Proposed Construction of a New Kusile-Vulcan Loop (Duvha By-Pass) (Bravo 5) Mpumalanga Province

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Wetland/Riparian Delineation Assessment
May 2016

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Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.

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2016.05.30

Date

Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as information available at the time of study. Therefore the author reserves the right to modify aspects of the report, including the recommendations, if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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EXECUTIVE SUMMARY

Limosella Consulting was appointed by Envirolution Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization process for the Proposed Construction of the new Kusile-Vulcan Loop (Duvha By-Pass), Mpumalanga Province.

Fieldwork was conducted on the 25th of May 2016.

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

- Delineate the wetland areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Undertake a functional assessment of wetlands areas within the area assessed;
- Recommend suitable buffer zones; and
- Discuss potential impacts, mitigation and management procedures relevant to the conserving wetland areas on the site.

One wetland and one dam were recorded on the study area. The wetland area was classified as a seepage wetland. It is likely that the wetland has a strong artificial component although natural wetland conditions are visible from historic aerial imagery. Proposed pylons that fall within the wetland area are KuVu 2 and KuVu3. Proposed pylon KuVu1 falls within the buffer zone of the wetland. Existing pylons Exist 4 and Exist 5 fall within the buffer zone of the wetland.

A summary of the conditions are described in the table below:

	Watercourse Type	Quaternary Catchment and WMA area	Linked to an important River System	Coordinates and Relation to study area	Present Ecological Score (PES)	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Management Class	Buffers
	Seepage Wetland	**B11G– Olifants WMA**	**Witbank dam nearby**	**25°57'29.93"S and 29°20'6.84"E**	**E**	**1.2**	**C**	**20 m**
Does the specialist support the development?	Yes. Although some wetland habitat will be lost, this should be a temporary condition which is quite easily rehabilitated. It is likely that the wetland is largely sustained by artificial water input which may currently be utilized by fauna species, particularly birds. Should monitoring show that loss of wetland habitat has an adverse effect on birds, the existing dam can be modified to accommodate for the habitat loss resulting from the proposed activities.							
Major concerns	Loss of wetland habitat currently utilized by birds. The impact of the powerlines on birds should be assessed by an avifauna specialist.							
Recommendations	Where possible pylons currently located in wetland area should be moved to minimise any potential impacts to the wetlands. If this is not possible, the existing dam can be modified to accommodate for the habitat loss resulting from the proposed activities.							

Broad potential impacts that may be associated with the proposed development include:

- Changing the quantity and fluctuation properties of the watercourse by changing runoff characteristics of the area surrounding the wetland (by for example compacting soils)
- Changing the amount of sediment entering water resource (increasing or decreasing the amount)
- Changing the physical structure within a water resource (habitat) including its associated buffer zone

In order to limit the impact on the hydrology of the area, the current assessment finds that a 20m buffer zone should be recognised from the edge of the wetland. However, linear developments such as the proposed powerlines, are rarely able to avoid crossing any watercourses whatsoever. Where construction of access roads and the construction activities within the 1:100 year floodline or the wetland/riparian area (whichever is the greatest), as well as within wetlands and associated buffers is unavoidable and a Water Use License granted, the buffer areas should still be respected as an area where impacts must be kept to an absolute minimal. The buffer areas should be clearly marked during construction and workers must be informed that activities and traffic beyond the buffer zone must be limited to only that which is necessary. In addition, it is important to note that construction within 500m of a wetland area can also only take place as authorised by DWS.

The impacts and mitigation briefly discussed are refined in the rehabilitation plan accompanying the current document. Where alternatives have been investigated and watercourse crossings have been shown to be necessary it is important that appropriate mitigation measures are put into place and carefully monitored to ensure minimal impact to regional hydrology. In the case of the proposed powerlines, mitigation should focus on the following principles:

- Rehabilitation / restoration of indigenous vegetative cover;
- Management of point discharges during construction activities;
- Alien plant control;
- Implementation of best management practices regarding stormwater and earthworks;

Table of Contents

1 INTRODUCTION 9
1.1 Terms of Reference 9
1.2 Assumptions and Limitations 10
1.3 Definitions and Legal Framework 10
1.4 Locality of the study site 12
1.5 Description of the Receiving Environment 14
2 METHODOLOGY 21
2.1 Wetland and Riparian Delineation 21
2.2 Wetland Classification and Delineation 27
2.3 Buffer Zones 31
2.4 Wetland Functionality, Status and Sensitivity 33
2.4.1 Present Ecological Status (PES) – WET-Health 34
2.4.2 Ecological Importance and Sensitivity (EIS) 35
2.4.3 Present Ecological Category (EC): Riparian 37
2.4.4 Quick Habitat Integrity Model 38
3 RESULTS 39
3.1 Wetland Classification and Delineation 39
3.1.1 Soil and Vegetation Indicators 42
3.2 Wetland Functional Assessment 49
3.2.1 Present Ecological State 49
3.3 Impacts and Mitigation 49
3.3.1 Significance Ranking Matrix 50
4 CONCLUSION 55
REFERENCES 56
APPENDIX A: GLOSSARY OF TERMS 58

APPENDIX B: Abbreviated CVs of participating specialists 59

Appendix C: Functional Assessment Data 65

Figures

Figure 1: Locality Map 13
Figure 2: Hydrology of the study site and surrounds as per existing spatial layers. 16
Figure 3: Vegetation types associated with the proposed lines. 17
Figure 4: Soil classes associated with the proposed lines. 19
Figure 5: Conservation and biodiversity areas of the region in relation to the proposed lines. 20
Figure 6: Threatened Ecosystems along the proposed line. .... **Error! Bookmark not defined.**
Figure 7: Typical cross section of a wetland (Ollis, 2013) 22
Figure 8. Terrain units (DWAF, 2005). 23
Figure 9: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013) 23
Figure 10: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007). 24
Figure 11: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013). 26
Figure 12: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010). 27
Figure 13: A represent the buffer zone setback for the wetland types discussed in this report 33
Figure 14: Wetland/Riparian areas associated with the proposed and alternative substation and powerlines (Part 1 of 3). 43
Figure 15: Wetland/Riparian areas associated with the proposed and alternative substation and powerlines (Part 2 of 3). 44
Figure 16: Wetland/Riparian areas associated with the proposed and alternative substation and powerlines (Part 3 of 3). .... **Error! Bookmark not defined.**
Figure 17: Example of a floodplain wetland recorded on the study area. .... **Error! Bookmark not defined.**
Figure 18: Example of an unchannelled valley bottom recorded on the study site.**Error! Bookmark not defined.**
Figure 19: Examples of different wetland types recorded on the study area. ... **Error! Bookmark not defined.**
Figure 20: Further examples of different wetland types recorded on the study area.**Error! Bookmark not defined.**
Figure 21: The PES and VEGRAI scores of the wetlands along the proposed line (Map 1 of 3). .... **Error! Bookmark not defined.**
Figure 22: The PES and VEGRAI scores of the wetlands along the proposed line (Map 2 of 3). .... **Error! Bookmark not defined.**
Figure 23: The PES and VEGRAI scores of the wetlands along the proposed line (Map 3 of 3). .... **Error! Bookmark not defined.**
Figure 24: The EIS and QHI of the wetlands along the proposed line (Map 1 of 3).**Error! Bookmark not defined.**
Figure 25: The EIS and QHI of the wetlands along the proposed line (Map 2 of 3).**Error! Bookmark not defined.**

Figure 26: The EIS and QHI of the wetlands along the proposed line (Map 3 of 3).**Error! Bookmark not defined.**

Tables

Table 1: Components of the Bravo Integration Project and associated activities 9
Table 2: Description of riparian vegetation zones (Kleynhans *et al,* 2007). 24
Table 3: Wetland Hydro-geomorphic types and descriptions. 28
Table 4: List of types of sites that are difficult to delineate (Jobs, 2009). 30
Table 5: Generic functions of buffer zones relevant to the study site (adapted from Macfarlane *et al*, 2010) 32
Table 6: Indirect Benefits provided by wetland habitats (Macfarlane *et al*, 2007). 34
Table 7: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al,* 2007) 34
Table 8: Trajectory class, change scores and symbols used to evaluate Trajectory of Change to wetland health (Macfarlane *et al*, 2007) 35
Table 9: Direct human benefits associated with wetland habitats (Macfarlane *et al*, 2007). 36
Table 10: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999) 36
Table 11: Generic ecological categories for EcoStatus components (modified from Kleynhans, 1996 & Kleynhans, 1999) 38
Table 12: The PES, EIS, VEGRAI and QHI scores of the possibly affected watercourses along the propopsed line. .... **Error! Bookmark not defined.**
Table 13: Significance Ranking matrix table 50
Table 14: Significance of impact table. 51
Table 15: Changes in water flow regime impact ratings .... **Error! Bookmark not defined.**
Table 16: Changes in sediment entering and exiting the system impact ratings 51
Table 17: Introduction and spread of alien vegetation impact ratings. 52
Table 18: Loss and disturbance of wetland/riparian habitat and fringe vegetation impact ratings. 53
Table 19: Changes in water quality due to foreign materials and increased nutrients impact ratings. .... **Error! Bookmark not defined.**

1 INTRODUCTION

Limosella Consulting was appointed by Envirolution Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization process for the proposed construction of a new Kusile-Vulcan Loop (Duvha By-Pass), Mpumalanga Province.

Fieldwork was conducted on the 25th of May 2016.

Eskom has been experiencing a growing demand for electricity which increasing pressure on the current existing power generation and transmission capacity. Eskom aims to improve the reliability of electricity supply to the country, and in particular, to provide for the growth in electricity demand in the Gauteng and Mpumalanga provinces. To this end the Bravo Integration Project was launched. This project was broken down into smaller individual Environmental Impact Assessments for which alternatives were evaluated during a previous phase of the project (Cymbian, 2009). Current assessments are evaluating the environmental impact of the final alignments.

This report addresses the Bravo 5 component of the Bravo Integration Project (Table 1)

Table 1: Components of the Bravo Integration Project and associated activities

Line Name	Description of activities
Bravo 3	Construction of a new 400 kV line from Bravo power station to Lulamisa (Kyalami) substation
Bravo 4	Construction of 2 x 400 kV lines from Kendal power station to Zeus substation and Bravo power station to Zeus substation. These two lines will run parallel to each other
Bravo 5	**Construction of a 400 kV by-pass line, approximately 10 km in length, on the Bravo – Vulcan (Witbank) line to by-pass Duvha**
Kyalami – Midrand Strengthening	Comprising a Substation and three 400kv Transmission Lines of approximately 13 Km between existing Lulamisa Substation and proposed Kyalami Substation, Gauteng.

1.1 Terms of Reference

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

- Delineate the wetland and riparian areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,

- Undertake a functional assessment of wetlands areas within the area assessed;
- Recommend suitable buffer zones; and
- Discuss potential impacts, mitigation and management procedures relevant to the conserving wetland areas on the site.

1.2 Assumptions and Limitations

The Garmin Montana 650 used for wetland and riparian delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, during the course of 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.

Furthermore, the assessment of wetlands is based on environmental indicators such as vegetation, that are subjected to seasonal variation as well as factors such as fire and drought. Although background information was gathered, the information provided in this report was mainly derived from what was observed on the study site at the time of the field survey. A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study. Description of the depth of the regional water table and geohydrological processes falls outside the scope of the current assessment. The site visit was conducted in within the winter months and the vegetation was both burnt and grazed and only limited species could be identified, the soil was also hardened in some areas due to drought and fire and soil samples could not be taken throughout the study site. Access was not available throughout the study site and easily accessible wetland areas were visited during the site visits. Furthermore due to the large amount of wetlands located on the proposed lines a strategical approach was taken in order to gain insight into the overall condition of the wetland areas. Should the proposed lines be approved a thorough groundtruthing of all the wetland areas should be done in order to minimise potential impacts.

