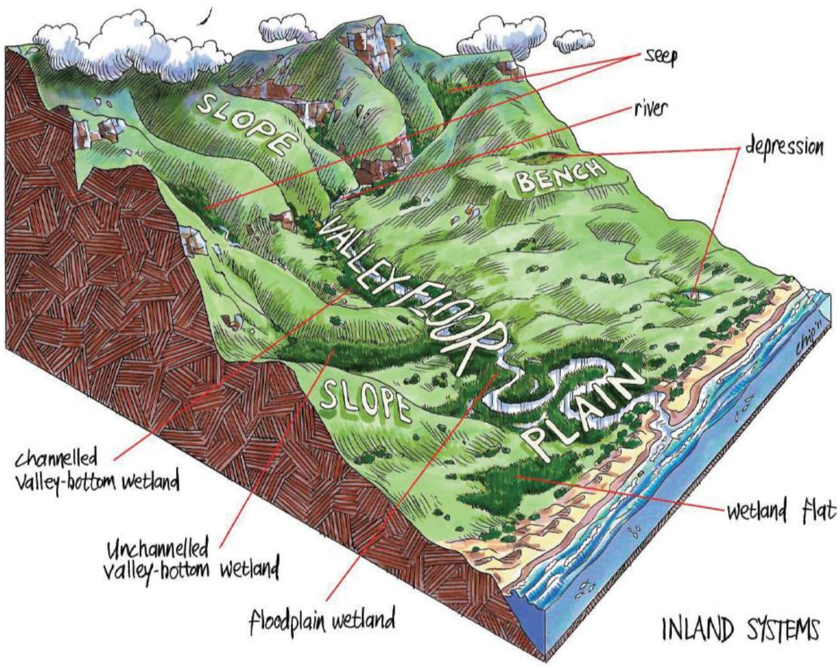


Figure 24: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

Riparian Indicators

Riparian habitat is classified primarily by identifying riparian vegetation along the edge of the macro stream channel. The macro stream channel is defined as the outer bank of a compound channel and should not be confused with the active river bank. The macro channel bank often represents a dramatic change in the energy with which water passes through the system. Rich alluvial soils deposit nutrients making the riparian area a highly productive zone. This causes a very distinct change in vegetation structure and composition along the edges of the riparian area (DWAF, 2008). The marginal zone includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (WRC Report No TT 333/08 April, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 25).

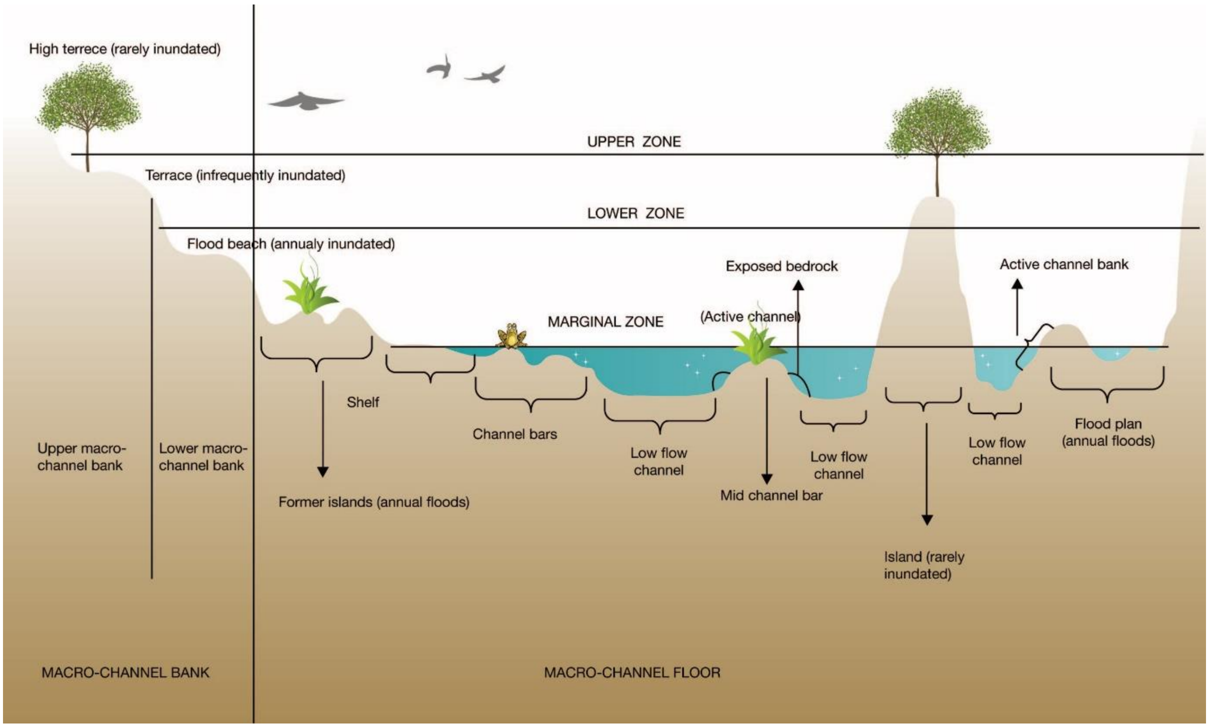


Figure 25: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

Riparian Area:

A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The “river” includes both the active channel (the portion which carries the water) as well as the riparian zone (Figure 26) (Kotze, 1999).

