Refurbishment of Existing Primary Sedimentation Tanks and Associated Infrastructure at Bushkoppies Waste Water Treatment Works, Johannesburg South, Gauteng Province

Wetland/Riparian Delineation and Functional Assessment Report

August 2019

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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.

______________________	2019.08.06
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EXECUTIVE SUMMARY

Johannesburg Water SOC Limited (JW) intends for refurbishment to be undertaken at the existing Bushkoppie Waste Water Treatment Works, Gauteng Province. The proposed expansion will entail construction of two new 35m diameter Primary Sedimentation Tanks (PSTs) including:

- Installation of half bridges on all PSTs
- Demolishing and re-routing the existing access road
- Construction of a new flow division box
- Construction of a new Primary Sludge Pump Station
- Construction of new terrace including retaining walls
- Construction of grit drying beds (GDB): ~30m x 120m
- Construction of new wash water pump station (WWPS)

Limosella Consulting was appointed by Zitholele Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization for the proposed new Primary Sedimentation Tanks which will trigger listed activities in terms of the Environmental Impact Assessment Regulations and Department of Water and Sanitation authorisation. A site visit was conducted on the 31st of July 2019 with additional information obtained from previous studies in the area.

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 functional and integrity assessment of wetlands areas within the area assessed as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations (as amended),
- Recommend suitable buffer zones, both generic (as required in GDARD, 2014) and scientific as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015 ; and
- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site.

No wetlands were recorded within the proposed PSTs site. However, two wetland systems were recorded on the larger study area, within the 500m DWS regulated area outside the WWTW site. The southernmost wetland (Klip River) is classified as a Floodplain wetland and the wetland in the central and northern section is classified as an unchannelled valley bottom wetland which drains into the Klip River. This wetland has numerous impoundments, within and adjacent to, the wetlands. It is likely that these impoundments are hydrologically connected to the wetlands and thus has some impacts on the systems. These impoundments are artificial as confirmed by the absence of any impoundments on early historical imagery of 1951 of the area. These historical imageries further indicated the prolonged agricultural impacts on the watercourses. The proposed PSTs site and associated infrastructures are however well buffered from the wetlands and the wetlands only encroaches into the 500 m buffer zone south of the proposed PSTs.

The important factors relevant to the project are summarised in the Table below:

	Quaternary Catchment and WMA areas		**Important Rivers possibly affected**	
	C22A – 5th WMA Vaal		Tributary of the Klip River	
Integrity and functional assessment of the wetland within 500m of the proposed refurbishment	Present Ecological Status (PES): 6.6 (**E – Low)**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The status of this wetlands is likely to remain stable over the next 5 years.			
	Ecological Importance and Sensitivity (EIS): 2.0 (**C - Moderate**). 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			
	Recommended Ecological Category (REC): **D**			
	WetEcoServices: Water supply for human use - 2.5 Toxicant removal - 2.6 Nitrate removal - 2.9			
Buffer zones	Generic (GDARD, 2014; CoJ, 2010): **30m**			
	Calculated (Macfarlane *et al*, 2015): **28m**			
NEMA 2014 Impact Assessment	The impact scores for the following aspects are relevant:		Without Mitigation	With Mitigation
	Changes to flow dynamics	Construction Phase	M	L
		Operation Phase	M	L
	Sedimentation	Construction Phase	M	L
		Operation Phase	M	L
	Establishment of alien plants	Construction Phase	M	L
		Operation Phase	M	L
	Pollution of watercourses	Construction Phase	M	L
		Operation Phase	M	L
	Loss of fringe vegetation and habitat	Construction Phase	M	L
		Operation Phase	M	L
DWS (2016) Risk Assessment	The risk scores fall in the **Low** category. Authorisation may proceed through a General Authorisation			
Does the specialist support the development?	Yes, however, care should be taken to prevent any sedimentation input into the watercourses and alien plant control should be effective.			

CBA and other important areas	The study site is located on an: • Protected Area – Olifantsvlei Nature Reserve • ESA • Important Area

Table of Contents

Figures

Tables

1 INTRODUCTION

Johannesburg Water SOC Limited (JW) intends for refurbishment to be undertaken at the existing Bushkoppie Waste Water Treatment Works, Gauteng Province. The proposed expansion will entail construction of two new 35m diameter Primary Sedimentation Tanks (PSTs) including:

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Figure 1 presents the proposed layout of the refurbishment activities which are focused around the existing infrastructure. Limosella Consulting was appointed by Zitholele Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization for the proposed new Primary Sedimentation Tanks which will trigger listed activities in terms of the Environmental Impact Assessment Regulations and Department of Water and Sanitation authorization. A site visit was conducted on the 31st of July 2019 with additional information obtained from previous studies in the area.

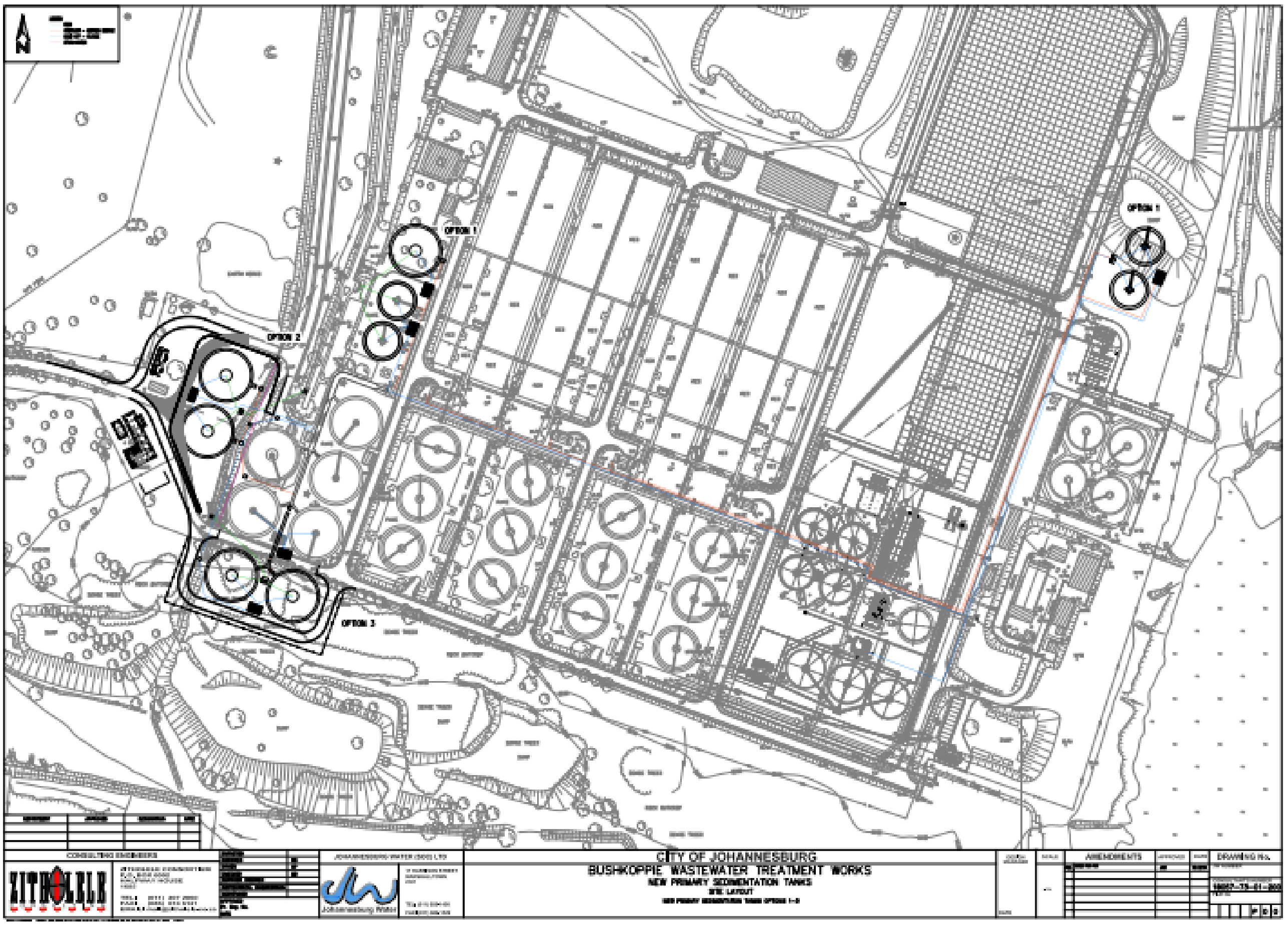

Figure 1: The proposed layout of the refurbishment activities at the Bushkoppies WWTW

1.1 Terms of Reference

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

- Delineate the wetland and riparian areas;
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- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site.

1.2 Assumptions and Limitations

- Although the field assessment for this study was conducted in winter, our team has worked extensively along this watercourse for previous projects and the current assessment of watercourses draws from data collected in the rainy season. We are therefore confident that our scores do not underestimate the biodiversity value of the watercourses.
- The information provided by the client forms the basis of the planning and layouts discussed.
- All wetlands within 500 m of any developmental activities should be identified as per the DWS regulations. In order to meet the timeframes and budget constraints for the project, wetlands within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fall outside of the site, but that fall within 500 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- The detailed field study was conducted from a once off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of the current assessment
- Floodline calculations fall outside the scope of the current assessment.
- A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- 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.
- The calculation of buffer zones does not take into account climate change or future changes to watercourses resulting from increasing catchment transformation.

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 and Sanitation (DWS). The NWA sets out a range of water use related principles that are to be applied by DWS 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 times performs 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 DWS are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a watercourse:

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 Notice 509 of 2016 regarding Section 21(c) and (i). This notice grants General Authorisation (GA) for the above water uses on certain conditions. This regulation also stipulates that 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, unless the impacts score as low in the requires risk assessment matrix (DWS, 2016) Such an activity requires a Water Use Licence (WUL) from the relevant authority.

Conditions for impeding or diverting the flow of water or altering the bed, banks, course or characteristics of a watercourse (Section 21(c) and (i) activities) include:

9. (3) (b). The water user must ensure that the selection of a site for establishing any impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse works:

(i) is not located on a bend in the watercourse;

(ii) avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps;.

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).
- GN 267 (Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals)

Any activity that is not related to the rehabilitation of a wetland and which takes place within 500m of a wetland are excluded from a GA under either of these regulations, unless the impacts score as low in the requires assessment matrix. Wetlands situated within 500m 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).
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- 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 Bushkoppies Waste Water Treatment Works (WWTW) is located south of Eldorado Park in Johannesburg South, Gauteng Province in the Oliefantsvlei Nature Reserve (Figure 2). The proposed new Primary Sedimentation Tanks (PSTs) are located within the study site adjacent to current infrastructure. The study area is border in the east by the national road, the N1, and in the north by the N12. The approximate central coordinates of the PSTs are 26°18'41.38"S and 27°55'51.18"E.