No alternative route options were available for evaluation during this assessment.

1.3 Definitions and Legal Framework

This section outlines the definitions, key legislative requirements and guiding principles of the wetland study and the Water Use Authorisation process.

The National Water Act, 1998 (Act No. 36 of 1998) [NWA] provides for Constitutional water demands including pollution prevention, ecological and resource conservation and sustainable utilisation. In terms of this Act, all water resources are the property of the State and are regulated by the Department of Water Affairs (DWA). The NWA sets out a range of water use related principles that are to be applied by DWA when taking decisions that significantly affect a water resource. The NWA defines a water resource as including a watercourse, surface water, estuary or aquifer. A watercourse includes a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake, pan or dam, into which or from which water flows; any collection of water that the Minister may declare to be a watercourse; and were relevant its beds and banks.

The NWA defines a wetland as "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." In addition to water at or near the surface, other distinguishing indicators of wetlands include hydromorphic soils and vegetation adapted to or tolerant of saturated soils (DWA, 2005).

Riparian habitat often perform important ecological and hydrological functions, some similar to those performed by wetlands (DWA, 2005). Riparian habitat is also the accepted indicator used to delineate the extent of a river's footprint (DWAF, 2005). It is defined by the NWA as follows: "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas".

Water uses for which authorisation must be obtained from DWA are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a wetland:
Section 21(c): Impeding or diverting the flow of water in a watercourse; and
Section 21(i): Altering the bed, banks, course or characteristics of a watercourse.

Authorisations related to wetlands are regulated by Government Notices R.1198 and R.1199 of 18 December 2009. GN 1198 and 1199 of 2009 grants General Authorisation (GA) for the above water uses on certain conditions:
GN R.1198: Any activity in a wetland for the rehabilitation of a wetland for conservation purposes.
GN R.1199: Any activity more than 500 m from the boundary of a wetland.

These regulations also stipulate that these water uses must the registered with the responsible authority. Any activity that is not related to the rehabilitation of a wetland and which takes place within 500 m of a wetland are excluded from a GA under either of these regulations. Wetlands situated within 500 m of proposed activities should be regarded as sensitive features potentially affected by the proposed development (GN 1199). Such an activity requires a Water Use Licence (WUL) from the relevant authority.

In addition to the above, the proponent must also comply with the provisions of the following relevant national legislation, conventions and regulations applicable to wetlands and riparian zones:

- Convention on Wetlands of International Importance - the Ramsar Convention and the South African Wetlands Conservation Programme (SAWCP).
- National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA].
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Environment Management Protected Areas Act, 2003 (Act No. 57 of 2003).
- Regulations GN R.982, R.983, R. 984 and R.985 of 2014, promulgated under NEMA
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983).
- Regulations and Guidelines on Water Use under the NWA.
- South African Water Quality Guidelines under the NWA.

- Mineral and Petroleum Resources Development Act, 2002 (Act No. 287 of 2002).

1.4 Locality of the study site

The Proposed Construction of a new Kusile-Vulcan Loop (Duvha By-Pass) is located at the Duvha Power Station southwest of Emalahleni, Mpumalanga Province (Figure 1).

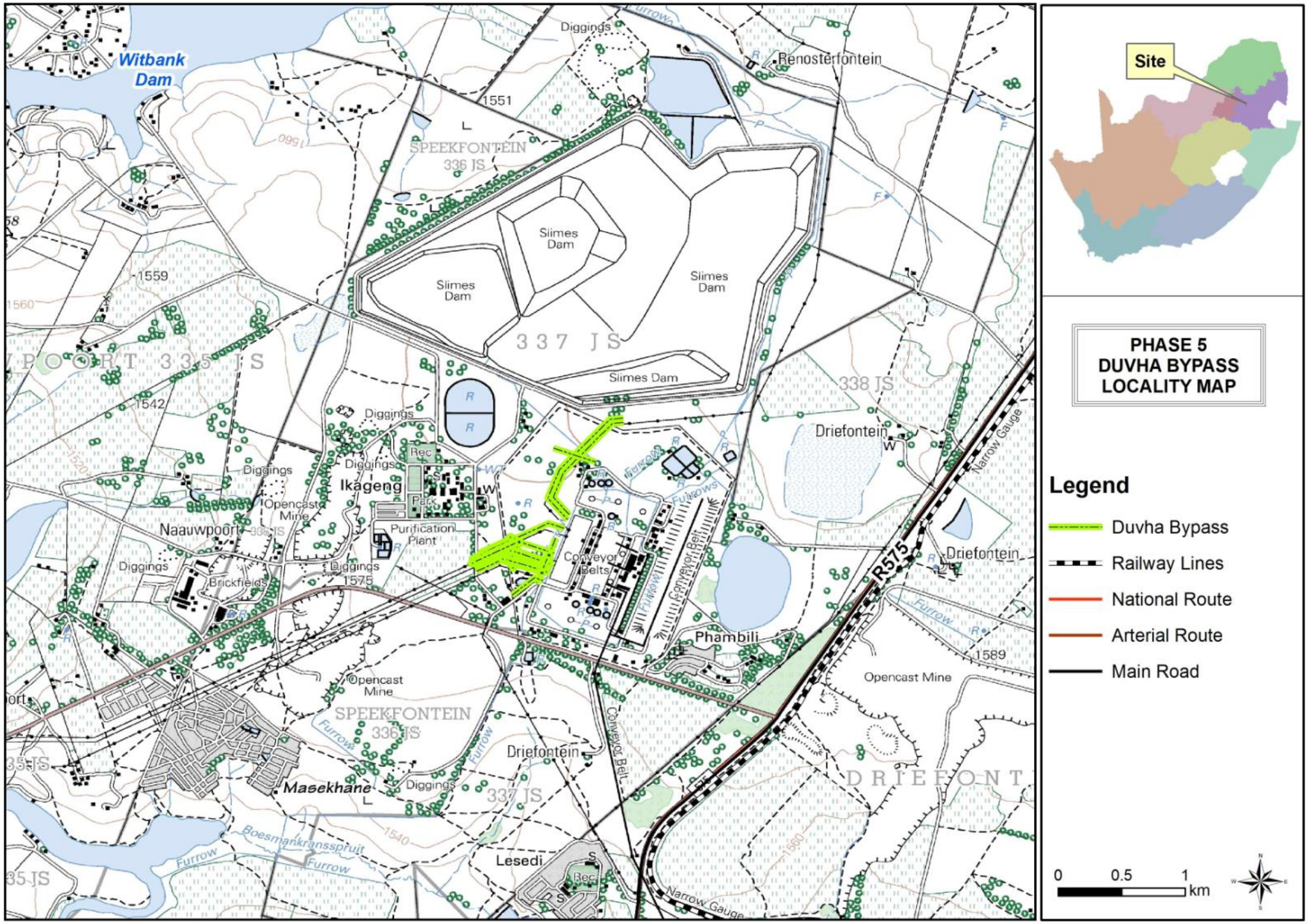


Figure 1: Locality Map

1.5 Description of the Receiving Environment

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.

Hydrology & Quaternary Catchments:

As per Macfarlane *et al*, (2009) one of the most important aspects of climate affecting a wetland's vulnerability to altered water inputs is the ratio of Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) (i.e. the average rainfall compared to the water lost due to the evapotranspiration that would potentially take place if sufficient water was available). The site is situated in the Quaternary Catchment B11G. In this catchment, the precipitation rate is lower than the evaporation rate with a Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) of 0.32. Consequently, watercourses in this area are sensitive to changes in regional hydrology, particularly where their catchment becomes transformed and the water available to sustain them becomes redirected.

19 Water Management areas (WMA) were established by, and their boundaries defined in, Government Notice No. 1160 on 1st October 1999. Quaternary Catchment B11G is located in the third water management area known as the Olifants WMA. In this WMA the major rivers include the Elands, Wilge, Steelpoort and Olifants Rivers.

Surface water spatial layers such as the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa (SANBI, 2010) reflect the presence of scattered wetlands some of which have been identified as ash dams and other artificial waterbodies (Figure 2).

Regional Vegetation:

The Bravo 5 infrastructure is located on the grassland biome. The vegetation types located on the study site are classified as Eastern Highveld Grassland and Rand Highveld Grassland (Figure 3).

Rand Highveld Grassland comprises species rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. This vegetation unit is poorly conserved with much of its area transformed by cultivation, plantations, urbanisation or dam-building and mining. Furthermore, the Eastern Highveld Grassland comprises short dense grassland and small, scattered rocky outcrops are characterised by wiry, sour grasses and some woody species. This vegetation unit is poorly conserved with much of its area transformed by cultivation, grazing, and mining. Both these vegetation types are impacted where disturbances occurred, by the invasive exotic tree *Acacia mearnsii* (Black Wattle) that can become dominant and displace the natural vegetation. Due to the extensive usage of the areas once covered by Eastern Highveld Grassland and Rand Highveld Grassland vegetation types, the remaining portions are of high conservation value and sensitivity and are thus classified as endangered vegetation types (Mucina & Rutherford, 2006).

Geology and soils:

The underlying geology is classified as Arenite, shale and sandstone of the Madzaringwe Formation (Karoo Supergroup) (Figure 4). The Duvha Power Station is located on an area with intercalated arenaceous and argillaceous strata. The soil classes of the study area are Ba4 and Fa8 (ENPATT, d.u). Ba4 soils are described as Plinthic catena: dystrophic and/or mesotrophic; red soils widespread, upland duplex and margalitic soils rare, Fa8 soils are classified as Glenrosa and/or Mispah forms (other soils may occur), lime rare or absent in the entire landscape (Figure 5). The Glenrosa soil form is described as a potential seasonal to temporary wetland soil (DWAF, 2005). This soil form is characterised by a surface horizon which is maintained by biological activity and underlying rock or saprolite. Saprolite refers to a horizon of weathering rock which still has distinct affinities with the parent rock (Fey, 2005).

Mpumalanga Conservation Plan

Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). These form the key output of a systematic conservation assessment and are the biodiversity sectors inputs into multi-sectoral planning and decision making. CBA's are therefore areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses (Desmet *et al,* 2009).

In addition, the assessment also made provision for Ecological Support Areas (ESA's), which are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas (Desmet *et al,* 2009).

The study area is located on an area classified as an area with no natural habitat remaining with only a small section of the proposed powerline located on areas classified as highly significant and important and necessary (Figure 6).

These areas are highlighted at a strategic level and site specific studies by vegetation ecologists should investigate conditions on a fine scale by intensive groundtruthing. Recommendations as to sensitive species and habitats, including mitigation measures should be obtained from these site-specific reports.