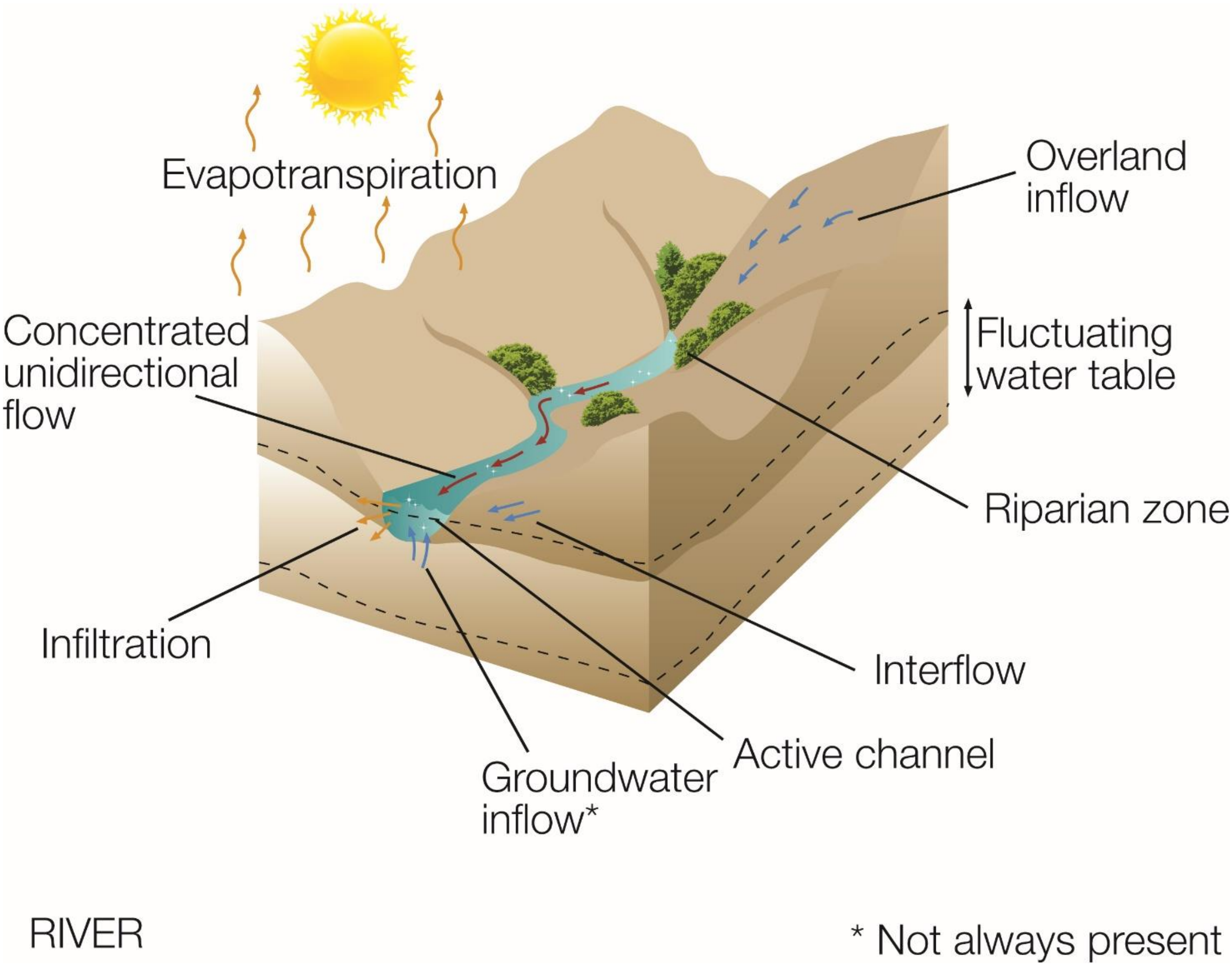


Figure 26: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

Riparian areas can be grouped into different categories based on their inundation period per year. Perennial rivers are rivers with continuous surface water flow, intermittent rivers are rivers where surface flow disappears but some surface flow remains, temporary rivers are rivers where surface flow disappears for most of the channel (Figure 26). Two types of temporary rivers are recognized, namely "ephemeral" rivers that flow for less time than they are dry and support a series of pools in parts of the channel, and "episodic" rivers that only flow in response to extreme rainfall events, usually high in their catchments (Seaman *et al.*, 2010).

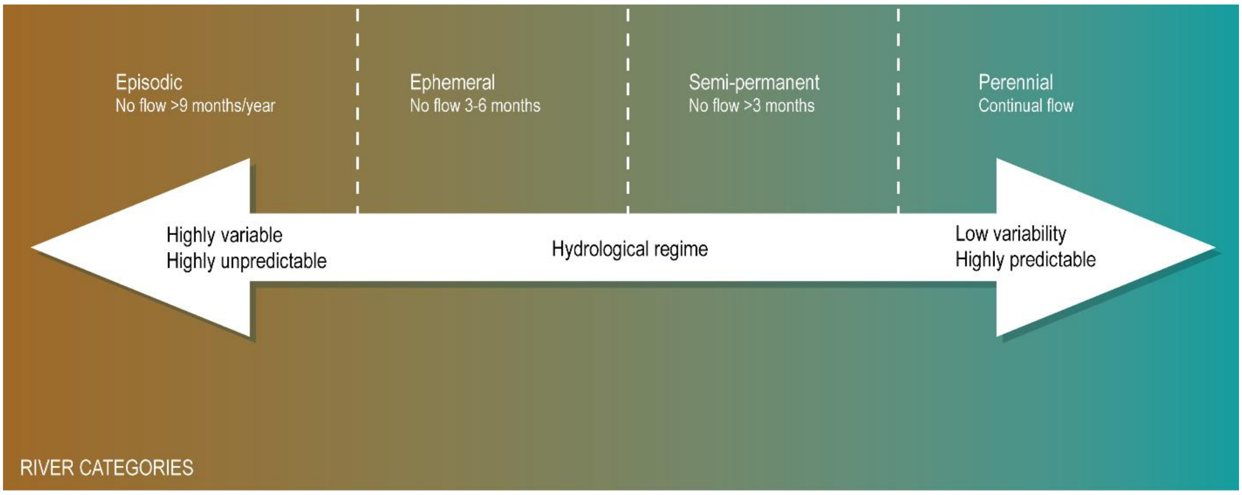


Figure 27: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

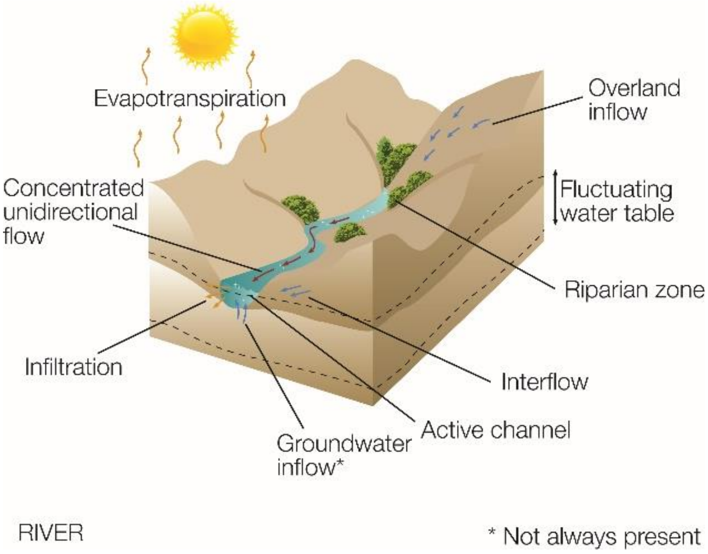
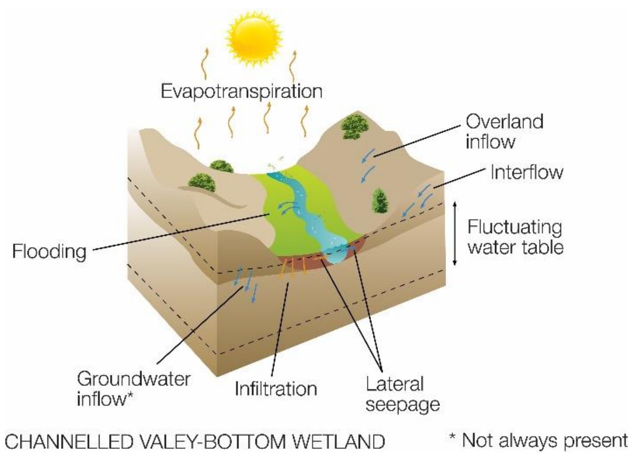
Watercourse Classification and Delineation