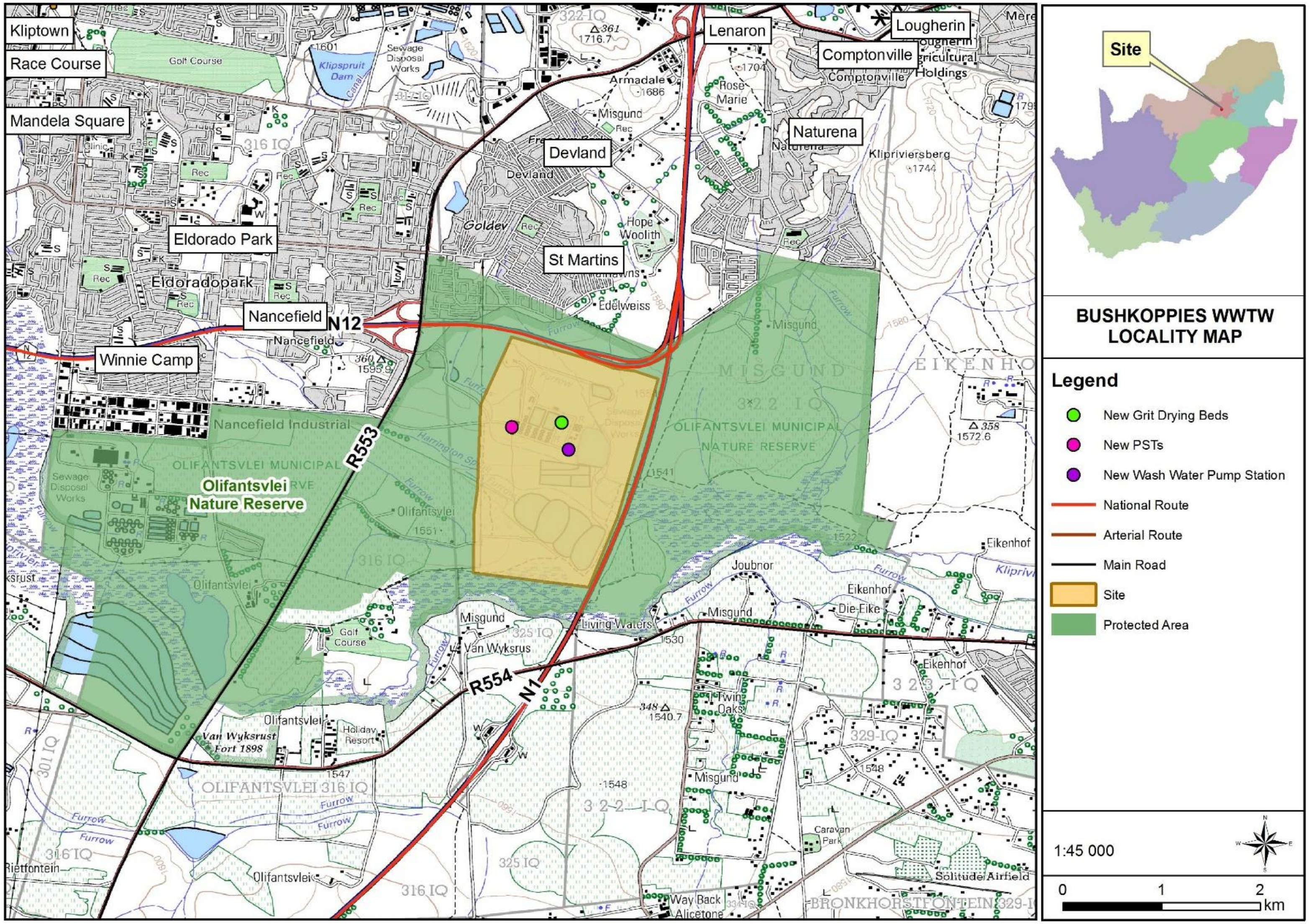


Figure 2: Locality Map

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.

Quaternary Catchments and Water Management Area (WMA):

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 C22A. 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.

Quaternary Catchment C22A is located in the fifth water management area (WMA), the Vaal Major WMA (Government Gazette, 16 September 2016). In this WMA the Major rivers include the Wilge -, Liebenbergsvlei -, Mooi -, Renoster -, Vals -, Sand -, Vet -, Harts -, Molopo and Vaal River. The watercourses on the study area drains south into the Klip River which feeds the Vaal River. The Vaal River is the largest tributary of the Orange River. Water is drawn from the Vaal to meet the industrial needs of the Greater Johannesburg Metropolitan Area and a large part of the Free State. As a part of the Vaal-Hartz Scheme it is a major source of water for irrigation. Water drawn from the Vaal supports 12 million consumers in Gauteng and surrounding areas (http://soer.deat.gov.za).

Large quantities of groundwater were located in the dolomitic rocks that underlie the Klip River wetland (Draper, 1898, Rand Water, 2004). The Klip River has been the subject of many years of research since the peat deposits sustained by this river constitute a valuable resource, as carbon sink, but maybe better known for its ability to mitigate the pollution effects of more than a century of gold mining in its catchment. The following extract is taken from the Water Wheel February 2008 (http://www.wrc.org.za):

"The wetland receives water that has been contaminated by acid mine drainage, industrial sources and runoff from urban sources. Water from sewage treatment plants, which contain residual phosphates and nitrates also find their way into the wetland. "Polluted water arising from these sources has left clear symptoms in the chemistry of the wetland peat," explains Prof McCarthy. "Accumulated concentrations of metals such as copper, mercury, lead, nickel, zinc, as well as uranium, nitrogen and phosphate have been found in the wetland material. The purified water flowing out of the wetland eventually enters the Vaal River, one of the country's largest rivers and a premier source of water. "For this reason the Klip River wetland is possibly one of the most economically important wetlands in the country".

Hydrology:

Surface water spatial layers such as the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa (SANBI, 2010) were consulted for the presence of wetlands, perennial and non-perennial rivers on or in proximity to the site. Based on these spatial layers the proposed study site crosses numerous watercourses, including the Klip River (Figure 3). The wetland vegetation associated with the study area includes; Dry Highveld Grassland Group 5, Mesic Highveld Grassland Group 2 & 3.

Regional Vegetation:

According to the Vegetation Map of South Africa, Lesotho and Swaziland *sensu* Mucina & Rutherfords (2006), the study site is located on three vegetation types namely; Tsakane Clay Grassland, Eastern Temperate Freshwater Wetlands and Carletonville Dolomite Grassland (Figure 4 & Table 1) sensu Mucina and Rutherford (2006).

Table 1: Conservation status of the Vegetation Types (Mucina & Rutherford, 2006)

Name of Vegetation type	Tsakane Clay Grassland	Eastern Temperate Freshwater Wetlands	Carletonville Dolomite Grassland
Code as used in the Book - contains space	Gm 9	AZf 3	Gh 15
Conservation Target (percent of area)	24%	24%	24%.
Description of conservation status	Endangered	N/A	Vulnerable.
Name of the biome	Grassland Biome	Inland azonal vegetation	Grassland Biome
Threats and uses	More than 60% transformed by cultivation, urbanisation, mining, dam-building and roads	Some 15% has been transformed to cultivated land, urban areas or plantations.	Almost a quarter already transformed for cultivation, by urban sprawl or by mining activity as well as the building of the Boskop and Klerkskraal Dams.

Geology and soils:

The study site is located on numerous geological areas namely Black Reef, Malmani, Quaternary, and Klipriviersberg (Figure 5). The soil type found throughout the study site are summarised in Table 2 and Figure 6.

Table 2: Soil types associated with the proposed study site and surroundings.

Soil Type (ARC, 2013)	Description	Relevance to wetlands (Fey, 2005)
dHu26	SOIL SERIES CLASS Deep (1200+mm), red apedal sandy loam/sandy clay loam, mesotrophic	None
dRg20	SOIL SERIES CLASS Deep (1200+mm), black swelling hydromorphic clay, calcareous	None
Hu3/R	SOIL ROCK COMPLEX Red apedal sandy loam/sandy clay loam, mesotrophic with rock outcrops	None
Ms/R	SOIL ROCK COMPLEX Brownish/grey structureless loamy sand on sandstone/quartzite with outcrops	None
sHu26	SOIL SERIES CLASS Shallow (300-600mm), red apedal sandy loam/sandy clay loam, mesotrophic	None
U	Other Urban Areas	None
xHu26	SOIL SERIES CLASS Red apedal sandy loam/sandy clay loam of variable depth (300-1200mm), mesotrophic	None

Critical Biodiversity areas and Biodiversity Sector 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 biodiversity map indicates where Critical Biodiversity Areas (CBA's) occur. CBA's are Terrestrial (T) and Aquatic (A) features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). The CBA's are ranked as follows:

- CBA 1 (including PA's, T1 and A1) which are natural landscapes with no disturbances and which is irreplaceable in terms of reaching conservation targets within the district
- CBA2 (including T2 and A2) which are near natural landscapes with limited disturbances which has intermediate irreplaceability with regards to reaching conservation targets
- In addition, Ecological Support Areas (ESA's) that support key biodiversity resources (e.g. water) or ecological processes (e.g. movement corridors) in the landscape are also mapped. ESA's are functional landscapes that are moderately disturbed but maintain basic functionality and connect CBA's.

The spatial priorities are accompanied by a set of land-use guidelines with the purpose promoting the effective management of biodiversity as required in Section 41(a) of the Biodiversity Act (Act 10 of 2004, as amended) and in terms of the National Environmental Management Act (Act 107 of 1998, as amended). The guidelines provide advice on which land-uses and activities are most compatible with maintaining the ecological integrity of CBAs and ESAs, and other parts of the landscape, based on the desired management objectives for the land and the anticipated impact of each land-use activity on biodiversity patterns and ecological processes (MPSP, 2015).

Based on the described methods the study site is located on a section classified as (Figure 7):

- ESA.
- Important Area.
- Entire site located on a Protected area known as the Olifantsvlei Nature Reserve.