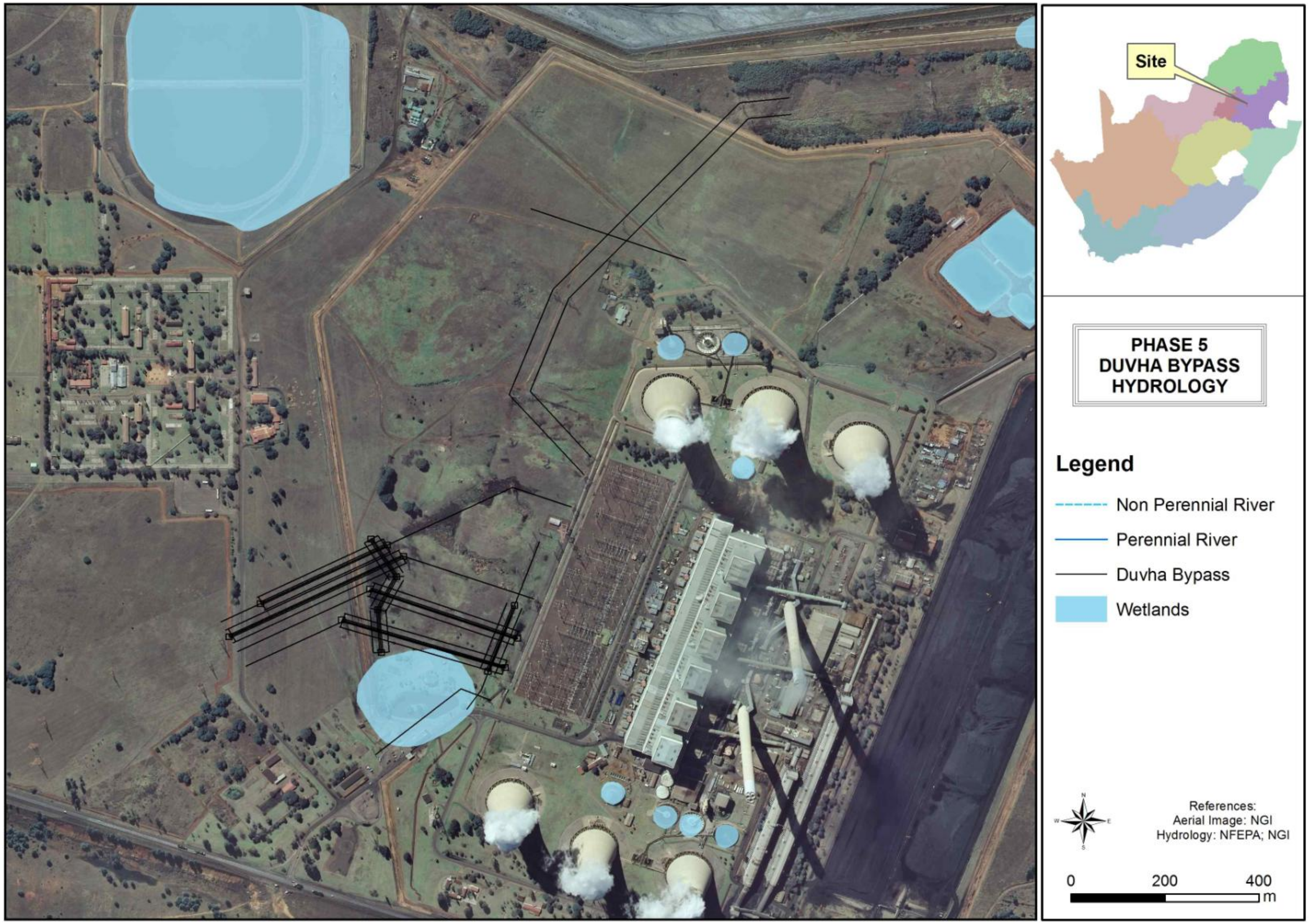


Figure 2: Hydrology of the study site and surrounds as per existing spatial layers.

Figure 3: Vegetation types associated with the proposed lines.

Figure 4: Geology of the proposed powerline.

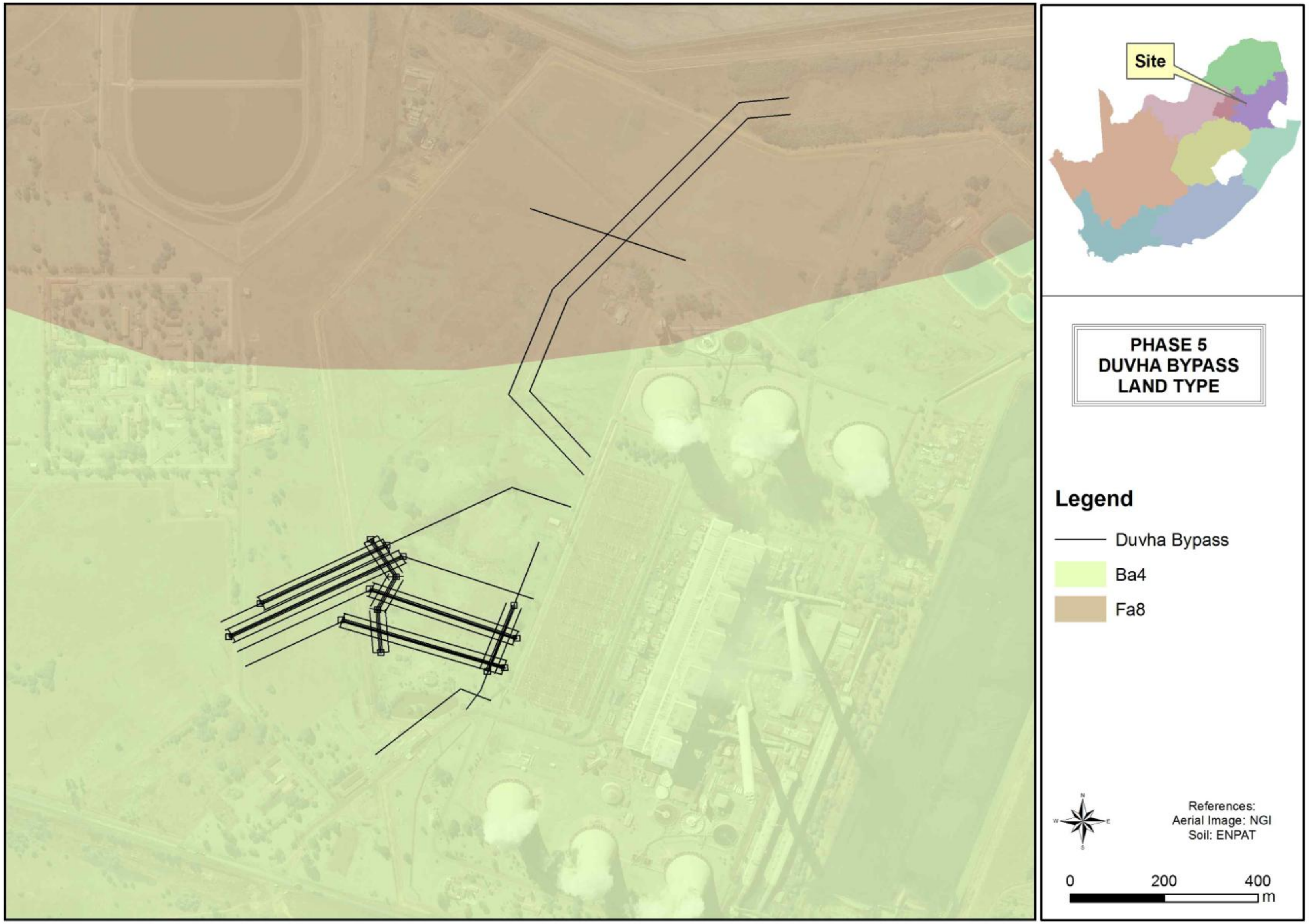


Figure 5: Soil classes associated with the proposed lines.

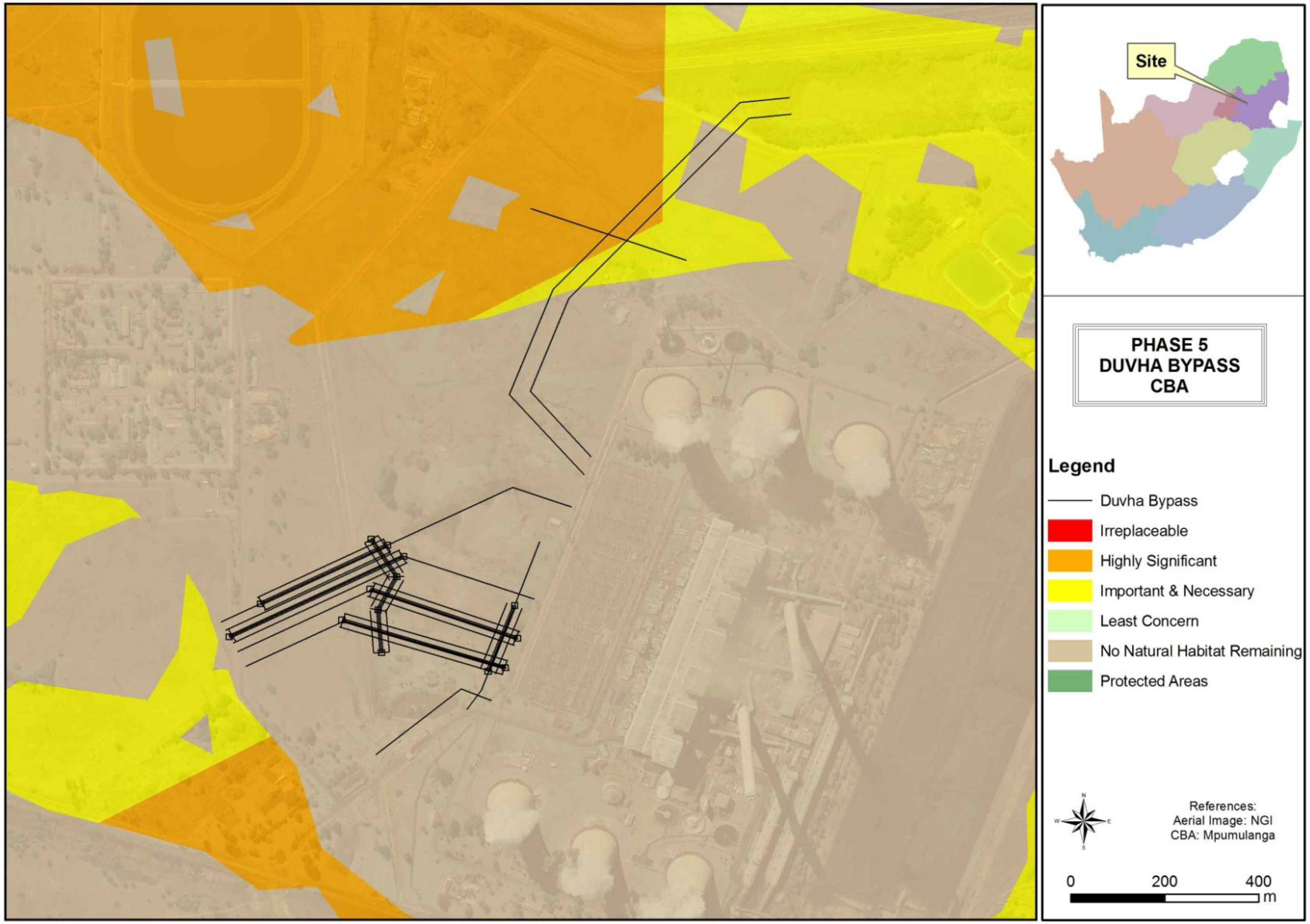


Figure 6: Conservation and biodiversity areas of the region in relation to the proposed lines.

2 METHODOLOGY

The delineation method documented by the Department of Water affairs and Forestry in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), and the Minimum Requirements for Biodiversity Assessments (GDACE, 2009) 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 hand held Garmin Montana 650 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.

2.1 Wetland and Riparian Delineation

Wetlands are delineated based on scientifically sound methods, and utilizes a tool from the Department of Water Affairs and Forestry named 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005). The delineation of the watercourses of the proposed powerline infrastructure are based on both desktop delineation and intensive groundtruthing.

Desktop Delineation

A desktop assessment was conducted of the proposed powerline routes, with wetland and riparian units crossed by the powerline were 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.