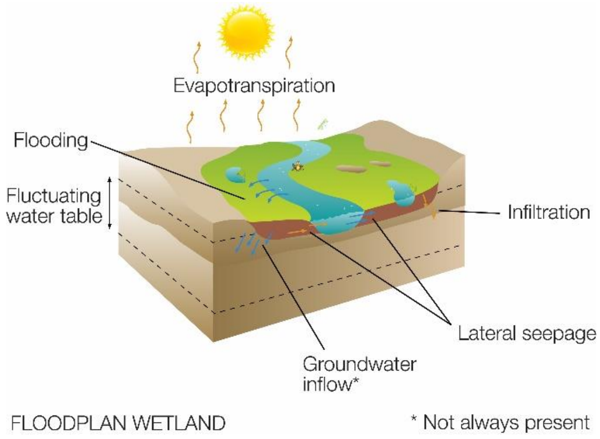
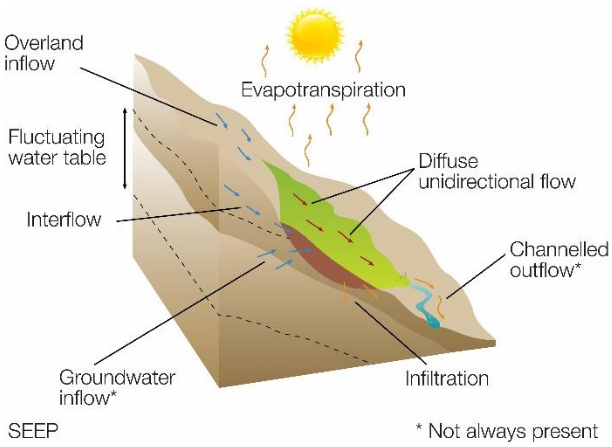
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2013). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed in SANBI (2013). HGM units take into consideration factors that determine the nature of water movement into, through and out of the wetland system. In general, HGM units encompass three key elements (Kotze *et al.*, 2005):

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
- Hydrodynamics - This refers to how water moves through the wetland.

The classification of wetland areas found within the study site and/or within 500 m of the study site (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWAF, 2005) are as follows (Table 18):

Table 18: Wetland Types and descriptions

Wetland Type:	Description:
Valley bottom without a channel  	Linear fluvial, eroded landforms which carry channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone.
Valley bottom with a channel  	Linear fluvial, net depositional valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis. Episodic flow is thought to be unlikely in this wetland setting. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no ox-bows or cut-off meanders are present in these wetland systems. The valley floor is, however, a depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas.

Wetland Type:	Description:
Meandering Floodplain 	Linear fluvial, net depositional valley bottom surfaces which have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea) . The meandering channel flows within an unconfined depositional valley, and ox-bows or cut-off meanders evidence of meandering – are usually visible at the 1:10 000 scale (i.e. observable from 1:10 000 orthomaps). The floodplain surface usually slopes away from the channel margins due to preferential sediment deposition along the channel edges and areas closest to the channel. This can result in the formation of backwater swamps at the edges of the floodplain margins.
Seepage Wetlands 	Seepage wetlands are the most common type of wetland (in number), but probably also the most overlooked. These wetlands can be located on the mid- and footslopes of hillsides; either as isolated systems or connected to downslope valley bottom weltands. They may also occur fringing depressional pans. Seepages occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where through flow in the soil profile is forced close to the surface due to impervious layers (such as plinthite layers; or where large outcrops of impervious rock force subsurface water to the surface).

Buffer Zones and Regulated Areas

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWAF, 2005). A development has several impacts on the surrounding environment and on a watercourse. The development changes habitats, the ecological environment, infiltration rate, amount of runoff and runoff intensity of the site, and therefore the water regime of the entire site. An increased volume of stormwater runoff, peak discharges, and frequency and severity of flooding is, therefore, often characteristic of transformed catchments. The buffer zone identified in this report serves to highlight an ecologically sensitive area in which activities should be conducted with this sensitivity in mind.

Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses; (iii) providing habitat for various aspects of biodiversity. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. Although buffer zones can be effective in addressing diffuse source pollution in storm water run-off, they should typically be seen as part of a treatment train designed to address storm water impacts (MacFarlane & Brendin, 2017).

Generic buffer zones are specified in regional and local policies including GDARD (2014). These include 30m for wetlands and 50m for rivers inside the urban edge within which development is not supported.

Authorisation from the DWS requires calculation of a site-specific buffer zone (General Notice 267 of 24 March 2017), following Macfarlane *et al* 2015. This Excel-based tool calculates the best suited buffer for each wetland or section of a wetland based on numerous on-site observations. The resulting buffer zone can thus have large differences depending on the current state of the wetland as well as the nature of the proposed development. Developments with a high-risk factor such as mining are likely to have a larger buffer area compared to a residential development with a lower risk factor.

Figure 28 images represent the buffer zone setback for the watercourse types discussed in this report.

It should be noted that the buffer calculation tool does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments. Therefore, a conservative approach to the application of buffer zones is encouraged.