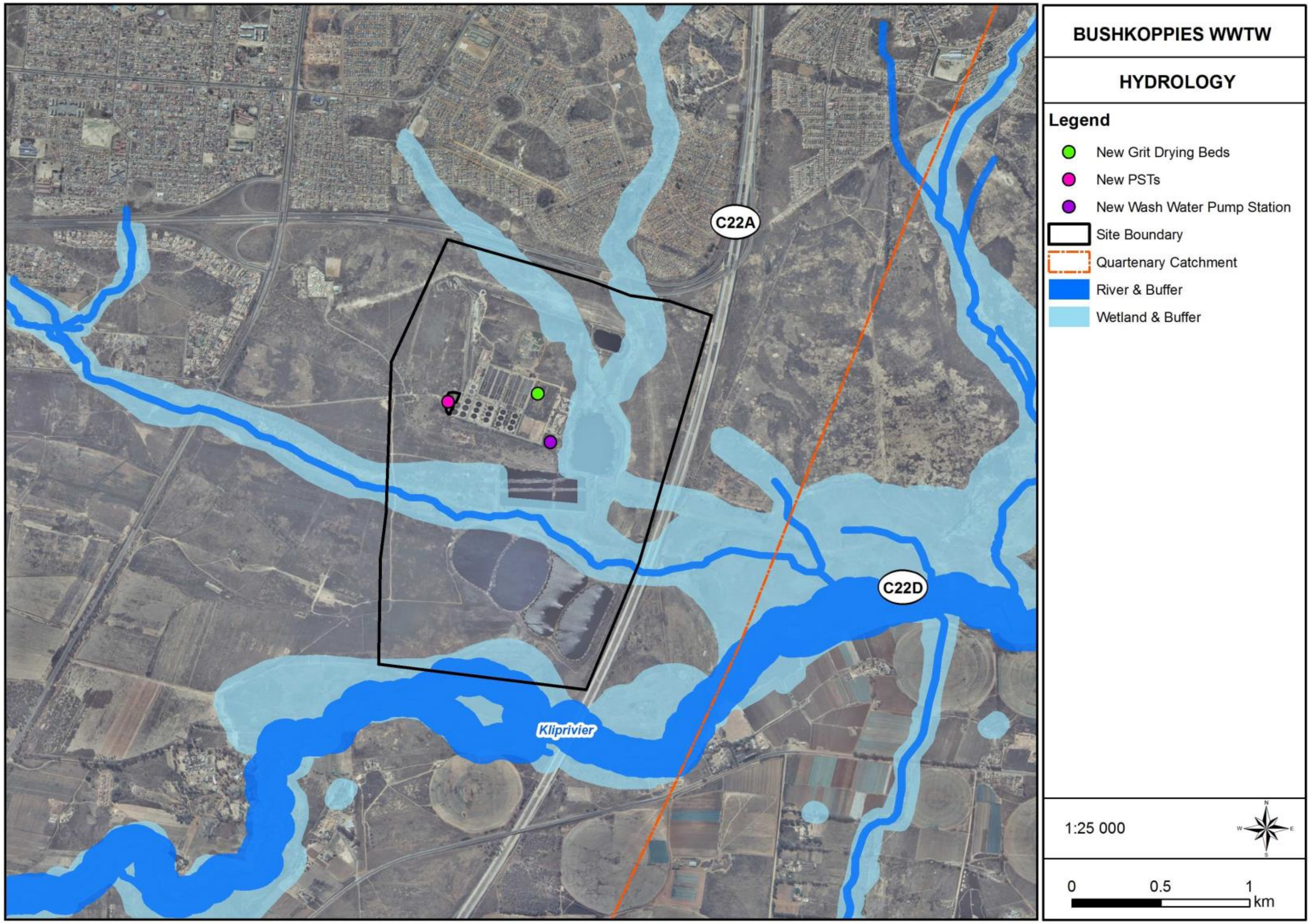


Figure 3: Hydrology of the study site and surrounds as per existing spatial layers.

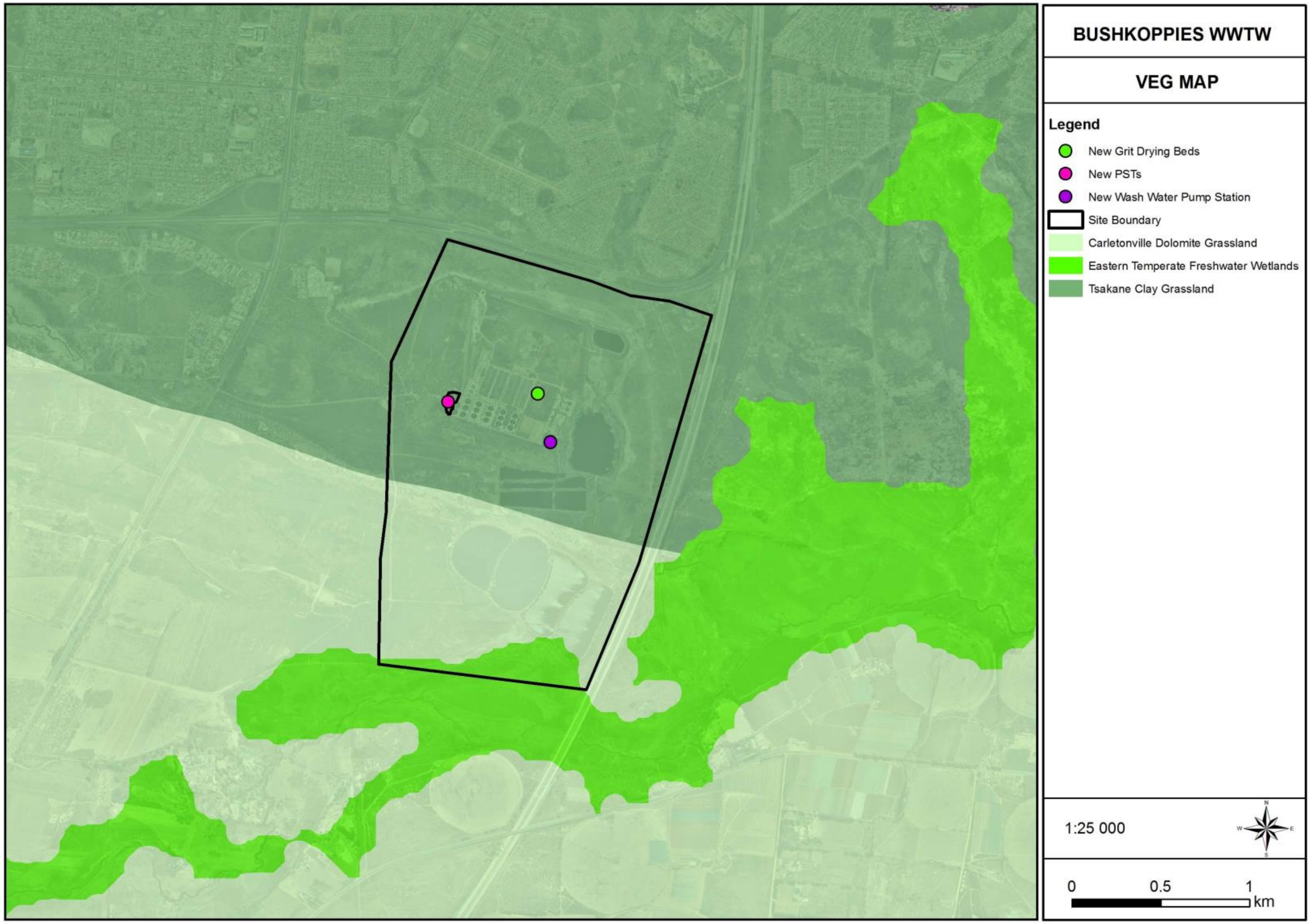


Figure 4: Vegetation type of the study area.

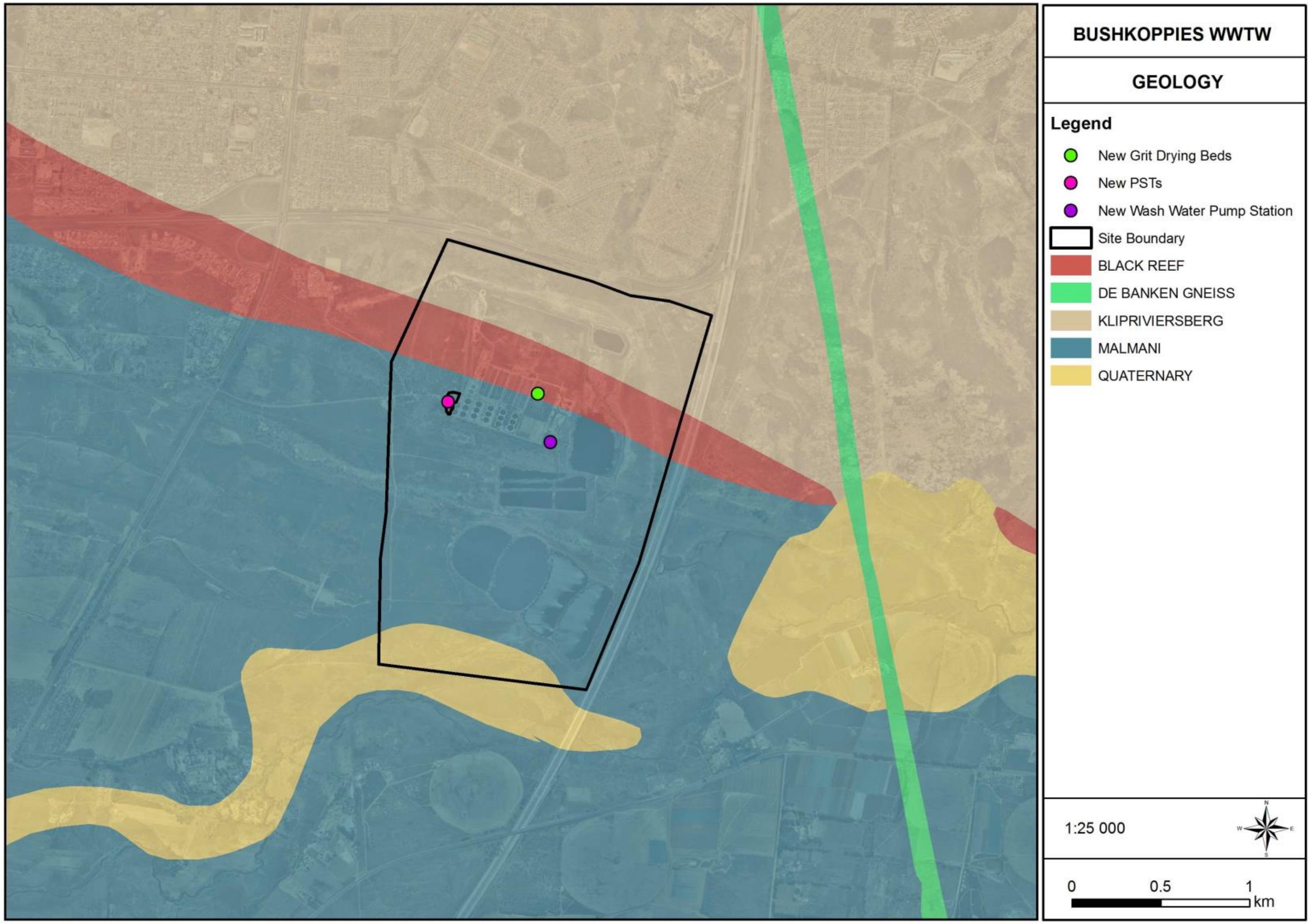


Figure 5: Geology of the proposed the study area.