Groundtruthing

Wetlands are identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figures 7 & Figure 8):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (Figure 7 and Figure 8);
- 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 50cm of the soil surface.

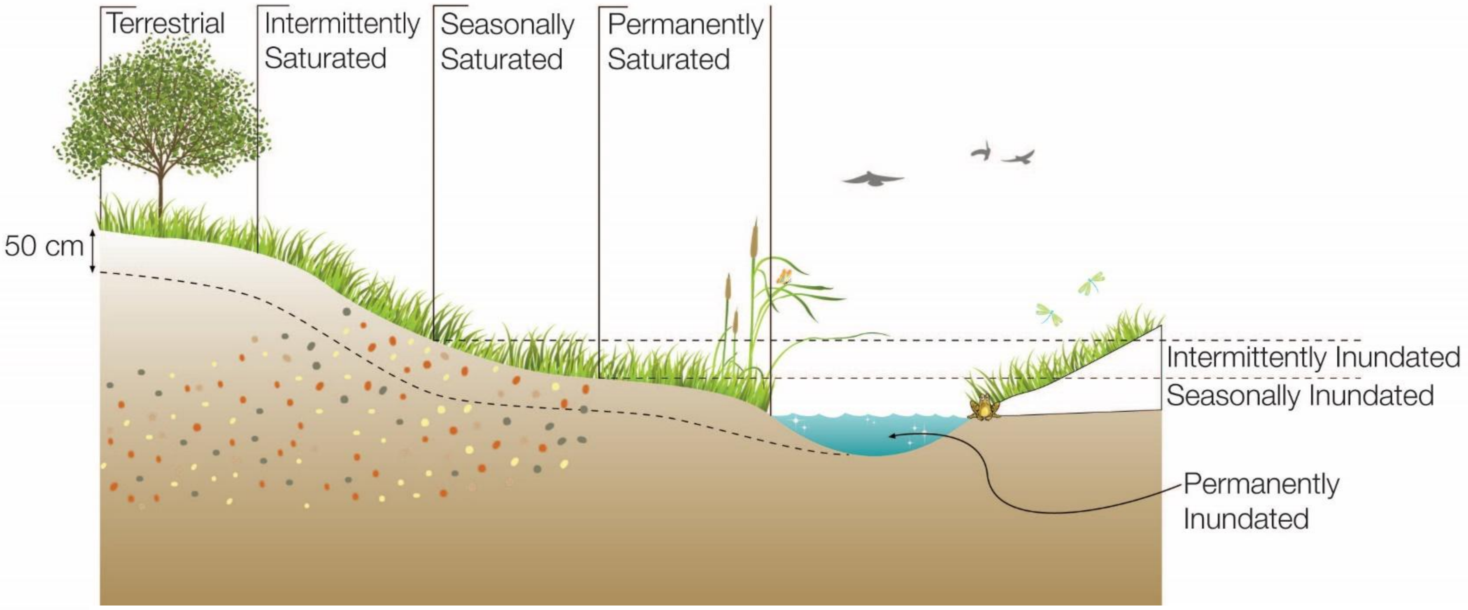


Figure 7: Typical cross section of a wetland (Ollis, 2013)

<u>The Terrain Unit Indicator</u>

The terrain unit indicator (Figure 8) 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 9).

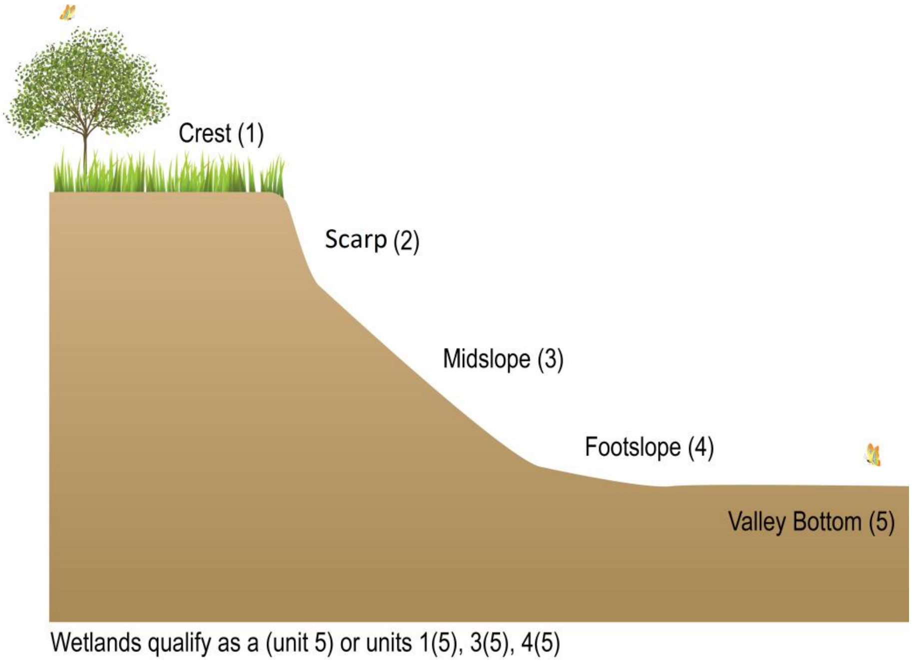


Figure 8. Terrain units (DWAF, 2005).

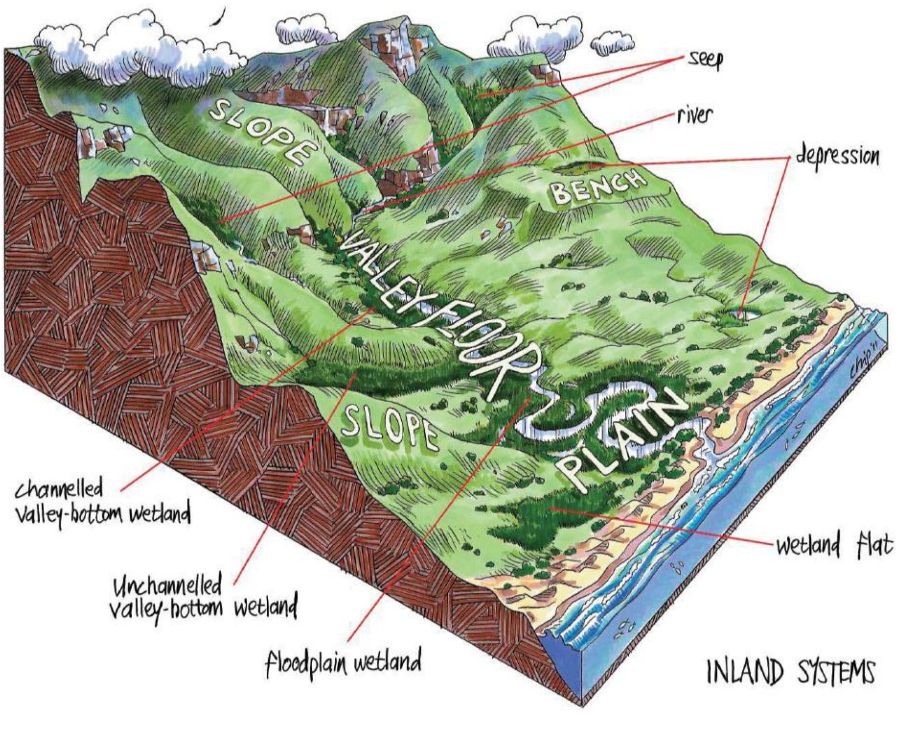


Figure 9: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

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 has also been referred to as active features or wet bank (Van Niekerk and Heritage, 1993, cited in DWAF, 2008). It includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (Kleyhans, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 11).

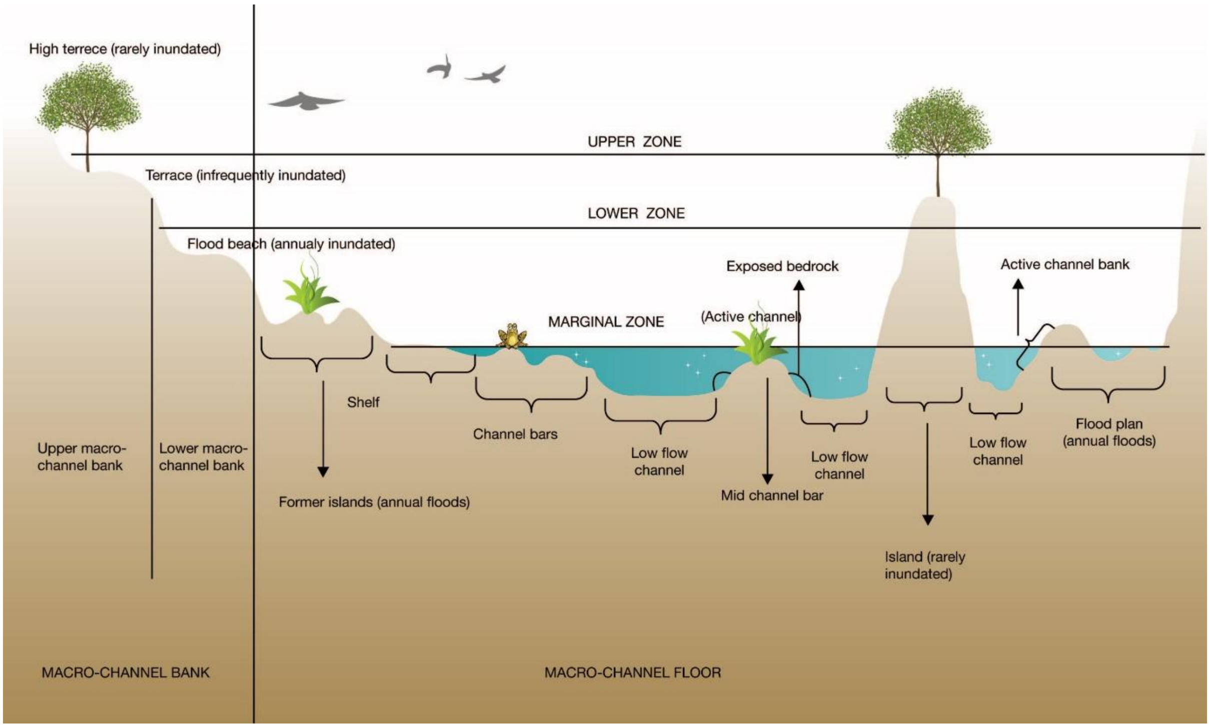


Figure 10: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

The vegetation of riparian areas is divided into three zones, the marginal zone, lower non-marginal zone and the upper non-marginal zone (Table 2). The different zones have different vegetation growth.

Table 2: Description of riparian vegetation zones (Kleynhans *et al*, 2007).

	Marginal	(Non-marginal) Lower	(Non-marginal) Upper
Alternative descriptions	Active features Wet bank	Seasonal features Wet bank	Ephemeral features Dry bank
Extends from	Water level at low flow	Marginal zone	Lower zone
Extends to	Geomorphic features / substrates that are	Usually a marked increase in lateral	Usually a marked decrease in lateral

	Marginal	(Non-marginal) Lower	(Non-marginal) Upper
	hydrologically activated (inundated or moistened) for the Greater part of the year.	Elevation.	elevation
Characterized by	See above ; Moist substrates next to water's edge; water loving- species usually vigorous due to near permanent access to soil moisture	Geomorphic features that are hydrologically activated (inundated or moistened) on a Seasonal basis. May have different species than marginal zone	Geomorphic features that are hydrological activated (inundated or moistened) on an Ephemeral basis. Presence of riparian and terrestrial species Terrestrial species with increased stature

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 12) (Kotze, 1999).