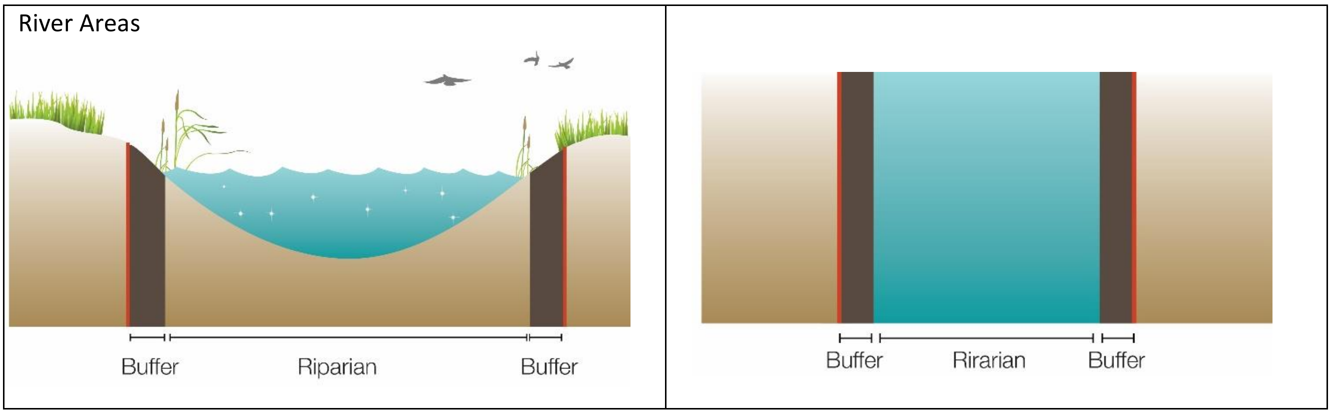


Figure 28: A represent the buffer zone setback for the wetland discussed in this report

Regulated areas are zones within which authorisation is required. The DWS specify a 500m regulated area around all wetlands and 100m around all riparian zones within which development must be authorised from their department. Development within 32m of the edge of the watercourse triggers the requirement for authorisation under the National Environmental Management Act (NEMA): Environmental Impact Assessment (EIA) Regulations of 2014 (GNR 326) as amended.

DWS (2016) Impact Ratings

Risk-based management has value in providing an indication of the potential for delegating certain categories of water use "risks" to DHWS regional offices (RO) or Catchment Management Agencies (CMA). Risk categories obtained through this assessment serve as a guideline to establish the appropriate channel of 109uthorization of these water uses.
The DHWS has therefore developed a risk assessment matrix to assist in quantifying expected impacts. The scores obtained in this assessment are useful in evaluating how the proposed activities should be 109uthorizat.
The formula used to derive a risk score is as follows:
RISK = CONSEQUENCE x LIKELIHOOD
CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION
LIKELIHOOD = FREQUENCY OF THE ACTIVITY + FREQUENCY OF THE IMPACT +LEGAL ISSUES + DETECTION

Table 19 below provides a description of the classes into which scores are sorted, and their implication for 109 authorization.

Table 19: An extract from DWS (2016) indicating the risk scores and classes as well as the implication for the appropriate authorization process

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

Wetland Functionality, Status and Sensitivity

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (HGM) unit. Following the calculation of PES and EC scores, a Recommended Ecological Category can be obtained. This score reflects an auditable management or rehabilitation target to be achieved by the proposed project. The sections below provide a brief description of each method employed in the 2021 assessment.

Wetland functionality is defined as a measure of the deviation of wetland structure and function from its natural reference condition. The natural reference condition is based on a theoretical undisturbed state extrapolated from an understanding of undisturbed regional vegetation and hydrological conditions. In the current assessment the hydrological, water quality, geomorphological and vegetation integrity was assessed for the wetland unit associated with the study site, to provide a Present Ecological Status (PES) score (Macfarlane *et al.*, 2020) and an Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020). These impacts are based on evidence observed during the field survey and land use changes visible on aerial imagery including historical images.

The allocations of scores in the functional and integrity assessment are subjective and are thus vulnerable to the interpretation of the specialist. Collection of empirical data is precluded at this level of investigation due to project constraints including time and budget. Water quality values, species richness and abundance indices, surface and groundwater volumes, amongst others, should ideally be used rather than a subjective scoring system such as is presented here.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (HGM) wetland unit. The aspect of wetland functionality and integrity that are predominantly addressed include hydrological and geomorphological function (subjective observations) and the integrity of the biodiversity component (mainly based on the theoretical intactness of natural vegetation) as directed by the assessment methodology.

Present Ecological Status (PES) – WET-Health

A summary of the four components of the WET-Health (2.0) namely Hydrological; Geomorphological, water quality and Vegetation Health assessment for the wetlands found on site is described in Table 20. For this assessment, WET-Health Version 2.0 was used. This method builds on the WET-Health Version 1.0 (Macfarlane *et al*. 2008) and Wetland-IHI (DWAF 2007) Tool, offering a refined and more robust suite of tools (Macfarlane *et al*. 2020). The WET-Health Version 2 considers four (4) components to assess the PES of wetland ecosystems. Geology, climate and topographic position determines the ecological setting of a wetland. Three (3) core interrelated drivers broadly influence all wetlands, namely Hydrology, Geomorphology and Water Quality (i.e. physico-chemical attributes). Wetland biology, and more specifically vegetation, responds to the changes in these drivers and to the surrounding environment. A level 2 assessment was used for the wetlands recorded on the study site (Table 20).

Table 20: The three levels of assessment to cater for application of the WET-Health Version 2 Tool across different spatial scales and for different purposes (Adapted from Macfarlane *et al*., 2020).

Level of Assessment	Spatial Scale	Description
Level 1A	Desktop-based, low resolution	Entirely desktop-based and only uses pre-existing landcover data. Landcover types within a buffer / "pseudo catchment" around a wetland is used to determine the impacts on the wetland arising from the upslope catchment. Impacts arising from within individual wetlands are inferred from landcover types occurring within desktop-delineated wetlands.
Level 1B	Desktop-based, high resolution	Largely desktop-based using pre-existing landcover data but makes a few finer distinctions than Level 1A in terms of landcover types and usually requires "heads-up" interpretation of the best available aerial imagery in order to do so. Upslope catchment of each wetland can be individually delineated at this level, and landcover in this area is used as a proxy of the impacts on a wetland arising from its upslope catchment. Impacts arising from within individual wetlands are inferred from landcover types occurring within desktop-delineated wetlands. In terms of water quality PES, the option is provided to factor in point-source pollution inputs in a Level 1B assessment.
Level 2	Rapid field-based assessment	Strongly informed by desktop landcover mapping; refined by assessing a range of catchment and wetland-related indicators known to affect wetland condition. Impacts arising from the upslope catchment of a wetland are inferred from landcover mapping but are refined based on additional information. Landcover types occurring within the wetland are used as the starting point for assessing human impacts arising from within the wetland but are refined through the assessment of additional indicators as part of a rapid field-based assessment. This involves sub-dividing the wetland into relatively homogenous "disturbance units" and assessing a suite of site-based wetland questions that provide a more direct assessment of change. Determination of water quality PES in a Level 2 assessment requires the identification and characterisation of point-source pollution inputs.