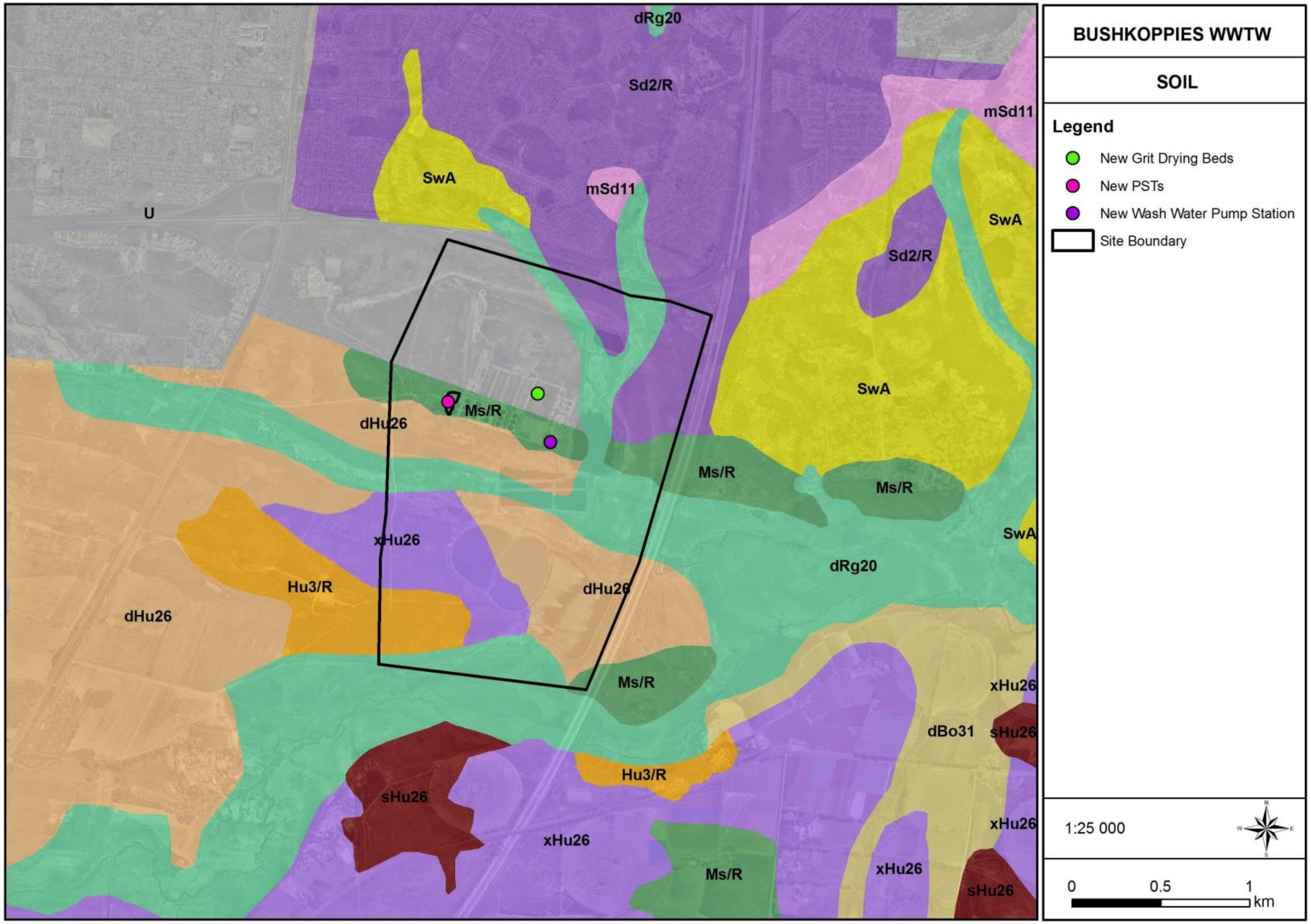


Figure 6: Soil of the proposed the study area.

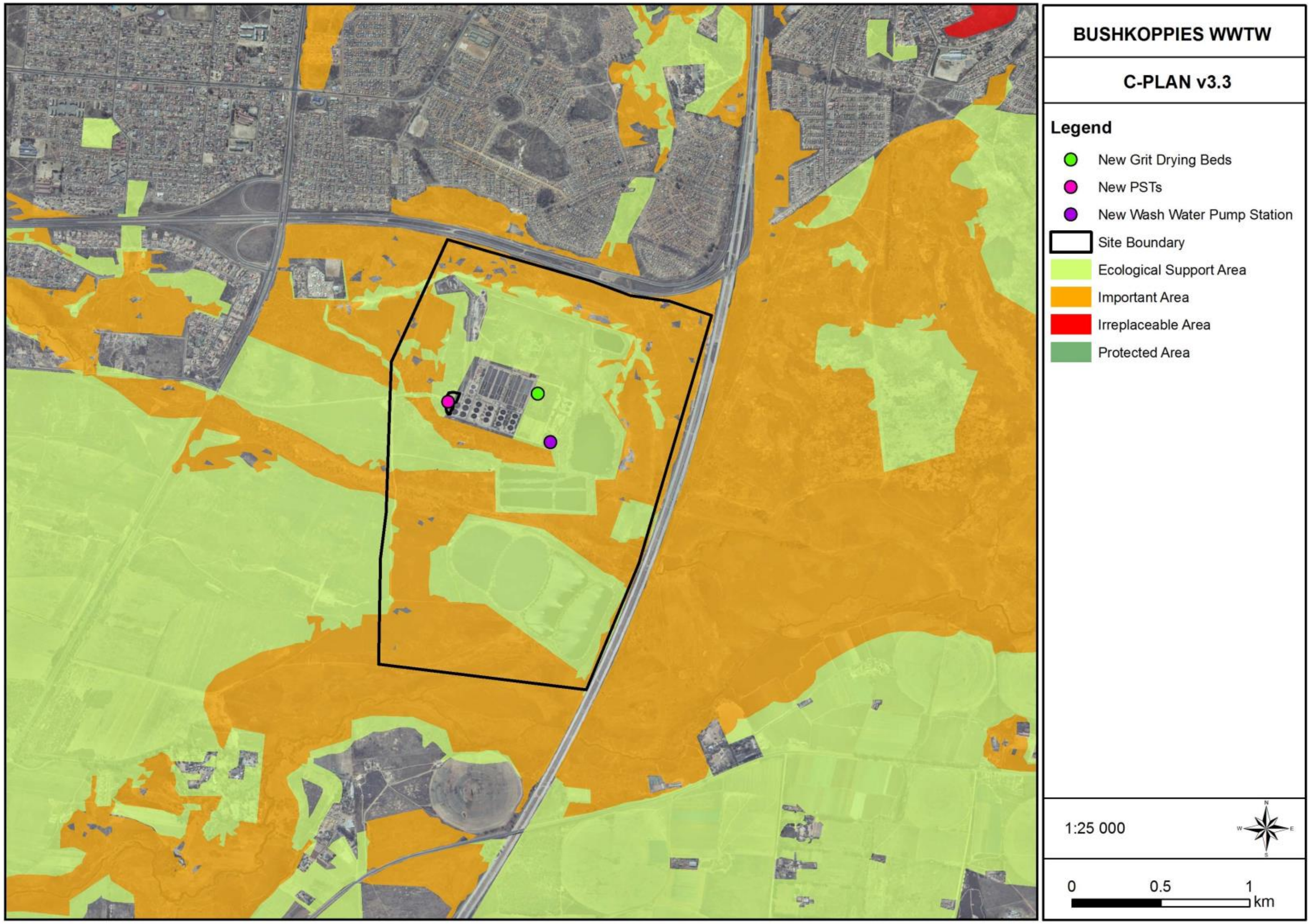


Figure 7: The Gauteng C-Plan for the proposed the study area.

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, 2014) 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 and Sanitation 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005) as well as the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008). The delineation of the watercourses presented in this report is based on both desktop delineation and groundtruthing.

<u>Desktop Delineation</u>

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

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

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

<u>Ground Truthing</u>

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figures 8 & Figure 9):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes);
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation; and

- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50 cm of the soil surface.

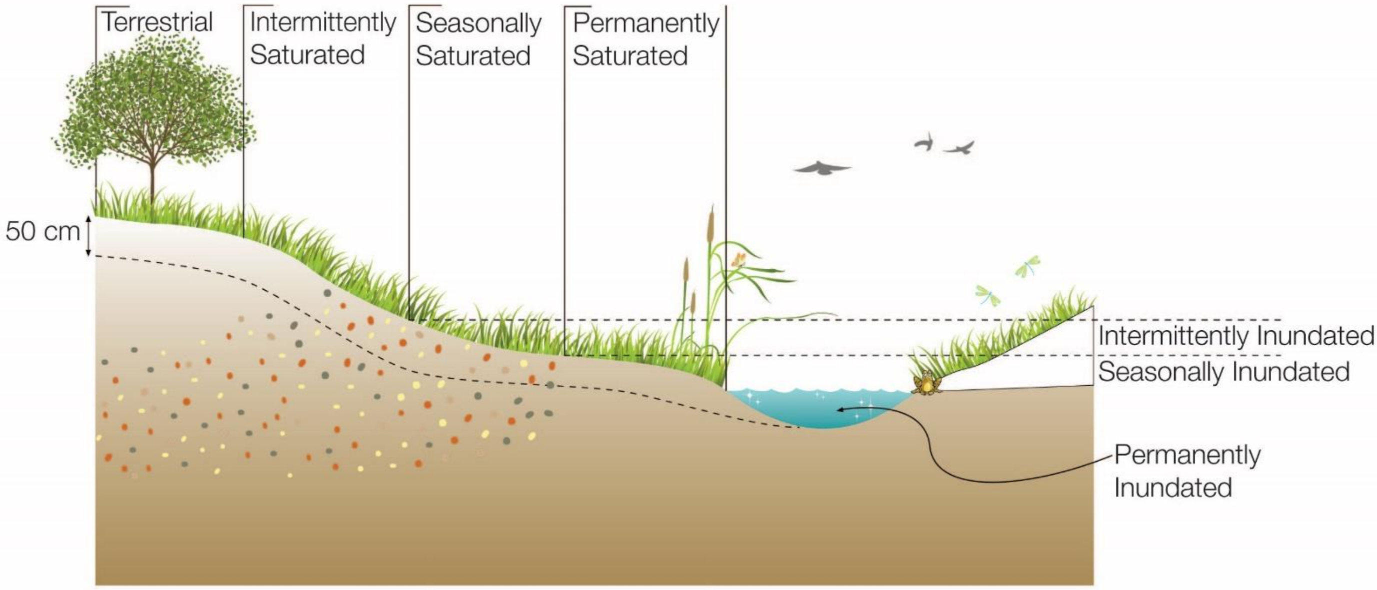


Figure 8:Typical cross section of a wetland (Ollis, 2013)

<u>The Terrain Unit Indicator</u>

The terrain unit indicator (Figure 9) 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 10).

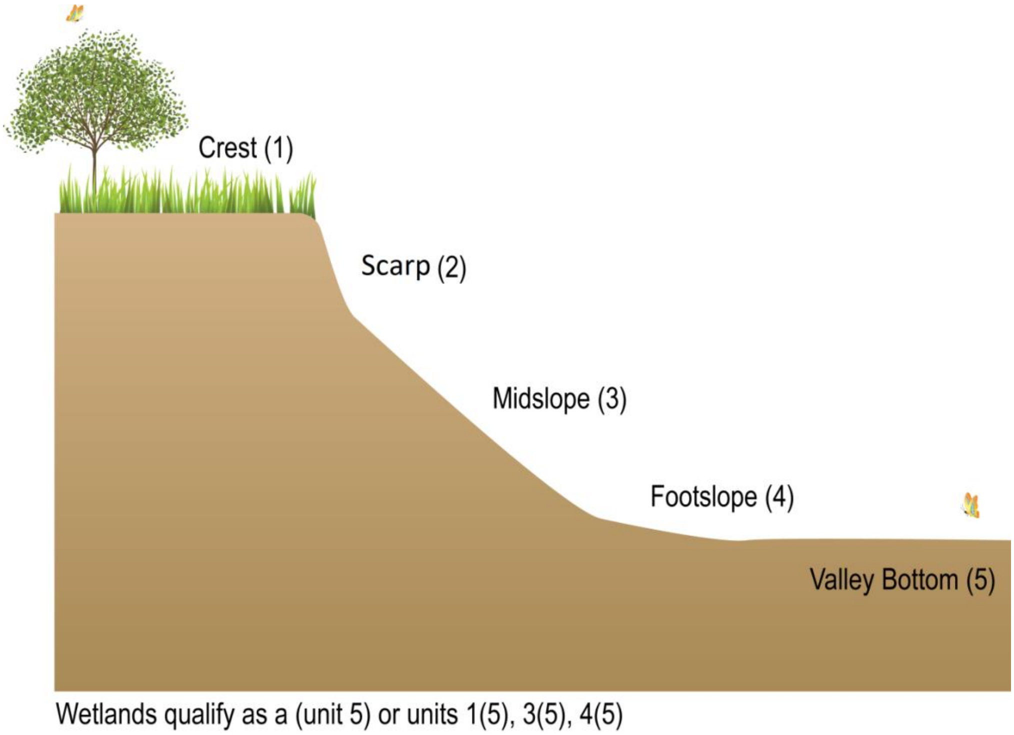


Figure 9. Terrain units (DWAF, 2005).