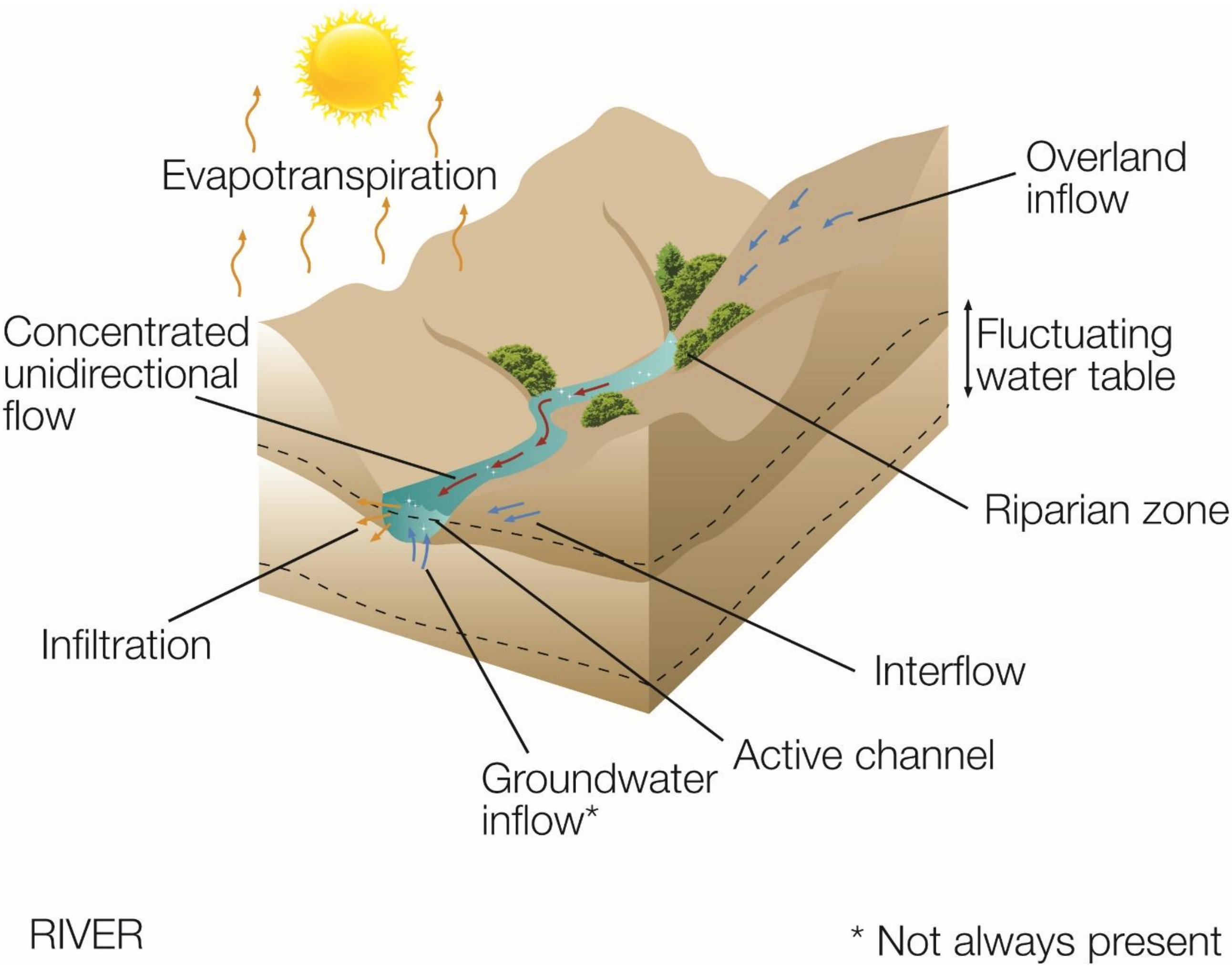


Figure 11: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

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 13). 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). The rivers recorded on site are classified as ephemeral rivers/streams due to the presence of pools as well as being dry for the majority of the year.

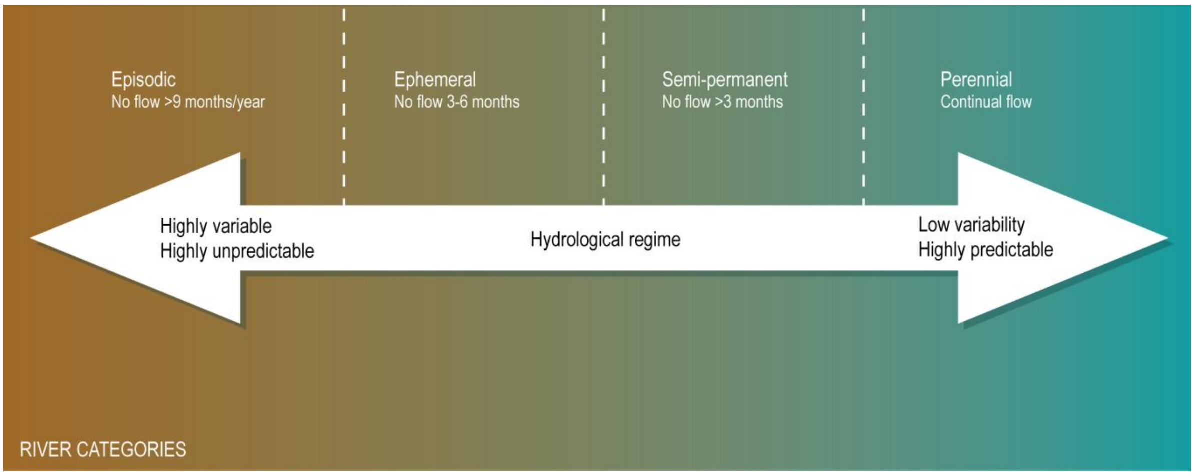


Figure 12: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

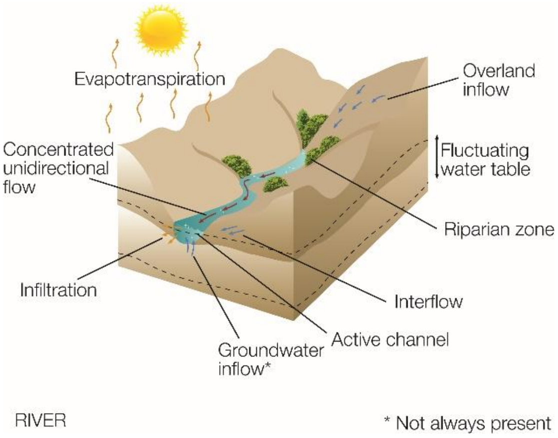
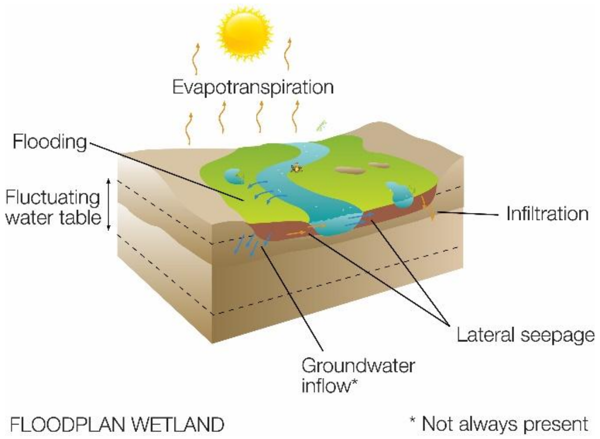
2.2 Wetland Classification and Delineation

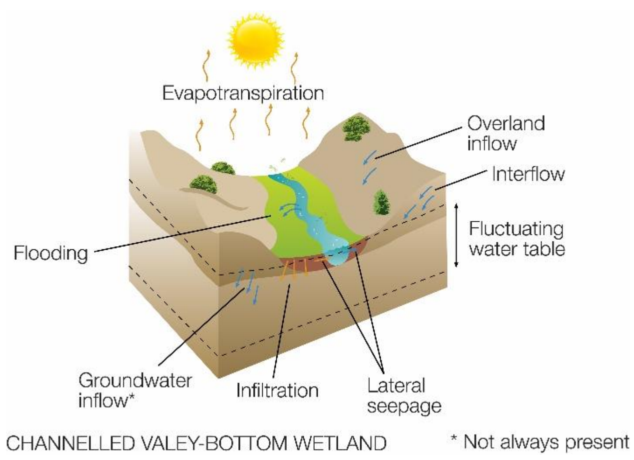
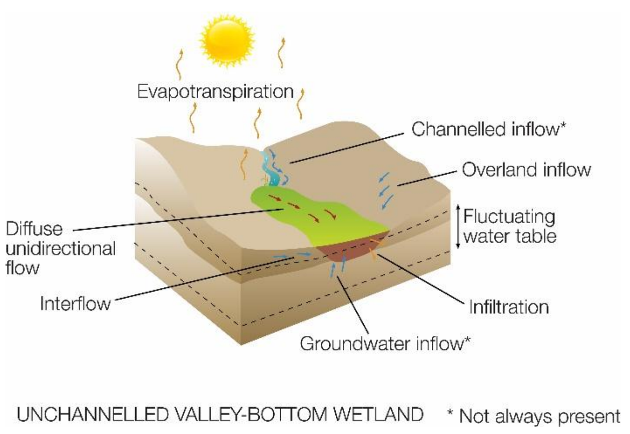
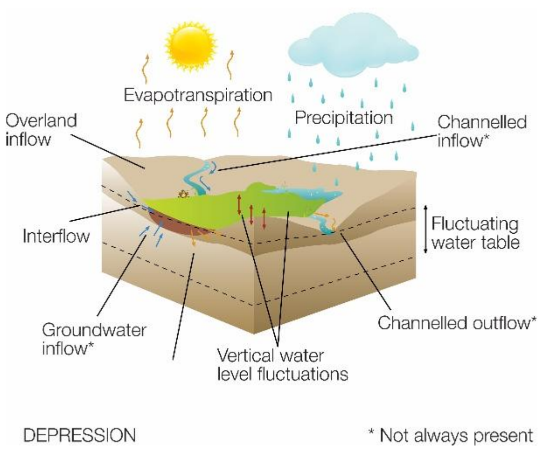
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed in SANBI (2009). 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):

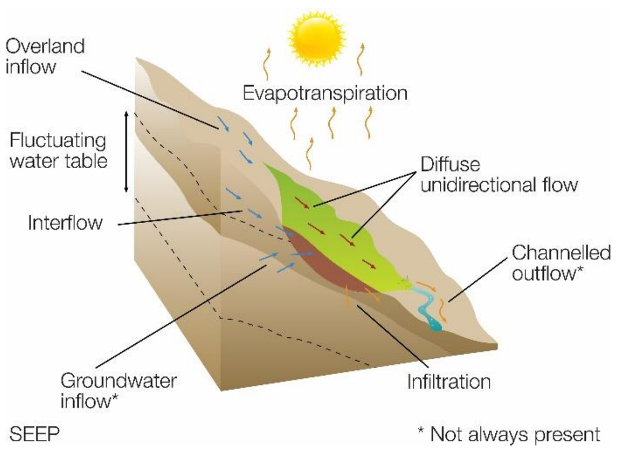
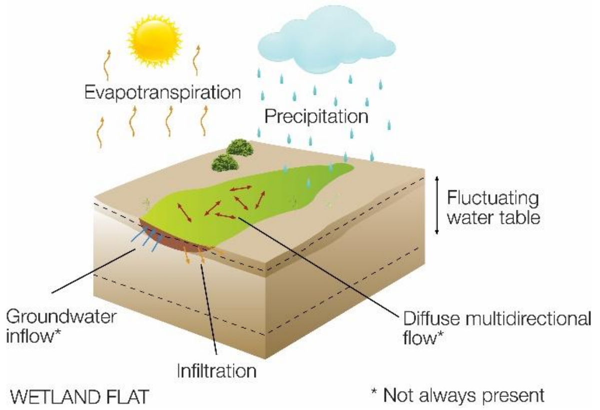
- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater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

The Classification of wetland areas found during the study (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWAF, 2005) are as follows (table 3):

Table 3: Wetland Hydro-geomorphic types and descriptions.