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 21. The trajectory of change is summarised in Table 22.

Table 21: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2020)

Ecological Category	Description	Impact Score	PES Score (%)
A	Unmodified, natural	0 to 0.9	90-00
B	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	80-89
C	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	60-79
D	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	40-59
E	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	20-39
F	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	0-19

Table 22: Trajectory class, change scores and symbols used to evaluate Trajectory of Change to wetland health (Macfarlane et al., 2007)

Change Class	Description		Symbol
Improve	Condition is likely to improve over the over the next 5 years		(↑)
Remain stable	Condition is likely to remain stable over the next 5 years		(→)
Slowly deteriorate	Condition is likely to deteriorate slightly over the next 5 years		(↓)
Rapidly deteriorate	Substantial deterioration of condition is expected over the next 5 years		(↓↓)

Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Wetland Importance and Sensitivity scoring system which also addresses hydrological importance and direct human benefits relevant to a HGM unit. Both PES and EIS form part of a larger reserve determination process documented by the Department of Water and Sanitation.

Ecological importance is an expression of a wetland's importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (DWAF, 1999). This classification of water resources allows for an appropriate management class to be allocated to the water resource and includes the following:

- Ecological Importance in terms of ecosystems and biodiversity such as species diversity and abundance;
- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors;
- Basic human needs including subsistence farming and water use.

The Ecological Importance and Sensitivity of the wetlands is represented are described in the results section. Explanations of the scores are given in Table 23.

Table 23: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers.	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers.	>1 and <=2
Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers.	>0 and <=1

Ecosystem Services (ES)

The DWS authorisations related to wetlands are regulated by Government Notice 267 published in the Government Gazette 40713 of 24 March 2017. Page 196 of this notice provides a detailed "terms of reference" for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed. This requirement is addressed through the WetEcoServices toolkit (Kotze *et al*., 2020). This wetland assessment method is an Excel based tool which is based on the integral function of wetlands in terms of their hydrogeomorphic setting. Each of seven benefits are assessed based on a list of characteristics (e.g. slope of the wetland) that are relevant to the particular benefit. Scores are subjectively awarded to characteristics of the wetland and its catchment relative to the proposed activity. Scores are ranked as Very High, High, Moderately-High, Moderate, Moderately-Low, Low and Very Low (Table 24 and Table 25).

Table 24: Integrating the scores for ecosystem supply and demand into an overall importance score

Integrating scores for supply & demand to obtain an overall importance score						
		Supply				
		Very Low	Low	Moderate	High	Very High
Demand		0	1	2	3	4
Very Low	0	0.0	0.0	0.5	1.5	2.5
Low	1	0.0	0.0	1.0	2.0	3.0
Moderate	2	0.0	0.5	1.5	2.5	3.5
High	3	0.0	1.0	2.0	3.0	4.0
Very High	4	0.5	1.5	2.5	3.5	4.0

Table 25: Categories used for reporting the overall importance of ecosystem services

Importance Category		Description
Very Low	0-0.79	The importance of services supplied is very low relative to that supplied by other wetlands.
Low	0.8 – 1.29	The importance of services supplied is low relative to that supplied by other wetlands.
Moderately-Low	1.3 – 1.69	The importance of services supplied is moderately-low relative to that supplied by other wetlands.
Moderate	1.7 – 2.29	The importance of services supplied is moderate relative to that supplied by other wetlands.
Moderately-High	2.3 – 2.69	The importance of services supplied is moderately-high relative to that supplied by other wetlands.
High	2.7 – 3.19	The importance of services supplied is high relative to that supplied by other wetlands.
Very High	3.2 - 4.0	The importance of services supplied is very high relative to that supplied by other wetlands.

Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Wetland Importance and Sensitivity scoring system which also addresses hydrological importance and direct human benefits relevant to a HGM unit. Both EC and EIS form part of a larger reserve determination process documented by the Department of Water and Sanitation.
Ecological importance is an expression of a wetland's importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (DWAF, 1999). This classification of water resources allows for an appropriate management class to be allocated to the water resource and includes the following:

- Ecological Importance in terms of ecosystems and biodiversity such as species diversity and abundance.

- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors.
- Basic human needs including subsistence farming and water use.

The Ecological Importance and Sensitivity of the riparian units is represented in the results section. Explanations of the scores are given in Table 26 below.

Table 26: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	>1 and <=2
Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <=1

Use of WET-EcoServices for assessing the Ecological Importance and Sensitivity (EIS) of wetlands

The term Ecological Importance and Sensitivity (EIS) is well entrenched in water resource management in South Africa. Ecological Importance (EI) is the expression of the importance of wetlands and rivers in terms of the maintenance of biological diversity and ecological functioning at a local and landscape level. Ecological Sensitivity (S) refers to ecosystem fragility or the ability to resist or recover from disturbance (Rountree and Kotze 2013). The purpose of assessing ecological importance and sensitivity of water resources like wetlands, and rivers is to be able to identify those systems that provide valuable biodiversity support functions, regulating ecosystem services, or are especially sensitive to impacts. Knowing what ecosystems are valuable enables the appropriate setting of management objectives (i.e. recommended ecological category - REC) and the prioritization of management actions and interventions to promote effective water resource management.

The tool currently used for assessing wetland EIS (Rountree and Kotze 2013) is somewhat outdated but is typically informed by a WET-EcoServices assessment. The implication is that practitioners involved in wetland assessments typically have to complete both a WET-EcoServices assessment and a stand-alone EIS assessment to inform decision-making processes. Recommendations to refine the wetland EIS tool have been documented (Macfarlane *et al.* 2019) and includes the need to revise and update the wetland EIS assessment framework to simply integrate the key outputs of the WET-EcoServices tool to produce an overall ecological importance (EI) score.

Specific recommendations for integrating the WET-EcoServices outputs into the wetland EIS assessment have also been documented. These include grouping of ecosystem service scores into broad categories which would then be integrated into an overall ecological importance (EI) score:

• ***Biodiversity maintenance importance***: This is the importance score derived from the biodiversity maintenance component of WET-EcoServices.
• ***Regulating services importance***: This would be calculated as the maximum score of all the importance scores for regulating services considered in WET-EcoServices.
• ***Provisioning and cultural services importance***: This would be calculated as the maximum score of all the importance scores for provisioning and cultural services considered in WET-EcoServices.