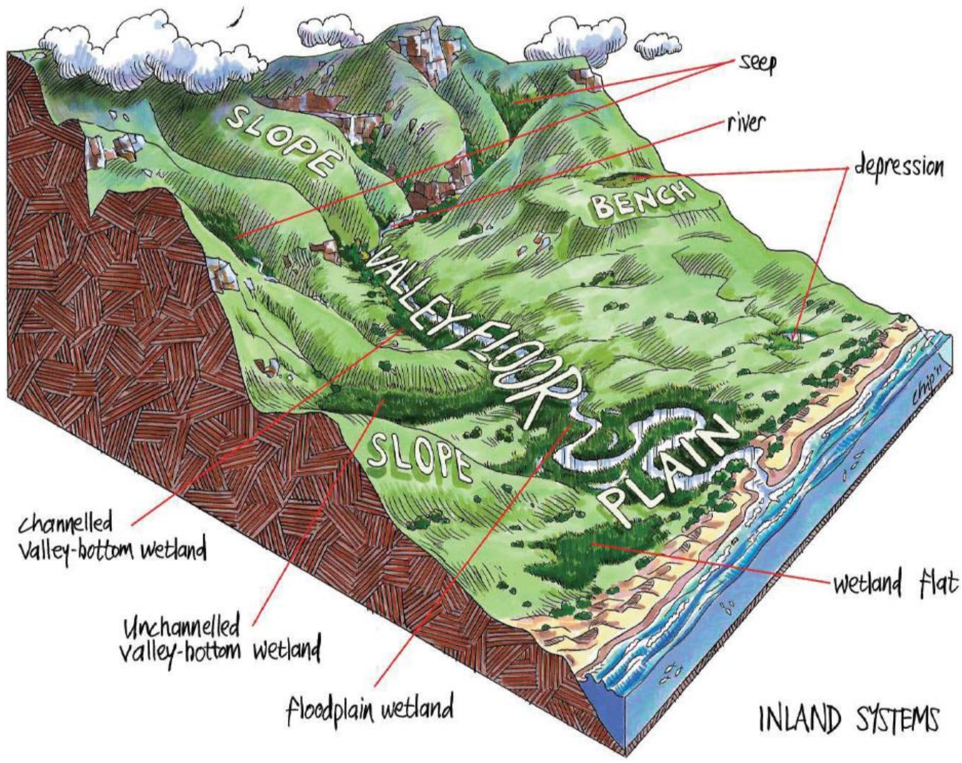


Figure 10: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

Riparian Indicators

Riparian habitat is classified primarily by identifying riparian vegetation along the edge of the macro stream channel. The macro stream channel is defined as the outer bank of a compound channel and should not be confused with the active river bank. The macro channel bank often represents a dramatic change in the energy with which water passes through the system. Rich alluvial soils deposit nutrients making the riparian area a highly productive zone. This causes a very distinct change in vegetation structure and composition along the edges of the riparian area (DWAF, 2008). The marginal zone includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (WRC Report No TT 333/08 April, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 11).

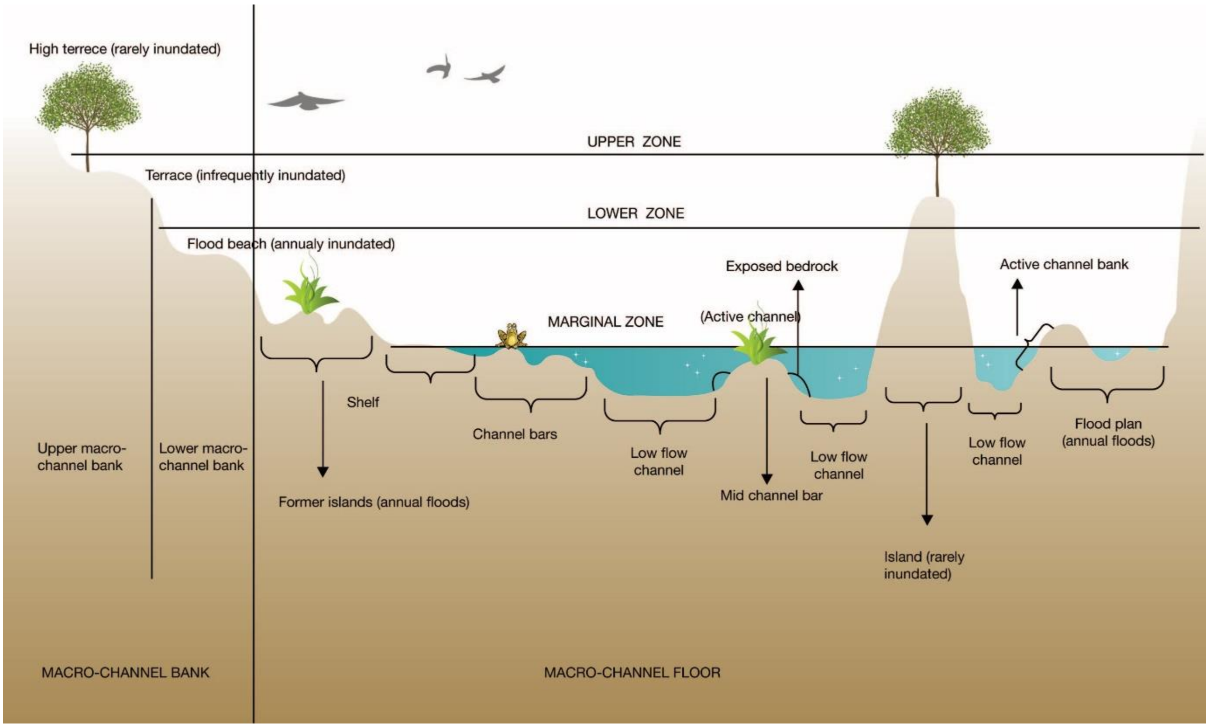


Figure 11: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

Riparian Area:

A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone (Figure 12) (Kotze, 1999).

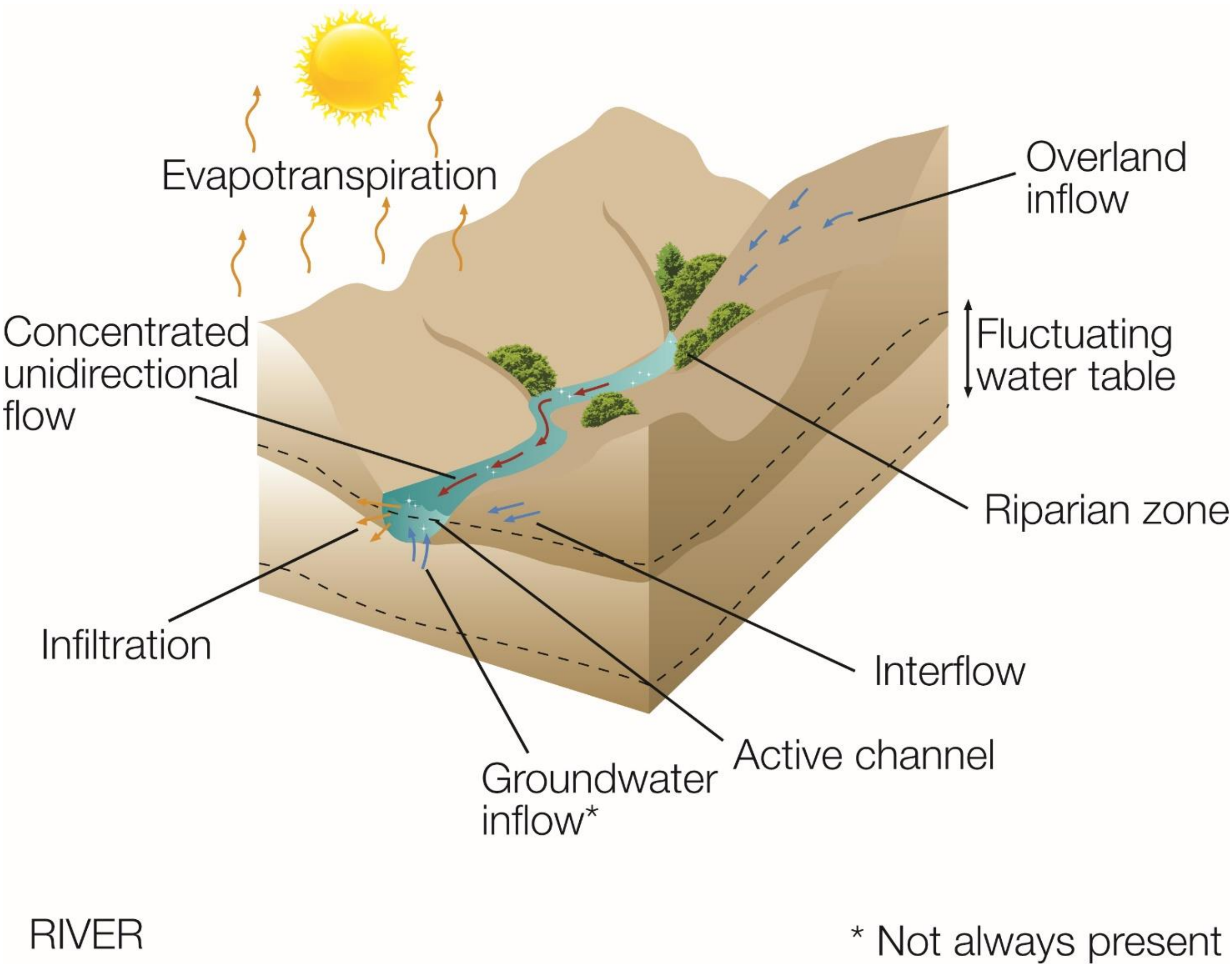


Figure 12: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

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 riparian areas recorded on site are thus classified as episodic streams due to the high elevation of these streams.