Hydro-geomorphic types	**Description**
Riparian habitat  	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.
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.

Hydro-geomorphic types	**Description**
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.
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.
Depressional pans 	Small (deflationary) depressions which are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are “leaky” in the sense that they are hydrologically connected to adjacent valley bottoms through subsurface diffuse flow paths.

Hydro-geomorphic types	**Description**
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).
Flat Wetland 	In areas with weakly developed drainage patterns and flat topography, rainfall may not drain off the landscape very quickly, if at all, due to the low relief. In such areas (commonly characterized by aeolian deposits or recent sea floor exposures) the wet season water table may rise close to, or above, the soil surface, creating extensive areas of shallow inundation or saturated soils. In these circumstances the seasonal or permanently high groundwater table creates the conditions for wetland formation.

The possibility of difficult wetland area exists on study areas and is summarised below including what approach to be taken in the case of a difficult wetland area (Table 4).

Table 4: List of types of sites that are difficult to delineate (Jobs, 2009).

Type of “difficult site”	**Approach**
Some or all, wetland indicators are present but is a non-natural wetland (e.g some dams, road islands)	• Decide on the relative permanence of the change and whether the area can now be said to be functioning as a wetland. • Time field observations during the wet season, when natural hydrology is at its peak, to help to differentiate between naturally-occurring versus human-induced wetland. • Decide appropriate policy/management i.e. can certain land uses be allowed due to “low” wetland functional

	value, or does the wetland perform key functions despite being artificial.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. wetland has been drained)	• Look for evidence of ditches, canals, dikes, berms, or subsurface drainage tiles. • Decide whether or not the area is currently functioning as a wetland.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. relic / historical wetland)	• Decide whether indicators were formed in the distant past when conditions were wetter than the area today. • Obtain the assistance of an experienced soil scientist.
Some, or all, wetland indicators are absent at certain times of year (e.g. annual vegetation or seasonal saturation)	• Thoroughly document soil and landscape conditions, develop rationale for considering the area to be a wetland. • Recommend that the site be revisited in the wet season.
Some, or all, wetland indicators are absent due to human disturbance (e.g. vegetation has been cleared, wetland has been ploughed or filled)	• Thoroughly document landscape conditions and any remnant vegetation, soil, hydrology indicators, develop rationale for considering the area to be wetland. • Certain cases (illegal fill) may justify that the fill be removed and the wetland rehabilitated.

2.3 Buffer Zones

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 wetland. 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. A brief description of each of the functions and associated services is outlined in Table 5 below.

Table 5: Generic functions of buffer zones relevant to the study site (adapted from Macfarlane *et al*, 2010)

Primary Role	Buffer Functions
Maintaining basic aquatic processes, services and values.	• Groundwater recharge: Seasonal flooding into wetland areas allows infiltration to the water table and replenishment of groundwater. This groundwater will often discharge during the dry season providing the base flow for streams, rivers, and wetlands.
Reducing impacts from upstream activities and adjoining land uses	• Sediment removal: Surface roughness provided by vegetation, or litter, reduces the velocity of overland flow, enhancing settling of particles. Buffer zones can therefore act as effective sediment traps, removing sediment from runoff water from adjoining lands thus reducing the sediment load of surface waters. • Removal of toxics: Buffer zones can remove toxic pollutants, such hydrocarbons that would otherwise affect the quality of water resources and thus their suitability for aquatic biota and for human use. • Nutrient removal: Wetland vegetation and vegetation in terrestrial buffer zones may significantly reduce the amount of nutrients (N & P), entering a water body reducing the potential for excessive outbreaks of microalgae that can have an adverse effect on both freshwater and estuarine environments. • Removal of pathogens: By slowing water contaminated with faecal material, buffer zones encourage deposition of pathogens, which soon die when exposed to the elements.

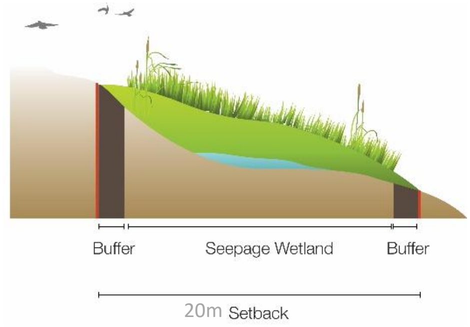
Despite limitations, buffer zones are well suited to perform functions such as sediment trapping, erosion control and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. These must however be considered in conjunction with other mitigation measures.

New buffer tools have been developed and been published as "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries. Consolidated Report" by the WRC (Macfarlane *et al* 2015). This new buffer tools aims to calculate the best suited buffer for each wetland or section of a wetland based on numerous on-site observations. The resulting buffer area 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. The minimum accepted buffer for low risk developments are however 15 meters from the edge of the wetland (Macfarlane, *et al* 2015) as opposed to the generic recommendation of 30 m for wetlands inside the urban edge and 50 m outside the urban edge (GDARD, 2012).

The current report suggests a buffer zone of 20 m.

Figure 14 images represent the buffer zone setback for the wetland types discussed in this report.

Seepage Wetlands



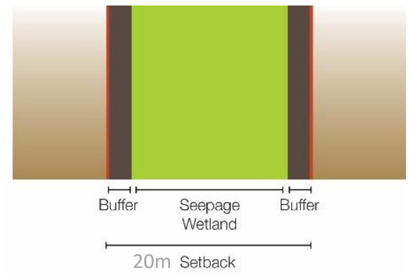


Figure 13: A represent the buffer zone setback for the wetland types discussed in this report

2.4 Wetland Functionality, Status and Sensitivity

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, 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*, 2007) and an Environmental Importance and Sensitivity category (EIS) (DWAF, 1999). The impacts observed for the affected wetlands on the study site are summarised for each wetland under section 3.2. These impacts are based on evidence observed during the field survey and land-use changes visible on aerial imagery.

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.

In the current study the wetland was assessed using, WET-Health (Macfarlane *et al*, 2007) and EIS (DWAF, 1999).

2.4.1 Present Ecological Status (PES) – WET-Health

The Present Ecological Score is based on the ability of the wetland to preform indirect benefits (Table 6).

Table 6: Indirect Benefits provided by wetland habitats (Macfarlane *et al*, 2007).

<table>
<tr><td rowspan="9">Regulating & supporting benefits</td><td colspan="2">Flood attenuation</td><td>The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream</td></tr>
<tr><td colspan="2">Streamflow regulation</td><td>Sustaining streamflow during low flow periods</td></tr>
<tr><td rowspan="6">Water Quality Enhancement</td><td>Sediment trapping</td><td>The trapping and retention in the wetland of sediment carried by runoff waters</td></tr>
<tr><td>Phosphate assimilation</td><td>Removal by the wetland of phosphates carried by runoff waters, thereby enhancing water quality</td></tr>
<tr><td>Nitrate assimilation</td><td>Removal by the wetland of nitrates carried by runoff waters, thereby enhancing water quality</td></tr>
<tr><td>Toxicant assimilation</td><td>Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters, thereby enhancing water quality</td></tr>
<tr><td>Erosion control</td><td>Controlling of erosion at the wetland site, principally through the protection provided by vegetation.</td></tr>
<tr><td colspan="2">Carbon storage</td><td>The trapping of carbon by the wetland, principally as soil organic matter</td></tr>
</table>

A summary of the three components of the WET-Health namely Hydrological; Geomorphological and Vegetation Health assessment for the wetlands found on site is described in Table 7. A Level 1 assessment was used in this report. Level 1 assessment is used in situations where limited time and/or resources are available.

Table 7: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

Description	Impact Score Range	PES Score	Summary
Unmodified, natural.	0.0.9	A	Very High
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.	1-1.9	B	High
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C	Moderate
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D	Moderate

Description	Impact Score Range	PES Score	Summary
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E	Low
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.10	F	Very Low

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 8.

Table 8: 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	(↓↓)

2.4.2 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 (Table 9).

Table 9: Direct human benefits associated with wetland habitats (Macfarlane *et al*, 2007).

Subsistence benefits	**Water for human use**	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
	Harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
	Cultivated foods	Areas in the wetland used for the cultivation of foods
Cultural benefits	**Cultural heritage**	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
	Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
	Education and research	Sites of value in the wetland for education or research

The Ecological Importance and Sensitivity of the seepage wetland is represented are described in the results section. Explanations of the scores are given in Table 10.

Table 10: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	**Rating**	**Recommended Ecological Management Class**
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	A
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	B

Ecological Importance and Sensitivity Categories	Rating	Recommended Ecological Management Class
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	C
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	D

2.4.3 Present Ecological Category (EC): Riparian

In the current study, the Ecological Category of the riparian areas was assessed using a level 3 VEGRAI (Riparian Vegetation Response Assessment Index) (Kleynhans et al, 2007). Table 11 below provides a description of each EC category.

Table 11: Generic ecological categories for EcoStatus components (modified from Kleynhans, 1996 & Kleynhans, 1999)

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

2.4.4 Quick Habitat Integrity Model

To accommodate a less-detailed process, a desktop habitat integrity assessment (using the Quick Habitat Integrity model) that allows for a coarse assessment was developed. This assessment rates the habitat according to a scale of 0 (close to natural) to 5 (critically modified) according to the following metrics (Seaman *et al*, 2010):

- Bed modification.
- Flow modification.
- Introduced Instream biota.
- Inundation.
- Riparian / bank condition.
- Water quality modification.

3 RESULTS

3.1 Wetland Classification and Delineation

One wetland was recorded on the study site and is classified as a seepage wetland. It is unknown if the wetland is a natural wetland or an artificial wetland. 1977 Historical aerial imagery was consulted and it was determined that a depression wetland existed where the current dam is located (Figure 16). The current wetland is however significantly larger than what was in 1977. The reason for the increased wetness signatures recorded on the study site is unknown although it could be caused by seepage from several ash dams and other dams likely to seep some water into the surrounding soil profile or from drains adjacent to the study area. The wetland is also located on shallow bedrock.

From the seepage wetland a drain was found that drains into the dam/pond south of the seepage wetland. This dam is currently used for aesthetic purposes and is stocked with many avifaunal species although mainly exotic. It is likely that the dam/pond was originally the original depression wetland observed in historical aerial imagery. Some potential water input areas were recorded.

Proposed pylons that fall within the wetland area are KuVu 2 and KuVu3. Proposed pylon KuVu1 falls within the buffer zone of the wetland. Existing pylons Exist 4 and Exist 5 fall within the buffer zone of the wetland.

Wetlands are classified up to level 6 according to the SANBI guidelines (Ollis *et al,* 2013) and summarised in the tables below (Table 12-14):

Table 12: Level 1- 4 classification of the wetland recorded on the study site (adapted from Ollis *et al*, 2013).

Level 1: System Type	Level 2: Regional Setting	Level 3: Landscape Setting	Level 4: HGM Unit		
System	**DWA Ecoregion**	**Landscape Unit**	**Level 4A:Wetland Type**	**Level 4B: Longtitudinal zonation**	**Level 4C: Inflow drainage**
Inland	Highveld	Slope	Seepage	With channelled outflow	n/a

Table 13: Level 5 classification of the wetlands recorded on the study site (adapted from Ollis *et al*, 2013).