The EI would be simply derived based on the maximum of these scores and could then be integrated with the ecological sensitivity (ES) score to produce an overall EIS score. A simple schematic of the proposed Wetland EIS framework is shown in Figure 29 below.

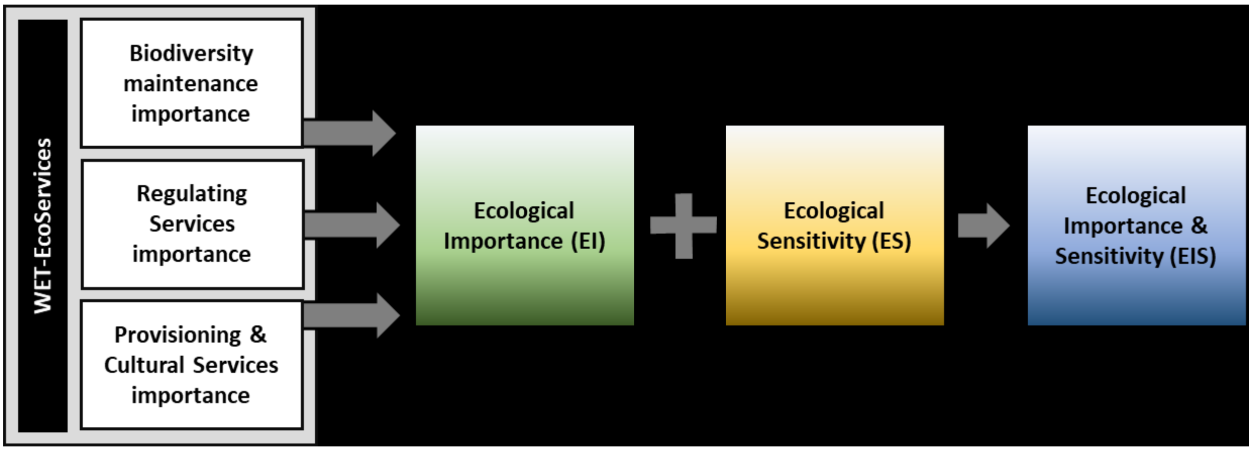


Figure 29: Schematic of the recommended Wetland EIS framework.

Recommended Ecological Category (REC)

"Upon completion of the EC and EIS assessments for the wetland, a Recommended Ecological Category for the Recommended Ecological Category (REC) of the water resource must be determined according to the methods set out in Roundtree *et al.* (2013).

The REC is determined by the Present Ecological State of the water resource and the importance and/or sensitivity of the water resource. Water resources which have Ecological Categories in an E or F class are deemed unsustainable by the DWS. In such cases the REC must automatically be increased to a D.

Where the PES is in the A, B, C, D or E the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the EC (particularly if the EC is in a low C or D category) should be evaluated. This is recommended to enable important and/or sensitive wetland water resources to maintain their functionality and continue to provide the goods and services for the environment and society.
If (Table 27):

- EC is in an E or F category:
  The REC should be set at at least a D, since E and F EC's are considered unsustainable.
    - The EC category is in a A, B, C or D category, AND the EIS criteria are low or moderate OR the EIS criteria are high or even very high, but it is not feasible or practicable for the EC to be improved:
- The REC is set at the current PES.
    - The EC category is in a B, C or D category, AND the EIS criteria are high or very high AND it is feasible or practicable for the EC to be improved:
- The REC is set at least one Ecological Category higher than the current EC." (Rountree *et al,* 2013)

Table 27: Generic Matrix for the determination of REC and RMO for water resources

			EIS			
			Very high	High	Moderate	Low
PES	A	Pristine/Natural	A Maintain	A Maintain	A Maintain	A Maintain
	B	Largely Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good - Fair	B Improve	B/C Improve	C Maintain	C Maintain
	D	Poor	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Very Poor	D Improve	E/F Improve	E/F Maintain	E/F Maintain

Site Ecological Importance

Based on the Species Environmental Assessment Guideline (SANBI, 2020) wetlands and specialised habitats should be assessed based on their Site Ecological Importance (SEI). The SEI is based on several factors (Figure **30**):

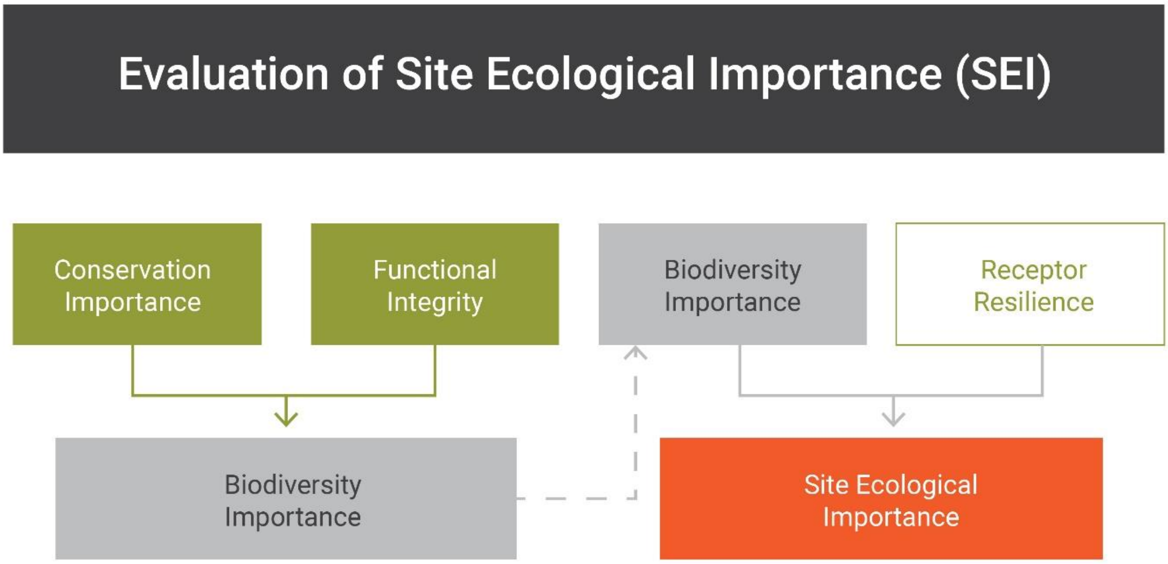


Figure 30: **Evaluation of Site Ecological Importance based on CI, FI, BI, RR and SEI (SANBI, 2020).**

Conservation Importance (CI) (Table 28) and Functional Integrity (FI) (Table 29) = Biodiversity Importance (Table 30).