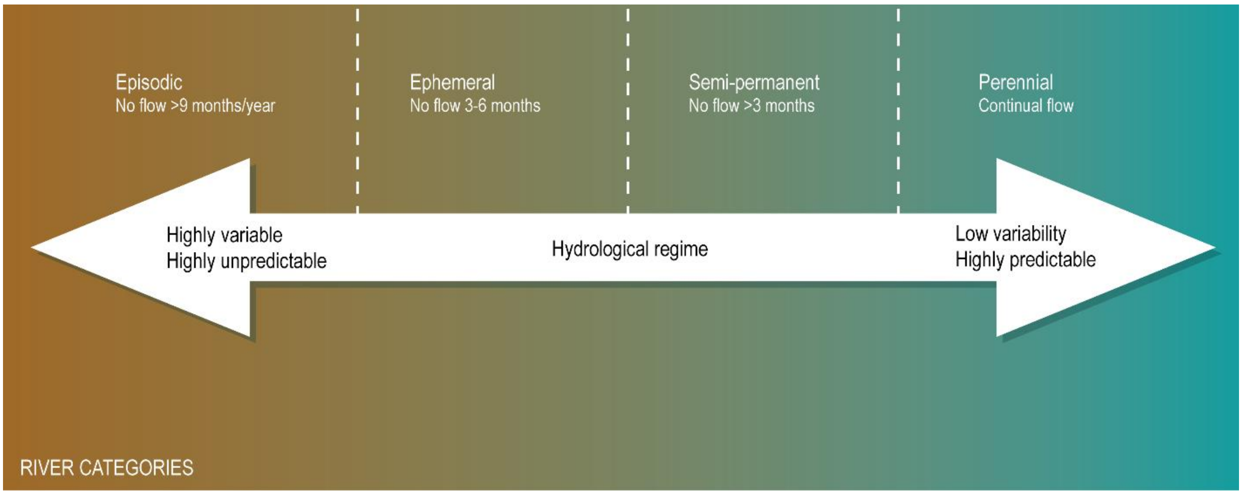


Figure 13: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

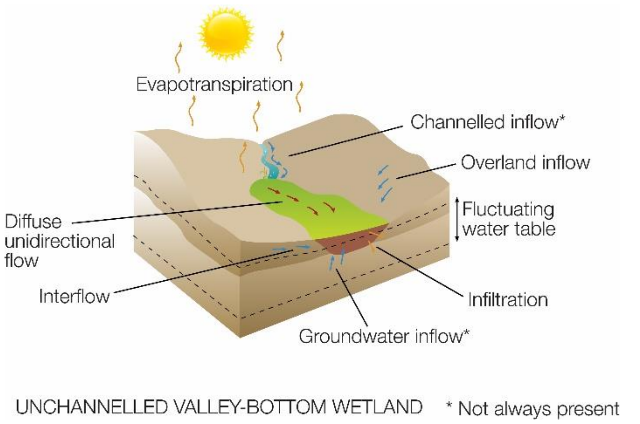
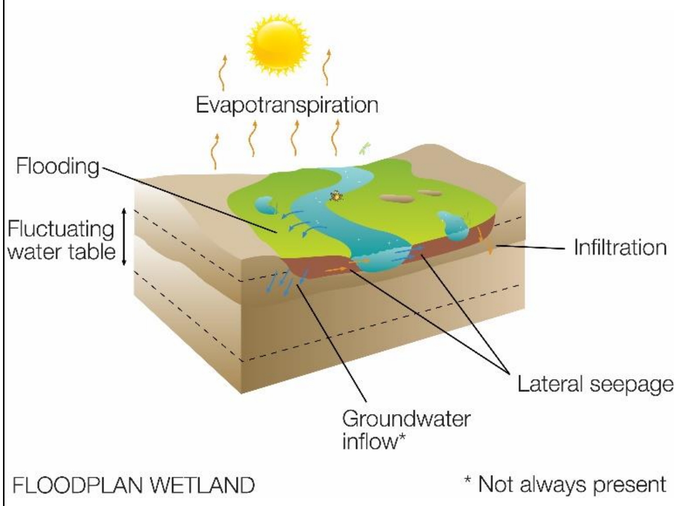
2.2 Wetland Classification and Delineation

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

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

The classification of wetland areas found within the study site and/or within 500 m of the study site (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWAF, 2005) are as follows (Table 4):

Table 3: Wetland Types and descriptions

Wetland Type:	**Description:**
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.
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.

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 4 below.

Table 4: 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.

Tools for calculating buffer zones have been developed and been published as "Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries. Consolidated Report" by the WRC (Macfarlane *et al* 2015). This tool 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. However, both the GDARD Minimum Requirements for Biodiversity Studies (2014) and the City of Johannesburg Catchment Management Policy (2010) require a generic 30m buffer zone for wetlands within the urban edge and 50m for wetlands outside the urban edge.

The recommended buffer zone applicable to the proposed PSTs is as follows:

- 28 m (Calculated buffer for construction and operational phase)
- 30 m (Generic GDARD and CoJ buffer)

It should be noted that the buffer calculation does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments. Therefore, a conservative approach to the application of buffer zones is encouraged. Furthermore, the buffer recommended in this report should be reviewed to include possible sensitive fauna species.

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

Wetland Areas

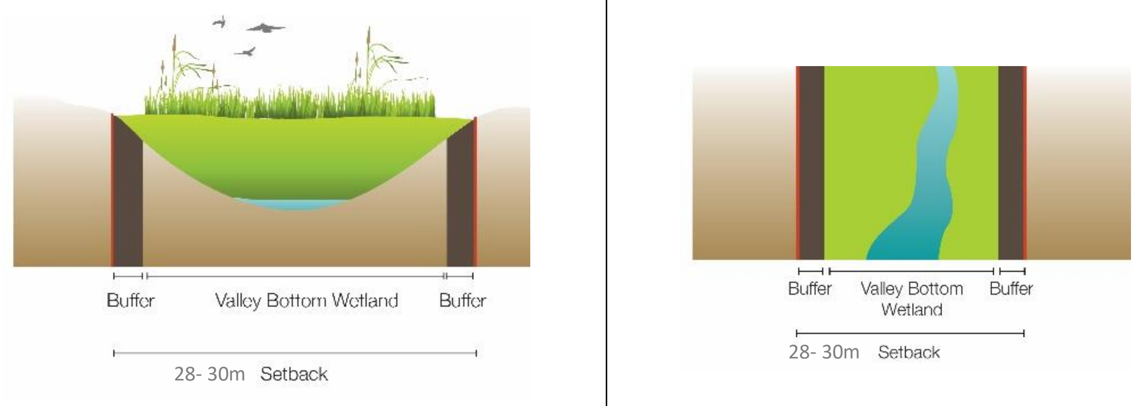


Figure 14: A represent the buffer zone setback for the wetland types discussed in this report

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), EIS (DWAF, 1999) and WetEcoServices, (Kotze *et al*, 2006).

2.4.1 Present Ecological Status (PES) – WET-Health

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 5. 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 5: 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
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 6.

Table 6: 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.

The Ecological Importance and Sensitivity of the wetlands is represented are described in the results section. Explanations of the scores are given in Table 7.

Table 7: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

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

"Upon completion of the PES and EIS assessments for the wetland, a Recommended Ecological Category for the Recommended Ecological Category (REC) of the water resource must be determined.

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

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

If:

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

2.4.3 WetEcoServices

The Department of Water and Sanitation authorisations related to wetlands are regulated by Government Notice 267 published in the Government Gazette 40713 of 24 March 2017 regarding Section 21(c) and (i). Page 196 of this notice provides a detailed terms of reference for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed.

Although it is our opinion that this section should draw from site specific fauna and flora data this requirement is addressed through the WetEcoServices toolkit (Kotze *et al*. 2006). This wetland assessment method is an excel based tool which is based on the integral function of wetlands in terms of their hydrogeomorphic setting. Each of seven benefits are assessed based on a list of characteristics (e.g. slope of the wetland) that are relevant to the particular benefit. Scores are subjectively awarded to characteristics of the wetland and its catchment relative to the proposed activity.

2.5 Impact and Risk Assessments

2.5.1 NEMA (2014) Impact Ratings

As required by the 2014 NEMA regulations (as ammended), impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. This assessment follows the format presented below. The impact assessment score below are calculated using the following parameters:

- Direct, indirect and cumulative impacts of the issues identified through the specialist study, as well as all other issues must be assessed in terms of the following criteria:
  - The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.

- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - The lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - The lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - Medium-term (5–15 years) – assigned a score of 3;
  - Long term (> 15 years) - assigned a score of 4; or
  - Permanent - assigned a score of 5;
- The consequences (magnitude), quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The probability of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The significance, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- The status, which will be described as either positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

- S=(E+D+M)P
- S = Significance weighting
- E = Extent
- D = Duration
- M = Magnitude
- P = Probability

The **significance weightings** for each potential impact will be determined as follows (Table 8):

Table 8: Significance Weightings

Points	Significant Weighting	Discussion
< 30 points	Low	This impact would not have a direct influence on the decision to develop in the area.
31-60 points	Medium	The impact could influence the decision to develop in the area unless it is effectively mitigated.
> 60 points	High	The impact must have an influence on the decision process to develop in the area.

2.6 DWS (2016) Impact Register and Risk Assessment

Section 21(c) and (i) water uses (Impeding or diverting low and/or impacts to the bed and banks of watercourses) are non-consumptive and their impacts more difficult to detect and manage. They are also generally difficult to clearly quantify. However, if left undetected these impacts can significantly change various attributes and characteristics of a watercourse, and water resources, especially if left unmanaged and uncontrolled.

Risk-based management has value in providing an indication of the potential for delegating certain categories of water use “risks” to DWS regional offices (RO) or Catchment Management Agencies (CMA). Risk categories obtained through this assessment serve as a guideline to establish the appropriate channel of authorisation of these water uses

The DWS has therefore developed a risk assessment matrix to assist in quantifying expected impacts. The scores obtained in this assessment are useful in evaluating how the proposed activities should be authorised.

The formula used to derive a risk score is as follows:

RISK = CONSEQUENCE x LIKELIHOOD

CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION

LIKELIHOOD = FREQUENCY OF THE ACTIVITY + FREQUENCY OF THE IMPACT +LEGAL ISSUES + DETECTION

Table 9 below provides a description of the classes into which scores are sorted, and their implication for authorization.

Table 9: An extract from DWS (2016) indicating the risk scores and classes as well as the implication for the appropriate authorization process

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

3 RESULTS

3.1 Land Use, Cover and Ecological State and Wetlands

The majority of the study area is located on vacant land with several large sections occupied by current waste water treatment works infrastructure, which includes large dams of an artificial nature adjacent to natural water features. The proposed new infrastructure is also located adjacent the WWTW infrastructure in a disturbed area. The proposed location of the new ifrastructure is well buffered from the natural watercourses with only small areas of the natural watercourses located within the 500 m DWS regulated area. The remainder of the larger study area is generally used for grazing. The surrounding area is characterised by high density residential areas in the north and farming areas in the south.

4 Wetland Classification and Delineation

No wetlands were recorded in the focus area earmarked for the new infrastructure. However, two wetland systems were recorded on the larger study area (Figure 15). The wetland in the south is classified as a floodplain wetland and the wetland in the central and northern section is classified as an unchannelled valley bottom wetland. This wetland has numerous impoundments, within and adjacent to, the wetlands. It is likely that these impoundments are hydrologically connected to the wetlands and thus have some impact on the systems. These impoundments are artificial as confirmed by the absence of any impoundments on early historical imagery of the area from 1951 (Figure 16). These historical imageries further indicated the prolonged agricultural impacts on the watercourses. The proposed development site is however well buffered from the wetlands which only encroaches into the 500 m DWS regulated zone to the south.