Level5: Hydroperiod and depth of inundation	
Level 5A	**Proportional Rating (0-6) for wetlands on site**
Inundation Peroid	
	Seepage Wetland
Permanently Inandated	2
Seasonally Inandated	5

Level5: Hydroperiod and depth of inundation	
Intermittently Inandated	2
Never/Rarely Inandated	1
Unknown	-
Level 5A	**Proportional Rating (0-6) for wetlands on site**
Saturartion periodicity (within 50 cm of the soil surface)	
Permanently Inandated	2
Seasonally Inandated	4
Intermittently Inandated	4
Never/Rarely Inandated	1
Unknown	-
Level 5C: Inundation depth-class	
	n/a

Table 14: Level 6 classification of the wetland recorded on the study site (adapted from Ollis *et al*, 2013).

Component	Dominant categories for selected descriptorss (Level 6)							
	Natural vs Artificial		Substratum Type	Vegetation Cover, Form and Status				
						Detailed Vagetation From		
	6A: NAtural vs Artificial	6B: Artificial Categories	6A: Primary Categories	6A: Vegetation Cover	6B: Primary Vegetation Cover	6C: Herbaceous Vegetation	6D: Forest Vegetation	6E: Vegetation Status
River	Natural	Possible Artificial	Clay/Bedrock	Vegetated	Herbaceous	Rushes	n/a	Exotic

3.1.1 Soil and Vegetation Indicators

Soil

The vegetation of the seepage wetland was characterised by low species richness with only a few wetland species. The dominant plant species recorded in the wetland included *Typha capensis, Persicaria lapathofofia, Juncus rigidus, Phragmites australis* as well as a high number of exotic species (Figure 17). The area is grazed by wildlife and has become overgrazed in some areas. The soil of the wetland was characterised by red soil with distinct red mottling as well as the presence of shallow bedrock (Figure 18).

Table 15: Summary of the wetland soil conditions on site (Adapted from Job, 2010).

Site Conditions:	
Do normal circumstances exist on the site?	No
Is the site significantly disturbed (difficult site)?	No
Indicators of soil wetness within 50 cm of soil surface:	
Sulfidic odour (a slight sulfidic odour was noted in permanent zone)	No
Mineral and Texture	Red Clay
Gley	No
Mottles or concretions	Yes
Organic streaking or oxidised rhizopheres	Yes
High organic content in surface layer	No
Setting (In bold):	
crest (1) **scarp (2)** midslope (3) footslope (4) valley bottom (5)	
Additional indicators of wetland presence:	
Concave	No
Bedrock	Yes
Dense clay	Yes
Flat	No
Associated with a river	No

Figure 14: 1977 historical imagery indicating a depression wetland located on the study site. The position of the wetland is shown by the yellow dashed line

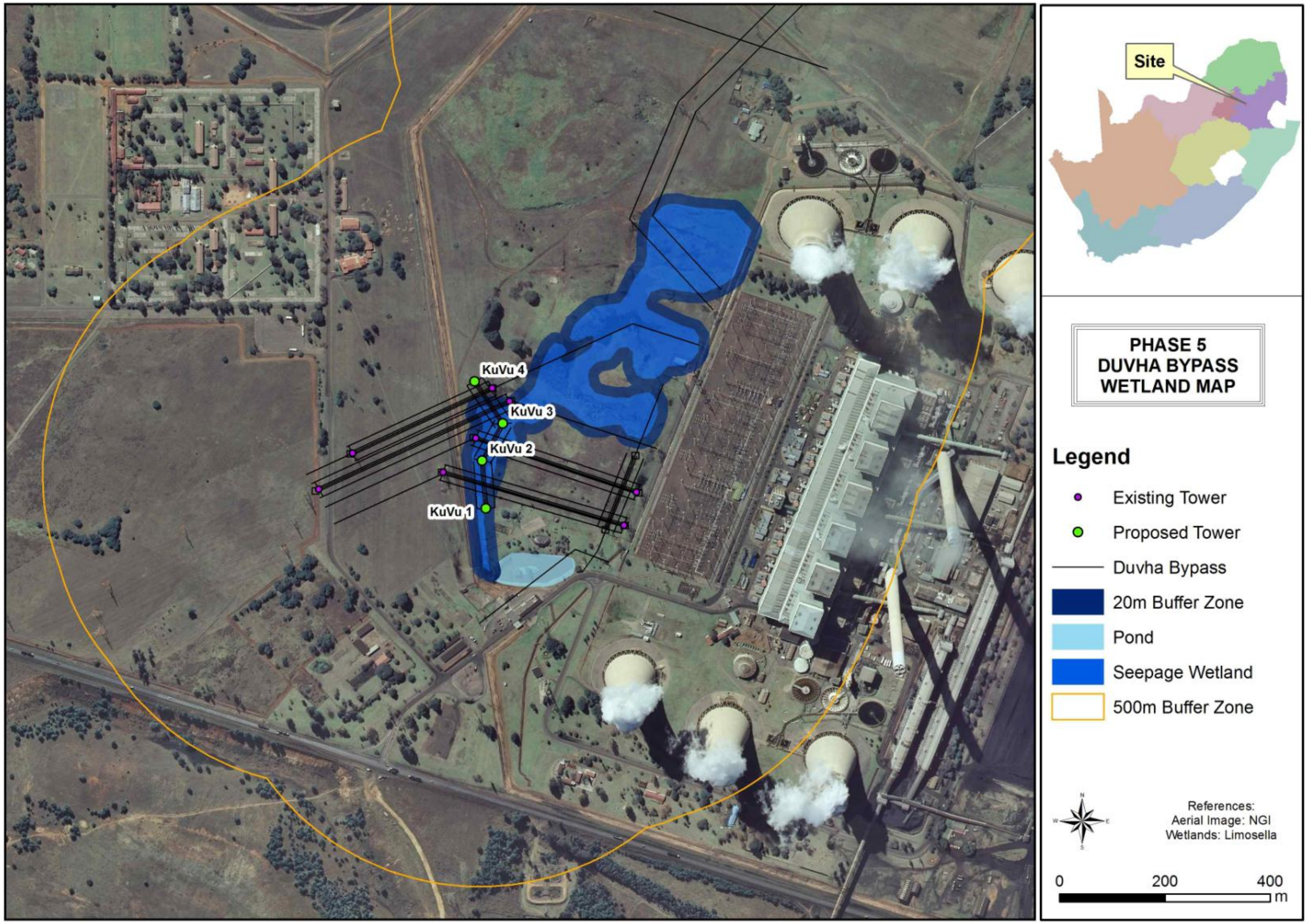


Figure 15: Wetland/Riparian areas associated with the proposed powerlines and associated infrastructure.

Figure 16: Indicating the Pond/dam located on the study area including the drainage channel leading to the pond.


UTC: 2016.05.24T08:38:16
Lat, Lon: -25,959089, 29,333526
Alt: 1615m MSL WGS84
CEP. 3m
0°
-1,1°
-5°
-15°
-1,3°
0°
+15°
NE
E
SE

Figure 17: Indicating the Seepage wetland located on the study site.

Figure 18: Soil characteristics of the seepage wetland as well as the shallow bedrock.

3.2 Wetland Functional Assessment

3.2.1 Present Ecological State

The combined PES scores for the wetlands on the study site is an **E – Largely modified.** The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable (Tables 16):

Table 16: Summary of hydrology, geomorphology and vegetation health assessment for the wetlands affected by the proposed dams (Macfarlane *et al*, 2009).

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation		Overall Health Score	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Seepage Wetland	7.5	7.3	0	5.9	0	6.1	0	6.5	0
PES Category and Projected Trajectory		E	→	D	→	E	→	E	→

The EIS score for the seepage wetland is **1.2** and falls into the **Moderate** ecological importance and sensitivity category. Wetlands in this category 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 (DWAF, 1999) (Table 17). **The Recommended Ecological Management Class for these wetlands is thus a C.** Details for the components assessed in the combined EIS score are presented in Appendix C.

Table 17: Combined EIS scores obtained for the wetland system on the study site (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	1.6	3.0
Hydro-functional importance	1.1	2.5
Direct human benefits	0.8	3.0
Overall EIS score	**1.2**	

3.3 Impacts and Mitigation

A development has several impacts on the surrounding environment and particularly on a river. The development changes habitats, the ecological environment, infiltration rates, amount of runoff and runoff intensity of stormwater, and therefore the hydrological regime of the area. A range of management measures are available to address threats posed to water resources (Table 18). In the context of the proposed powerlines, the mitigation measures proposed below are intended to prevent further degradation to the riparian areas as a result of the construction of the powerline. It is important to note that this section aims to highlight areas of concern. The details of the mitigation measures that are finally put in place should ideally be based on these issues, but must necessarily take into consideration the physical and economical feasibility of mitigation. It is important that any mitigation be implemented in the context of an Environmental Management Plan to in order to ensure accountability and ultimately the success of the mitigation.

3.3.1 Significance Ranking Matrix

The significance of potential impacts is presented in Table 18 & Table 19 & Table 20. Significance is calculated as Consequence (Magnitude+ Duration+ Extent) X Probability wherein the following meaning applies:

- The Magnitude of the impact is quantified as either:
  - Low: Will cause a low impact on the environment;
  - Moderate: Will result in the process continuing but in a controllable manner;
  - High: Will alter processes to the extent that they temporarily cease; and
  - Very High: Will result in complete destruction and permanent cessation of processes.

- The Probability: which shall describe the likelihood of impact occurring and will be rated as follows:
  - Extremely remote: Which indicates that the impact will probably not happen;
  - Unusual but Possible: Distinct possibility of occurrence;
  - Can Occur: there is a possibility of occurrence;
  - Almost Certain: Most likely to occur; and
  - Certain/ Inevitable: Impact will occur despite any preventative measures put in place.

- The duration (Exposure) which indicates whether:
  - The impact will be of a immediate;
  - The impact will be of a short tem (Between 0-5 years);
  - The impact will be of medium term (between 5-15 years);
  - The impact will be long term (15 and more years); and
  - The impact will be permanent.

Table 18: Significance Ranking matrix table

RANKING	MAGNITUDE	REVERSIBILITY	EXTENT	DURATION	PROBABILITY
5	Very high/ don't know	Irreversible	International	Permanent	Certain/inevitable
4	High		National	Long term (impact ceases after operational life of asset	Almost certain
3	Moderate	Reversibility with human intervention	Provincial	Medium term	Can occur

2	Low		Local	Short term	Unusual but possible
1	Minor	Completely reversible	Site bound	Immediate	Extremely remote
0	None		None		None

- Significance= Consequence (Magnitude+ Duration+ Extent) X Probability

Table 19: Significance of impact table.

SIGNIFICANCE OF IMPACT = CONSEQUENCE (Magnitude + Duration +Extent) X PROBABILITY			
RANKING	**60-100**	**30-60**	**0-30**
SIGNIFICANCE	**High**	**Moderate**	**Low**

Suggested mitigation/management measures are summarised in Table 20–23.

Table 20: Changes in sediment entering and exiting the system impact ratings

Nature: Changes in sediment entering and exiting the system.