Biodiversity Importance (BI) and Receptor Resilience (RR) (Table 31) = Site Ecological Importance (Table 32).

Table 28: Conservation Importance (SANBI, 2020).

Conservation importance	Fulfilling criteria
Very High	Confirmed or highly likely occurrence of CR, EN, VU or Extremely Rare23 or Critically Rare24 species that have a global EOO of < 10 km2. Any area of natural habitat25 of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent26) of natural habitat of EN ecosystem type. Globally significant populations of congregatory species (> 10% of global population).
High	Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 km2 . IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A. If listed as threatened only under Criterion A, include if there are less than 10 locations or < 10 000 mature individuals remaining. Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type. Presence of Rare species. Globally significant populations of congregatory species (> 1% but < 10% of global population).
Medium	Confirmed or highly likely occurrence of populations of NT species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals. Any area of natural habitat of threatened ecosystem type with status of VU. Presence of range-restricted species. > 50% of receptor contains natural habitat with potential to support SCC
Low	No confirmed or highly likely populations of SCC. No confirmed or highly likely populations of range-restricted species. < 50% of receptor contains natural habitat with limited potential to support SCC
Very low	No confirmed and highly unlikely populations of SCC. No confirmed and highly unlikely populations of range-restricted species. No natural habitat remaining.

Table 29: Functional Integrity (SANBI, 2020)

Functional Integrity	Fulfilling criteria
Very High	Very large (>100 ha) intact area for any conservation status of ecosystem type or >5 ha for CR ecosystem types Very High High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches No or minimal current negative ecological impacts with no signs of major past disturbance (e.g. ploughing)
High	Large (>20 ha but <100 ha) intact area for any conservation status of ecosystem type or >10 ha for EN ecosystem types Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches Only minor current negative ecological impacts (e.g. few livestock utilising area) with no signs of major past disturbance (e.g. ploughing) and good rehabilitation potential
Medium	Medium (>5 ha but <20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches Mostly minor current negative ecological impacts with some major impacts (e.g. established population of alien and invasive flora) and a few signs of minor past disturbance; moderate rehabilitation potential
Low	Small (>1 ha but <5 ha) area Almost no habitat connectivity but migrations still possible across some transformed or degraded natural habitat and a very busy used road network surrounds the area. Low rehabilitation potential Several minor and major current negative ecological impacts
Very low	Very small (<1 ha) area No habitat connectivity except for flying species or flora with wind-dispersed seeds. Several major current negative ecological impacts

Table 30: Biodiversity Importance (SANBI, 2020)

Biodiversity Importance		Conservation Importance				
		Very High	High	Medium	Low	Very Low
Functional Integrity	Very High	Very High	Very High	High	Medium	Low
	High	Very High	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very Low	Medium	Low	Very Low	Very Low	Very Low

Table 31: Receptor Resilience (SANBI, 2020)

Resilience	Fulfilling criteria
Very High	Habitat that can recover rapidly (~ less than 5 years) to restore > 70 % of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed
High	Habitat that can recover relatively quickly (~ 5-10 years) to restore > 70 % of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a high likelihood of returning to a site once the disturbance or impact has been removed
Medium	Will recover slowly (~more than 10 years) to restore > 70 % of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed
Low	Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~less than 50 % of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a low likelihood of returning to a site once the disturbance or impact has been removed
Very low	Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed

Table 32: Site Ecological Importance (SANBI, 2020)

Site Ecological Importance		**Biodiversity Importance**				
		Very High	High	Medium	Low	Very Low
Receptor Resilience	Very Low	Very High	Very High	High	Medium	Low
	Low	Very High	Very High	High	Medium	Very Low
	Medium	Very High	High	Medium	Low	Very Low
	High	High	Medium	Low	Very Low	Very Low
	Very High	Medium	Low	Very Low	Very Low	Very Low

Aquatic Assessment

Physical Habitat Assessment: The IHAS Method

The quality of the instream and riparian habitat has a direct influence on the aquatic community. Evaluating the structure and functioning of an aquatic ecosystem must therefore take into account the physical habitat to assess the ecological integrity. The IHAS sampling protocol, of which version 2 is currently used, was developed by McMillan in 1998 for use in conjunction with the SASS5 protocol to determine which habitats are present for aquatic macroinvertebrates.

IHAS consists of a scoring sheet that assists to determine the extent of each of the instream habitats, together with the physical parameter of the stream. For example, the proportion of stones in current and stones out of current will be compared with the presence of instream vegetation. This sampling protocol assists with the interpretation of the SASS5 data.

Data recorded during the site visit concerning sampling habitat and stream condition is uploaded into an excel spreadsheet. The results are then interpreted according to the categories supplied by McMillan:

IHAS score	Interpretation
<65%	Insufficient for supporting a diverse aquatic macro invertebrate community
65%-75%	Acceptable for supporting a diverse aquatic macroinvertebrate community
75%	Highly suitable for supporting a diverse aquatic macroinvertebrate community

Chemical Habitat Assessment: In Situ Water Quality

Water quality has a direct influence on in stream biota, and can fluctuate, depending on site-specific conditions. The biological monitoring of especially macroinvertebrates and fish thus need to be augmented with the *in situ* measurement of basic water quality indicator parameters (DWAF 1996), namely:

Temperature, which plays an important role in water by affecting the rates of chemical reactions and therefore the metabolic rates of organisms. Temperature is one of the major factors controlling the distribution of aquatic organisms. The temperatures of inland waters in South Africa generally range from 5 – 30°C. Natural variations in water temperature occur in response to seasonal and diel cycles and organisms use these changes as cues for activities such as migration, emergence and spawning. Artificially-induced changes in water temperature can thus impact on individual organisms and on entire aquatic communities.

pH, which gives an indication of the level of hydrogen ions in water, as calculated by the expression: $pH = -log_{10}[H^+]$, where $[H^+]$ is the hydrogen ion concentration. The pH of pure distilled water (that is, water containing no other soluble chemicals) at a temperature of 24°C is 7.0, implying that the number of H^+ and OH^- ions are equal and the water is therefore electrochemically neutral. As the concentration of hydrogen ions increases, pH decreases and the solution becomes more acidic. As $[H^+]$ decreases, pH increases and the solution becomes more alkaline. For natural surface water systems, pH values typically range between 4 and 11, and depends on the availability of carbonate and bicarbonate, which influences the buffer capacity of the water, and which are determined by geological and atmospheric circumstances.