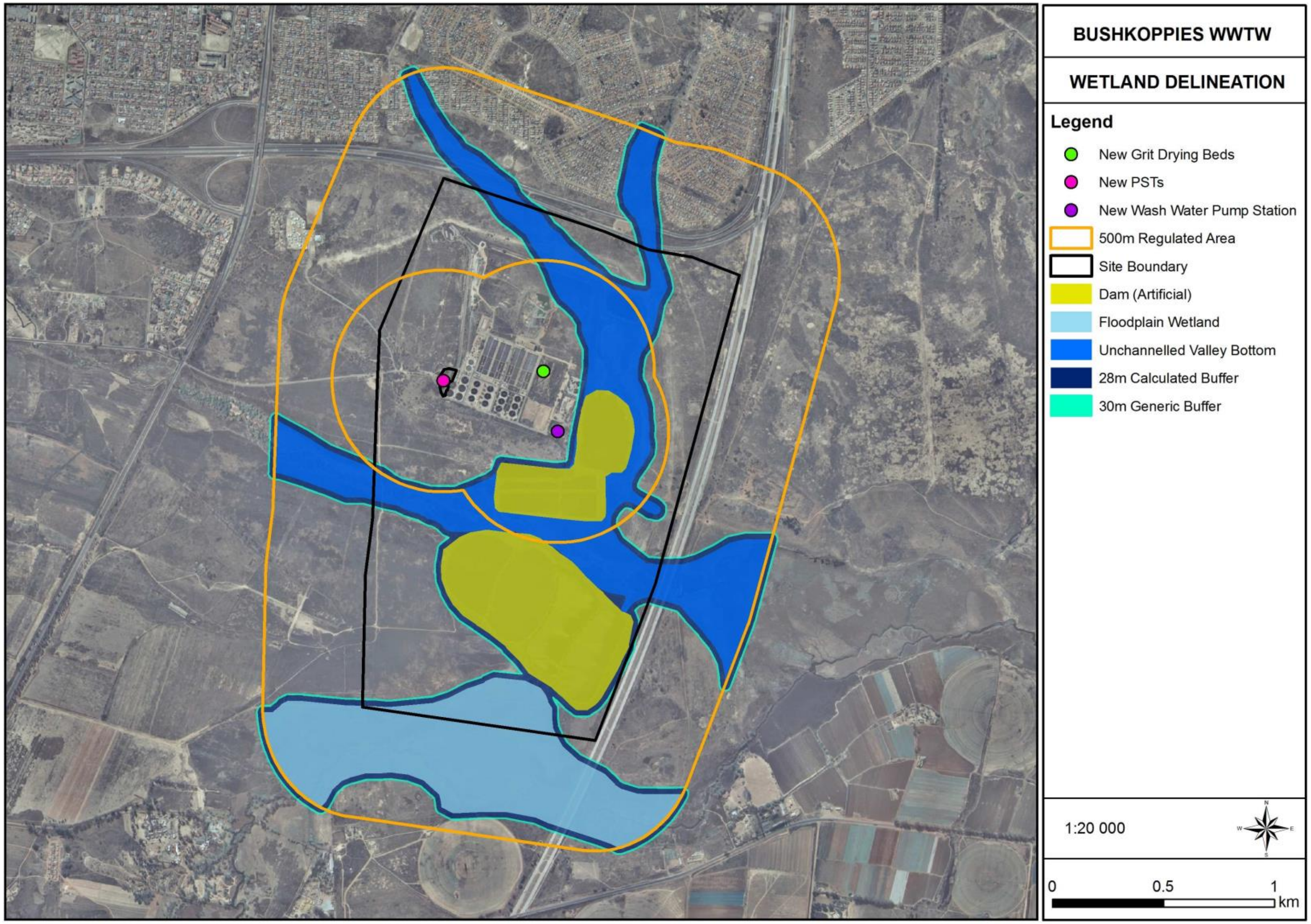


Figure 15: The location and extent of wetland areas in relation to the Bushkoppies WWTW, the proposed development sites and the 500 m DWS regulated area.

Figure 16: 1951 Historical Aerial imagery of the study site indicating agriculture and the absence of impoundments.

4.1.1 Soil Indicators

Soil

Although some redoximorphic features were recorded in the nearby wetland areas, soil samples with to depth of 1.5m and/or refusal showed no redoximorphic signs, or clear signs of interflow within and adjacent to the proposed PSTs area (Figure 17). The soil of the areas surrounding the proposed PSTs and supporting infrastructure are generally disturbed.

Figure 17: Soil characteristics of the proposed PSTs area in an excavated trench. Note the rocky red soil with no grey matrix or mottling.

4.1.2 Vegetation Indicators

The vegetation associated with the proposed development area is generally characterised by invasive species with a few indigenous species. The floodplain wetland (Klip River) farthest south of the proposed development area is characterised by dense stands of *Phragmites australis.* The valley bottom wetland east and south of the proposed development area is characterised by overgrazed areas with short grass cover as well as exotic woody species on the channel banks such as *Salix babylonica.* The vegetation is visually represented in the figures below (Figure 18) (Photos are taken in the rainy season and during the recent site visit).

Figure 18: General characteristics of the wetland in the study area as seen in the dry and rainy seasons.

4.2 Wetland Functional Assessment

The functionality of the wetland has been significantly impacted by a long history of mining in the catchment of the Klip River. Furthermore, the increased hardened surfaces in its local catchment due to increased development and development encroachment onto the wetland and natural buffers has led to an increase in exotic species in the area, increased sediment and a change in geomorphology. The hydrology has been impacted by the input of foreign materials input from the roads and industrial and mining areas, inadequate stormwater management and run-off from roads and surfaces leading to an increase in hydro-carbon contamination and sediment input. The geomorphology of the wetlands has been impacted by dumped material including rubble and garden refuse, trenches, gullies and many roads and footpaths traversing the wetland. Lastly, the vegetation composition has also been impacted as a result of the changes discussed above. The current species composition is dominated by exotic plants with a few hardy indigenous individuals surviving. Furthermore, the vegetation has also been impacted by grass cutting and vegetation clearing (reduced surface roughness). It is important to note that the flood peaks of the majority of the wetlands in this area has been greatly altered with flooding occurring regularly often resulting in damages of property and watercourses.

4.2.1 Scores

Only the unchannelled valley bottom wetland falls within the 500m DWS regulated area from the PSTs and associated infrastructure. Scores for this wetland, and not for the Klip River are therefore presented in this section.

The wetland scored a PES of **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. The wetland conditions recorded on the study site are likely to remain stable over the next 5 years. The PES scores of the wetland is reflected in the table below (Table 10).

Table 10: Summary of hydrology, geomorphology and vegetation health assessment for the unchannelled valley bottom wetland on the study site (Macfarlane *et al*, 2009).

Wetland Unit	Hydrology		Geomorphology		Vegetation		Overall Score	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Unchannelled Valley Bottom (Within 500 m)	7.2	0	6.3	0	5.9	0	6.6	0
PES Category and Projected Trajectory	**E**	**→**	**E**	**→**	**D**	**→**	**E**	**→**

Ecological Importance and Sensitivity (EIS)

The EIS score of **2.0** for all the wetlands fall into a category characterised by **Moderate** ecological importance and sensitivity. Wetlands that fall into this category are considered to be ecologically important and sensitive. 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 (DWAF, 1999) (Table 11).

Table 11: WIS including EIS scores obtained for the unchannelled valley bottom wetland on the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	**2.0**	**3.0**
Hydro-functional importance	1.3	2.5
Direct human benefits	0.5	3.0

The ecosystem services provided by the wetlands on the study site is summarised in the table below (Table 12). The table is listed from the lowest scores to the highest score. The highest scores are associated with toxicant and nitrate removal due to the close association of the wetlands with the water treatment works and potential contamination.

Table 12: Results and brief discussion of the Ecosystem Services provided by the unchannelled valley bottom wetland

Function	Score	Significance
Education and research	0.5	Low
Maintenance of biodiversity	0.9	Low
Natural resources	1.0	Low
Tourism and recreation	1.0	Low
Cultivated foods	1.2	Low
Cultural significance	1.5	Low
Carbon storage	1.7	Low
Flood attenuation	1.8	Low
Sediment trapping	1.9	Low
Threats	2.0	Moderate
Opportunities	2.0	Moderate

Function	Score	Significance
Erosion control	2.1	Moderately High
Streamflow regulation	2.2	Moderately High
Phosphate trapping	2.3	Moderately High
Water supply for human use	2.5	Moderately High
Toxicant removal	2.6	Moderately High
Nitrate removal	2.9	Moderately High

4.3 Summary of Findings

Table 13 provides a summary of the results recorded for the wetland within the 500m DWS regulated area.

Table 13: Summary of results for the wetland unit within the 500m DWS regulated area

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007)	EIS (DWAF, 1999)	WetEcoServices (3 most prominent scores)	Buffer	REC
Unchannelled Valley Bottom	6.6 E	2.0 (Moderate)	Water supply for human use - 2.5 Toxicant removal - 2.6 Nitrate removal - 2.9	28 m, (Macfarlane *et al* 2015) 30m, GDARD, 2014, COJ, 2010	D

4.4 Impacts and Mitigations

A development has several impacts on the surrounding environment and particularly on a wetland. 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. The majority of the watercourses are located far enough from the proposed PSTs and associated infrastructure that they are unlikely to be significantly impacted.

Mitigation measures mentioned in this report are likely to be adequate to protect the watercourses. 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. Suggested mitigation/management measures are summarised in Table 14-18. The DWS Risk Assessment is presented in Table 19.

NEMA (2014) Impact Assessment

Table 14: Changes in water flow regime impact ratings

Nature: Changing the quantity and fluctuation properties of the watercourse by for example diverting or obstructing flow.		
ACTIVITY: The sources of this impact include the compaction of soil, the removal of vegetation, surface water redirection during construction activities. Inappropriate, concentrated stormwater release during the operational phase		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Highly probable (4)	Probable (3)
Duration	Medium term (3)	Short term (2)
Extent	Regional (3)	Limited to Local Area (2)
Magnitude	Moderate (6)	Low (4)
Significance	**48 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Highly probable (4)	Possible (2)
Duration	Medium term (3)	Short term (2)
Extent	Regional (3)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**40 (moderate)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Design of watercourse crossings should ensure no nett negative effect on local or regional hydrology
- Construction methods should be carefully reviewed to ensure the least impact to the watercourse is ensured.
- Effective stormwater management should be a priority during the construction phase. This should be monitored as part of the EMP. High energy stormwater input into the watercourses should be prevented at all cost.
- Sediment control should be effective and not allow any release of sediment pollution downstream. This should be audited on a weekly basis to demonstrate compliance with upstream conditions.
- Where necessary, corrective action should be determined by a team of specialists including engineers, hydrologists and ecologists

Cumulative impacts: Some changes in the hydrology of the rivers could occur due to ineffective sediment control during the construction phase.

Residual Risks: Considered to be low given that optimal design is followed

Table 15: 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 water resource and associated change in turbidity (increasing or decreasing the amount). Construction and maintenance activities will result in earthworks and soil disturbance as well as the disturbance of natural vegetation. Possible sources of the impacts include:

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

	Without mitigation	With mitigation
	CONSTRUCTION PHASE	
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Short-term (2)
Extent	Regional (3)	Local (2)
Magnitude	Moderate (6)	Low (4)
Significance	**36 (moderate)**	**16 (low)**

Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium term (3)	Medium term (3)
Extent	Regional (3)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**30 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	
Mitigation: • Consider the various methods and equipment available and select whichever method(s) that will have the least impact on watercourses. • Remove only the vegetation where essential for construction and do not allow any disturbance to the adjoining natural vegetation cover. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Runoff from the construction area must be managed to avoid erosion and pollution problems. • Implementation of best management practices • Maintain buffer zones to trap sediments • Monitoring should be done to ensure that sediment pollution is timeously dressed		
Cumulative impacts: Expected to be moderate to low. Should mitigation measure not be implemented effectively, sediment deposition may affect the capacity of downstream watercourses and may cause flooding. Reversing this process is unlikely and should be prevented in the first place.		
Residual Risks: Moderate to high since reversing sediment pollution is unlikely to be effective and may cause more damage		

Table 16: 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 reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plans can easily colonise and impact on downstream users.		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Highly Probable (4)	Probable (3)
Duration	Medium-term (3)	Medium-term (3)
Extent	Local (2)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**36 (moderate)**	**27 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Highly Probable (4)	Probable (3)
Duration	Medium-term (3)	Medium-term (3)
Extent	Local (2)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**36 (moderate)**	**27 (moderate)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation: • Implement an Alien Plant Control Plan • 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: Cumulative impacts include further infestation of alien plants. Regular monitoring should be implemented during construction, rehabilitation including for a period after rehabilitation is completed.
Residual Risks: Expected to be high due to high density of alien plants on the study site

Table 17: Loss and disturbance of watercourse habitat and fringe vegetation impact ratings.