Activity: Changing the amount of sediment entering the wetland. 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. Possible sources of the impacts include:

- Earthwork activities during road 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 species can spread easily into these eroded soil.
- Disturbance of soil surface
- Disturbance of slopes through creation of roads and tracks adjacent to the wetland

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Definite (5)	Highly probable (4)
Duration	Short-term (2)	Short-term (2)
Extent	Limited to Local Area (3)	Limited to Local Area (2)
Magnitude	Moderate (3)	Low (2)
Significance	**40 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Highly probable (3)	Improbable (2)
Duration	Permanent (5)	Permanent (4)
Extent	Limited to Local Area (2)	Limited to the Site (1)
Magnitude	Moderate (3)	Low (2)
Significance	**30 (moderate)**	**14 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High

Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area (DWAF, 2005).
- Rehabilitation plans must be submitted and approved for rehabilitation of damage during construction 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.
- Runoff from the construction area must be managed to avoid pollution.
- Implementation of best management practices
- Source-directed controls

Cumulative impacts: Expected to be low since the wetland is not hydrologically connected to a watercourse. Refer to the accompanying General Monitoring and Rehabilitation report.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 21: Introduction and spread of alien vegetation impact ratings.

Nature: Introduction and spread of alien vegetation.

Activity: 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 plants can impact on hydrology, by outcompeting natural vegetation and decreasing the natural biodiversity.

	Without mitigation	**With mitigation**
	CONSTRUCTION PHASE	
Probability	Definite (6)	Highly probable (4)
Duration	Medium-term (4)	Medium-term (2)
Extent	Limited to Local Area (4)	Limited to Local Area (4)
Magnitude	High (8)	Moderate (4)
Significance	**64 (high)**	**40 (moderate)**
Status (positive or negative)	Negative	Negative
	OPERATIONAL PHASE	
Probability	Highly probable (2)	Improbable (1)
Duration	Permanent (4)	Permanent (3)
Extent	Limited to Local Area (2)	Limited to the Site (1)
Magnitude	High (8)	Low (4)
Significance	**28 (low)**	**8 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation: • Weed control • 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. • 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. • Rehabilitate or revegetate disturbed areas
Cumulative impacts: Expected to be moderate to low. Regular monitoring should be implemented during construction, rehabilitation including for a period after rehabilitation is completed. Refer to the accompanying General Rehabilitation and Monitoring Report
Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 22: Loss and disturbance of wetland habitat impact ratings.

Nature: Loss and disturbance of wetland habitat		
Activity: Direct development within wetland area as well as changes in management and fire regime.		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Definite (6)	Highly probable (4)
Duration	Medium-term (2)	Medium-term (1)
Extent	Limited to Local Area (4)	Limited to Local Area (4)
Magnitude	High (6)	Moderate (4)
Significance	**72 (high)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Highly probable (2)	Improbable (1)
Duration	Permanent (4)	Permanent (3)
Extent	Limited to Local Area (2)	Limited to the Site (1)
Magnitude	High (6)	Low (4)
Significance	**24 (low)**	**8 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation: • Effective rehabilitation should be done (refer to the accompanying General Rehabilitation and Monitoring report) • Other than approved and authorized structure, no other development or maintenance infrastructure is allowed within the delineated watercourse or associated buffer zones. • 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 • Operational activities should not impact on rehabilitated or naturally vegetated areas
Cumulative impacts: Expected to be moderate and can be effectively rehabilitated
Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

4 CONCLUSION

One wetland and one dam were recorded on the study area. The wetland area was classified as a seepage wetland.

A summary of the conditions are described in the table below:

	Watercourse Type	Quaternary Catchment and WMA area	Linked to an important River System	Coordinates and Relation to study area	Present Ecological Score (PES)	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Management Class	Buffers
	Seepage Wetland	B11G–Olifants WMA	Witbank dam nearby	25°57'29.93"S and 29°20'6.84"E	E	1.2	C	20 m
Does the specialist support the development?	Yes. Although some wetland habitat will be lost, this should be a temporary condition which is quite easily rehabilitated. It is likely that the wetland is largely sustained by artificial water input which may currently be utilized by fauna species, particularly birds. Should monitoring show that loss of wetland habitat has an adverse effect on birds, the existing dam can be modified to accommodate for the habitat loss resulting from the proposed activities.							
Major concerns	Loss of wetland habitat currently utilized by birds. The impact of the powerlines on birds should be assessed by an avifauna specialist.							
Recommendations	Where possible pylons currently located in wetland area should be moved to minimise any potential impacts to the wetlands. If this is not possible, the existing dam can be modified to accommodate for the habitat loss resulting from the proposed activities.							

Broad potential impacts that may be associated with the proposed development include:

- Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount)
- Changing the physical structure within a water resource (habitat) including its associated buffer zone

The current assessment finds that a 20m buffer zone should be recognised from the edge of the seepage wetland recorded on the site. However, linear developments such as the proposed powerlines, are rarely able to avoid crossing any watercourses whatsoever. Where construction of access roads and the construction activities within the 1:100 year floodline or the wetland/riparian area (whichever is the greatest), as well as within wetlands and associated buffers is unavoidable and a Water Use License granted, the buffer areas should still be respected as an area where impacts must be kept to an absolute minimal. The buffer areas should be clearly marked during construction and workers must be informed that activities and traffic beyond the buffer zone must be limited to only that which is necessary. In addition, it is important to note that construction within 500m of a wetland area can also only take place as authorised by DWS.

The impacts and mitigation briefly discussed are refined in the rehabilitation plan accompanying the current document. Where alternatives have been investigated and wetland crossings have been shown to be necessary it is important that appropriate mitigation measures are put into place and carefully monitored to ensure minimal impact to regional hydrology. In the case of the proposed powerlines, mitigation should focus on the following principles:

- Rehabilitation / restoration of indigenous vegetative cover;
- Management of point discharges during construction activities;
- Alien plant control;
- Implementation of best management practices regarding stormwater and earthworks;
- Provision of adequate sanitation facilities located outside of the wetland/riparian area or its associated buffer zone during construction activities;
- Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation; and

The impact assessment found that the greatest impact that the construction of powerline infrastructure is likely to have on the assessed wetland is the removal of vegetation and compaction of soil around the pylon footprint as well as along the servitude. If not remediated, these impacts can result in loss of habitat currently utilized by bird species. Therefore, the successful re-establishment of vegetation is imperative in order to limit impacts on the biodiversity element of the area. Mitigation measures as set out in this report should be strictly adhered to as well as the accompanying general rehabilitation and monitoring plan.

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APPENDIX A: GLOSSARY OF TERMS

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
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)
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)
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).
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

APPENDIX B: Abbreviated CVs of participating specialists

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
ID Number	7604250013088
Name of Firm:	Limosella Consulting
Position:	Director - Principal Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology
Nationality:	South African
Marital Status:	Married
Languages:	Afrikaans (mother tongue), English, basic French

EDUCATIONAL QUALIFICATIONS

- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- Short course in wetland soils, Terrasoil Science (2009)
- MSc Ecology, University of South Africa (2010 - ongoing). Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management

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- 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
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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 250 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape. 2007, ongoing.
- 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

Name:	**RUDI BEZUIDENHOUDT**
ID Number	880831 5038 081

Name of Firm:	Limosella Consulting
Position:	Wetland Specialist
SACNASP Status:	Cert. Nat. Sci (Reg. No. 500024/13)
Nationality:	South African
Marital Status:	Single
Languages:	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 – Ongoing)
- 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)
- Tropical Coastal Ecosystems, edX (2015 – ongoing)

KEY EXPERIENCE

- **<u>Wetland Specialist</u>**

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.

Large Eskom projects include:

- Eskom 88kV Rigi – Sonland
- Eskom 88kV Simmerpan Line
- Eskom 88kV Meteor Line
- Eskom 88kV Kookfontein – Jaguar
- Eskom 132kV Dipomong
- Eskom 132kV Everest – Merapi
- Eskom 132kV Vulcan – Enkangala
- Eskom 400kV Helios – Aggenys
- Eskom 400kV Hendrina – Gumeni
- Eskom 765kV Aries – Helios
- Eskom 765kV Aries – Kronos
- Eskom 765kV Kronos – Perseus
- Eskom 765kV Perseus – Gamma
- Eskom 765kV Helios – Juno
- Eskom 765kV Aries- Helios

- **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.

- **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 Controlling 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.

EMPLOYMENT 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:

- GIS Spatial layering
- Wetland and Riparian delineation studies, opinions and functional assessments including data collection and analysis
- 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 (Cert. Nat. Sci. Reg. No. 500024/13)

Appendix C: Functional Assessment Data

Table 23: Ecological Importance and Sensitivity Calculations of the seepage wetland

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	Confidence (1-5)	Motivation	Scoring Guideline
Biodiversity support		3.00		
Presence of Red Data species	0	3.00	Unlikely due to regular disturbance	Endangered or rare Red Data species presence
Populations of unique species	0	3.00	Unlikely due to regular disturbance	Uncommonly large populations of wetland species
Migration/breeding/feeding sites	1	3.00	Unlikely due to regular disturbance	Importance of the unit for migration, breeding site and/or a feeding.
Landscape scale		3.00		
Protection status of the wetland	2	3.00	All wetlands are protected under the NWA	National (4), Provincial, private (3), municipal (1 or 2), public area (0-1)
Protection status of the vegetation type	3	3.00	Untransformed vegetation is protected and the wetland area is relatively undisturbed	SANBI guidance on the protection status of the surrounding vegetation
Regional context of the ecological integrity	1	3.00	Majority of wetland in this region is disturbed	Assessment of the PES (habitat integrity), especially in light of regional utilisation
Size and rareity of the wetland type/s present	1	3.00	Small wetland system	Identification and rareity assessment of the wetland types
Diversity of habitat types	1	3.00	Located in a disturbed area	Assessment of the variety of wetland types present within a site.

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	Confidence (1-5)	Motivation	Scoring Guideline
Sensitivity of the wetland		2.33		
Sensitivity to changes in floods	1	2.00	Seepage Wetland	floodplains at 4; valley bottoms 2 or 3; pans and seeps 0 or 1.
Sensitivity to changes in low flows/dry season	1	3.00	Seepage Wetland	Unchannelled VB's probably most sensitive
Sensitivity to changes in water quality	1	2.00	Seepage Wetland	Esp naturally low nutrient waters - lower nutients likely to be more sensitive
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.6	2.8		

Table 24: Hydrological Functional Importance Calculations of the seepage wetland

HYDRO-FUNCTIONAL IMPORTANCE			Score (0-4)	Confidence (1-5)	Motivation	Scoring Guideline
Regulating & supporting benefits		Flood attenuation	2		Headwaters of the wetland thus only contributes small scale	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
		Streamflow regulation	2			Sustaining streamflow during low flow periods
	Water Quality Enhancement	Sediment trapping	1			The trapping and retention in the wetland of sediment carried by runoff waters
		Phosphate assimilation	1		Small wetland system without robust vegetation	Removal by the wetland of phosphates carried by runoff waters, thereby enhancing water quality
		Nitrate assimilation	1			Removal by the wetland of nitrates carried by runoff waters, thereby enhancing water quality
		Toxicant assimilation	1			Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters, thereby enhancing water quality
		Erosion control	1		Vegetation cover islow	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
		Carbon storage	0		Unlikely	The trapping of carbon by the wetland, principally as soil organic matter
HYDRO-FUNCTIONAL IMPORTANCE			**1.1**			

Table 25: Direct Human Benefits Calculations of the seepage wetland

DIRECT HUMAN BENEFITS		Score (0-4)	Confidence (1-5)	Motivation	Scoring Guideline
Subsistence benefits	Water for human use	0	3	Power station thus not accessible	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
	Harvestable resources	0	3	Power station thus not accessible	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
	Cultivated foods	0	3	Power station thus not accessible	Areas in the wetland used for the cultivation of foods
Cultural benefits	Cultural heritage	0	3	Power station thus not accessible	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
	Tourism and recreation	3	3	Recreation area	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
	Education and research	2	3	None known but possible	Sites of value in the wetland for education or research
DIRECT HUMAN BENEFITS		**0.8**	**3**		