Electrical Conductivity ("EC") is the measurement of the ease with which water conducts electricity (in milli-Siemens/meter – mS/m) and can also be used to estimate the total dissolved salts ("TDS"): EC in mS/mx 7 ≈ TDS in mg/ℓ. Changes in the EC values provide useful and rapid estimates of changes in the TDS concentration, which indicates the quantity of all compounds dissolved in the water that carry an electrical charge. Natural waters contain varying concentrations of TDS as a consequence of the dissolution of minerals in rocks, soils and decomposing plant material. TDS thus depends on the characteristics of the geological formations which the water has been in contact with, and on physical processes such as rainfall and evaporation. Plants and animals possess a wide range of physiological mechanisms and adaptations to maintain the necessary balance of water and dissolved ions in cells and tissues. Changes in EC can affect microbial and ecological processes such as rates of metabolism and nutrient cycling. The effect on aquatic organisms depend more on the rate of change than absolute changes in concentrations of salts.

It should be noted that the *in situ* measurement of these water quality parameters does not represent the general water quality at the sampling points or the streams. It is not a laboratory analysis of water quality, and does not measure macro anions and cations, metals or organic contaminants, nutrients or pesticides. The *in situ* measurements of these parameters provide a snapshot of the water quality at the survey site **at the time the biological samples were taken**, and thus can provide valuable insight into the characteristics at a survey site that could have an influence on the aquatic biota at that site, and at the time of conducting the sampling for biomonitoring.

In situ measurements of pH, temperature (in °C), and EC (in µS/cm) were taken by means of a calibrated hand-held instrument (Hanna - HI 991300) in the main flow of the river or stream sampled, both prior to conducting the sampling for biomonitoring as well as after the completion of conducting the sampling for biomonitoring.

The EC measurements in µS/cm were converted to mS/m (10 µS/cm = 1 mS/m) by dividing with a factor of 10.

Receiving water quality objectives ("RWQOs") based on the water quality requirements for different users, are contained in a set of documents first published by DWAF in 1993, and revised in 1996 (DWAF, 1996). These documents are collectively known as the "South African Water Quality Guidelines" ("SAWQGs") and contain guidelines for specific types of water users, namely:
SAWQG Volume 1: Domestic Water Use
SAWQG Volume 2: Recreational Water Use
SAWQG Volume 3: Industrial Water Use
SAWQG Volume 4: Agricultural Water Use: Irrigation
SAWQG Volume 5: Agricultural Water Use: Livestock Watering
SAWQG Volume 6: Agricultural Water Use: Aquaculture
SAWQG Volume 7: Aquatic Ecosystems

These guidelines provide useful information on the effects of various chemical substances on water resource quality and establish objectives for the management of the water resource based on the requirements of the different users of the water resource. The water quality requirements for protecting and maintaining the health of aquatic ecosystems differ from those of other water uses. It is difficult to determine the effects of changes in water quality on aquatic ecosystems, as the cause-effect relationships are not well understood. Therefore, water quality guidelines have to be derived indirectly through extrapolation of the known effects of water quality on a very limited number of aquatic organisms. Certain quality ranges are required to protect and maintain aquatic ecosystem health. For each constituent, guideline ranges are specified, including the No Effect Range (Target Water Quality Range or "TWQR"), Minimum Allowable Values, Acceptable Range, and, for some parameters, Intolerable levels.

The SAWQGs for aquatic ecosystems that are applicable to the *in situ* measurements of water quality, are summarised below (DWAF 1996):

Parameter	Unit	Target Water Quality Range	Minimum Allowable Values
Temperature	°C	should not vary from the background average daily water temperature considered to be normal for that specific site and time of day, by > 2 °C, **or** by > 10 %, whichever estimate is the more conservative	
EC	mS/m	Should not be changed by > 15 % from the normal cycles of the water body	
pH	pH units	Variation from background pH limited to <0.5 of a pH unit, or < 5%, whichever is the more conservative estimate	

Data collected during the *in situ* measurements were compared against these SAWQGs for aquatic ecosystems.

Species Response: Aquatic Invertebrates & the SASS5 Method

SASS5 is a rapid bioassessment method used to identify changes in species composition of aquatic invertebrates to indicate relative water quality (Dickens and Graham 2002). SASS5 requires the identification of invertebrates to a family level in the field.

SASS5 is based on the principle that some invertebrate taxa are more sensitive than others to pollutants. In particular, macroinvertebrate assemblages are good indicators of localized conditions in rivers. Many macroinvertebrates have limited migration patterns or are not free-moving, which makes them well-suited for assessing site specific impacts with upstream/downstream studies. Benthic macroinvertebrates are abundant in most streams. Even small streams (1st and 2nd order) which may have a limited fish population will support a diverse macroinvertebrate fauna. These groups of species constitute a broad range of trophic levels and pollution tolerances. Thus, SASS5 is a useful method for interpreting the cumulative effects of impacts on aquatic environments.

Using a 'kick net', the SASS5 sampling method entails prescribed time-periods and spatial areas for the kicking of in-current and out-current stones and bedrock; sweeping of in-current and out-current marginal and aquatic vegetation, as well as of gravel, stones and mud ("GSM"); followed by visual observations and hand-picking. The results of each biotope are kept separate, until all observations are noted. The entire sample is then returned to the river, retained alive, or preserved for further identification.

In SASS5 analysis, species abundance is recorded on an SASS5 data sheet which weighs the different taxa common to South African rivers from 1 (pollutant tolerant) to 15 (pollution sensitive). The SASS5 score will be high at a particular site if the taxa are pollution sensitive and low if they are mostly pollution tolerant.

The SASS5 Score, the number of taxa observed, and the average score per taxon ("ASPT") are calculated for all of the biotopes combined. Dallas (2007) used available SASS5 Score and ASPT values for each eco-region in South Africa to generate biological bands on standardised graphs that are used as a guideline for interpreting any data obtained during the study. The meaning of each *SASS5 Ecological Category* is as follows (Dallas 2007).

EC	Ecological category	Description
A	Natural	Unmodified natural
B	Good	Largely natural with few modifications
C	Fair	Moderately modified
D	Poor	Largely modified
E	Seriously modified	Seriously modified
F	Critically modified	Critically or extremely modified

Appendix F – Results of the Aquatic Baseline Assessment

To be included once completed