Nature: Loss and disturbance of watercourse habitat and fringe vegetation.		
Activity: Earthworks within the wetland areas		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Possible (2)	Possible (2)
Duration	Short term (2)	Short-term (2)
Extent	Local (2)	Local (2)
Magnitude	Moderate (6)	Moderate (6)
Significance	**20 (low)**	**20 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Possible (2)	Possible (2)
Duration	Short-term (2)	Short-term (2)
Extent	Local (2)	Local (2)
Magnitude	Moderate (6)	Low (4)
Significance	**20 (low)**	**16 (low)**

Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	
Mitigation: • No development or maintenance infrastructure is allowed within the delineated watercourse or associated buffer zones. • Demarcate the watercourse areas and buffer zones to limit disturbance, clearly mark these areas as no-go areas • 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 take place within watercourses or buffer zones, nor should edge effects impact on these areas • Operational activities should not impact on rehabilitated or naturally vegetated areas		
Cumulative impacts: Expected to be low since the development footprint lies well outside the delineated wetlands		
Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation and control of alien species on the site is undertaken where necessary.		

Table 18: Changes in water quality due to foreign materials and increased nutrients impact ratings.

Nature: Changes in water quality due to foreign materials and increased nutrients.		
Activity: Construction and operational activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the wetlands' and a reduction in watercourse function.		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Probable (3)
Duration	Medium-term (3)	Short-term (2)
Extent	Limited to Local Area (2)	Local (2)
Magnitude	Moderate (6)	Low (4)
Significance	**33 (moderate)**	**24 (Low)**

Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Probable (3)
Duration	Medium-term (3)	Short-term (2)
Extent	Regional (3)	Local (2)
Magnitude	High (8)	Low (4)
Significance	**42 (moderate)**	**24 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	
Mitigation: • Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone. • Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation and to prevent contaminated runoff into the watercourse. • The development footprint must be fenced off from the watercourses and no related impacts may be allowed into the watercourse e.g. water runoff from cleaning of equipment, vehicle access etc. • After construction, the land must be cleared of rubbish, surplus materials, and equipment, and all parts of the land shall be left in a condition as close as possible to that prior to use. • Maintenance of construction vehicles / equipment should not take place within the watercourse or watercourse buffer. • Ensure that no operational activities impact on the watercourse or buffer area. This includes edge effects. • Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse • Treatment of pollution identified should be prioritized accordingly.		
Cumulative impacts: Expected to be low given that standard best practice is followed during construction		
Residual Risks: Expected to be low since the development footprint is located outside the delineated wetlands or buffer zones		

DWS (2016) Risk Assessment

Table 19: The DWS (2016) risk assessment matrix for the proposed refurbishment activities. Risk is determined after considering all listed control / mitigation measures

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol): Refurbishment of Existing Primary Sedimentation Tanks at Bushkoppies Waste Water Treatment Works, Johannesburg South, Gauteng Province - August 2019

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

				Severity																		
Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Veg etation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
C	Construction of the new PST tanks and associated infrastructure	Preparation of the footprint	Potential pollution and dispersal of alien plants	1	1	1	1	1	1	2	4	1	1	5	2	9	36	L	80%	• Implement best practice mitigation measures during the construction phase to ensure no negative effect on the watercourses. • Implement and Alien Plant Management Plan on the WWTW property	N	PES: ,E EIS: C REC: D
		Earthworks		1	1	1	1	1	1	2	4	1	1	5	2	9	36	L	80%		N	
		Crew camps		1	1	1	1	1	1	2	4	1	1	5	2	9	36	L	80%		N	
O	Opeartion of the coal wash plant	Day to day operation of the coal was plant including roads, stormwater system and services	Potential pollution, primarily by wind-blown coal dust and sediment deposit into the adjacent wetland	1	1	1	1	1	1	2	4	2	1	5	2	10	40	L	80%	• Ensure that vehicles are kept clean so as to not inadvertently disperse seeds of alien plants from other sites • Ensure that optimal stormwater management is applied throughout the site and that no polluted or high-energy water from the site is discharged into the adjacent wetland.	N	PES: ,E EIS: C REC: D
		Maintenenace		1	1	1	1	1	2	1	4	1	2	5	2	10	40	L	80%		N	

5 CONCLUSION

No wetlands were recorded within the proposed development site. However, two wetland systems were recorded on the larger study area, within the 500m DWS regulated area outside the WWTW site. The southernmost wetland (Klip River) is classified as a Floodplain wetland and the wetland in the central and northern section is classified as an unchannelled valley bottom wetland which drains into the Klip River. This wetland has numerous impoundments, within and adjacent to, the wetlands. It is likely that these impoundments are hydrologically connected to the wetlands and thus has some impacts on the systems. These impoundments are artificial as confirmed by the absence of any impoundments on early historical imagery of 1951 of the area. These historical imageries further indicated the prolonged agricultural impacts on the watercourses. The proposed development site is however well buffered from the wetlands and the wetlands only encroaches into the 500 m buffer zone south of the proposed PSTs and associated infrastructure.

The important factors relevant to the project are summarised in Table 20 below:

Table 20: Summary of findings

	Quaternary Catchment and WMA areas	**Important Rivers possibly affected**		
	C22A – 5th WMA Vaal	Tributary of the Klip River		
Integrity and functional assessment of the wetland within 500m of the proposed refurbishment	Present Ecological Status (PES): 6.6 (**E – Low)**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The status of this wetlands is likely to remain stable over the next 5 years.			
	Ecological Importance and Sensitivity (EIS): 2.0 (**C - Moderate**). 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			
	Recommended Ecological Category (REC): **D**			
	WetEcoServices: Water supply for human use - 2.5 Toxicant removal - 2.6 Nitrate removal - 2.9			
Buffer zones	Generic (GDARD, 2014; CoJ, 2010): **30m**			
	Calculated (Macfarlane *et al*, 2015): **28m**			
NEMA 2014 Impact Assessment	The impact scores for the following aspects are relevant:		Without Mitigation	With Mitigation
	Changes to flow dynamics	Construction Phase	M	L
		Operation Phase	M	L
	Sedimentation	Construction Phase	M	L
		Operation Phase	M	L
	Establishment of alien plants	Construction Phase	M	L

		Operation Phase	M	L
	Pollution of watercourses	Construction Phase	M	L
		Operation Phase	M	L
	Loss of fringe vegetation and habitat	Construction Phase	M	L
		Operation Phase	M	L
DWS (2016) Risk Assessment	The risk scores fall in the **Low** category. Authorisation may proceed through a General Authorisation			
Does the specialist support the development?	Yes, however, care should be taken to prevent any sedimentation input into the watercourses and alien plant control should be effective.			
CBA and other important areas	The study site is located on an: • Protected Area – Olifantsvlei Nature Reserve • ESA • Important Area			

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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 CV of participating specialists

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
Position:	Director - Principal Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology
Nationality:	South African

EDUCATIONAL QUALIFICATIONS

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

PUBLICATIONS

- A.A. Boostma, S. Elshehawi, A.P. Grootjans, P.L Grundling, S. Khosa, M. Butler, L. Brown, P. Schot. 2019. Anthropogenic disturbances of natural ecohydrological processes in the Matlabas mountain mire, South Africa. South African Journal of Science Volume 115| Number 5/6, May/June 2019, P1 to 8
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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 90 external peer reviews as part of mentorship programs for companies including Gibb, Galago Environmental Consultants, Lidwala Consulting Engineers, Bokamoso Environmental Consultants, 2009 ongoing
- More than 300 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape 2007, ongoing
- Strategic wetland specialist input into the Open Space Management Framework for Kyalami and Ruimsig, City of Johannesburg, 2016
- Fine scale wetland specialist input into the ESKOM Bravo Integration Project 3, 4, 5 and Kyalami – Midrand Strengthening.
- Wetland/Riparian delineation and functional assessment for the proposed maintenance work of the rand water pipelines and valve chambers exposed due to erosion in Casteel A, B and C in Bushbuckridge Mpumalanga Province
- Wetland/Riparian delineation and functional assessment for the Proposed Citrus Orchard Establishment, South of Burgersfort (Limpopo Province) and North of Lydenburg (Mpumalanga Province).
- Scoping level assessment to inform a proposed railway line between Swaziland and Richards Bay. April 2013.
- Environmental Control Officer. Management of onsite audit of compliance during the construction of a pedestrian bridge in Zola Park, Soweto, Phase 1 and Phase 2. Commenced in 2010, ongoing.
- Fine scale wetland delineation and functional assessments in Lesotho and Kenya. 2008 and 2009;
- Analysis of wetland/riparian conditions potentially affected by 14 powerline rebuilds in Midrand, Gauteng, as well submission of a General Rehabilitation and Monitoring Plan. May 2013.
- Wetland specialist input into the Environmental Management Plan for the upgrade of the Firgrove Substation, Western Cape. April 2013
- An audit of the wetlands in the City of Johannesburg. Specialist studies as well as project management and integration of independent datasets into a final report. Commenced in August 2007
- Input into the wetland component of the Green Star SA rating system. April 2009;
- A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- As assessment of wetlands in southern Mozambique. This involved a detailed analysis of the vegetation composition and sensitivity associated with wetlands and swamp forest in order to inform the development layout of a proposed resort. May 2008.

- An assessment of three wetlands in the Highlands of Lesotho. This involved a detailed assessment of the value of the study sites in terms of functionality and rehabilitation opportunities. Integration of the specialist reports socio economic, aquatic, terrestrial and wetland ecology studies into a final synthesis. May 2007.
- Ecological studies on a strategic scale to inform an Environmental Management Framework for the Emakazeni Municipality and an Integrated Environmental Management Program for the Emalahleni Municipality. May and June 2007

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)

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

- **Wetland Specialist**

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

- Approximately 200+ specialist investigations into wetland and riparian conditions on strategic, as well as fine scale levels in Gauteng, Limpopo, North-West Province Mpumalanga KwaZulu Natal, North-West Province, Western Cape, Eastern Cape & Northern Cape
- Ensuring the scientific integrity of wetland reports including peer review and publications.

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.

EMPLOYEE EXPERIENCE:

➢ **GIS Specialist – AfriGIS**

January 2008 – August 2010

Tasks include:

- GIS Spatial layering
- Google Earth Street View Mapping
- Data Input

➢ **Wetland Specialist - Limosella Consulting**

September 2010 – Ongoing

Tasks include:

- 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)