Proposed Vryburg Mall, North-West Province.

Wetland and Riparian Functional Assessment

August 2021

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Please note that the incorrect cadastral boundaries have been used in this report which resulted in survey outside of the property boundary

Declaration of Independence

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

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

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2021.10.03
Date

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EXECUTIVE SUMMARY

Limosella Consulting was appointed by Elemental Sustainability to undertake a wetland and riparian assessment, to inform the requirements of the Water Use Licence Application from the Department of Water and Sanitation for the proposed Vryburg Mall. Fieldwork was conducted on the 20th and 21st of September 2021.

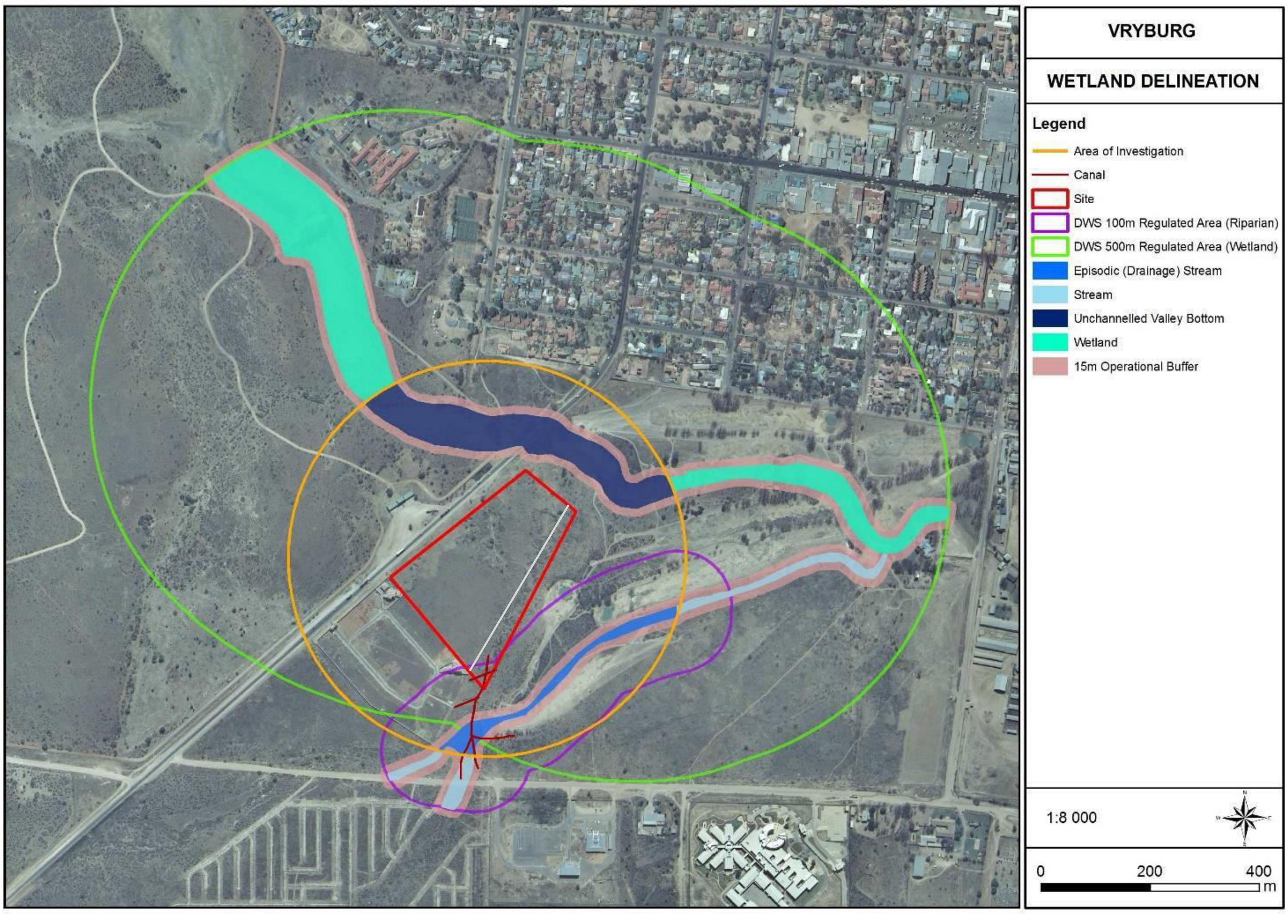
The terms of reference for the study were as follows:

- 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 a risk assessment as specified in General Notice 509 in published in the Government Gazette 40713 of 24 March 2017,
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015; and
- Discuss appropriate mitigation and management procedures relevant to the conserving watercourse on the site and downstream of the site.

Two watercourse types were recorded on the study site and are classified as:

- Unchannelled Valley Bottom Wetland and
- Non-Perennial Episodic (Drainage) Stream

Although many woody trees can be seen in the watercourse north of the study site, these are predominantly Alien Invasive Species. Based on soil characteristics and historic aerial imagery, this section of the watercourse is classified as a valley bottom wetland. The episodic stream located south of the site will only flow during rainfall events and does not provide specialised habitat for wetland or riparian species. Both the wetland and the episodic stream, including their operational phase buffer zones (a 15m zone from the edge of the watercourse in which the development footprint is excluded) are located outside of the study site. The construction phase buffer zones, which highlights an environmentally sensitive area in which careful mitigation should be implemented, is likely to encroach onto the study site (38 m for the episodic stream and 32 m for the wetland). The figure below presents the delineated watercourses, canals, operational phase buffer zones and the DWS regulated areas relative to the site boundary.



A summary of the on-site conditions relevant to authorisation is presented in the table below. ***Please note the incorrect cadastral information was used and resulted in survey outside of the property boundary. The grey line indicated the approximate location of the correct eastern cadastral boundary.**

	Quaternary Catchment and WMA areas	
	A63C, #1, Limpopo	
Classification (SANBI, 2013)	**Non-Perennial Episodic Streams south of the site**	**Unchannelled Valley Bottom north of the site (Vryburg River)**
PES/EC Scores	QHI (Seaman *et al.*, 2010) VEGRAI (Kleynhans, 1999) (EC) - **D – Largely modified.** A large loss of natural habitat, biota and basic ecosystem functions has occurred	Present Ecological Status (PES) - **D - Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred
WetEcoServices (Kotze *et al.*, 2020) –	Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low	Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low. Sediment Trapping, Phosphate and Toxicant Assimilation scored Low

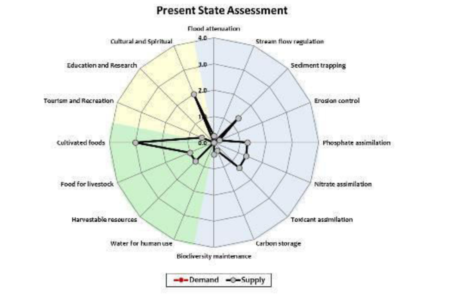
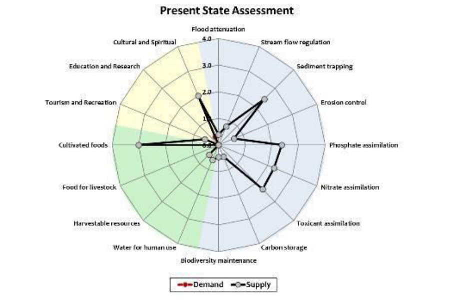
		
REC (Rountree *et al.,* 2013)	D – The Ecological Category of the watercourses should be maintained	
Calculated Buffer Zone (Macfarlane *et al*, 2015) – **Operational Phase** (Development footprint is precluded	15m – falls outside the study site	15m – falls outside the study site
Calculated Buffer Zone (Macfarlane *et al*, 2015) – **Construction Phase** (Should be viewed as an environmentally sensitive zone in which mitigation measures should be applied	38m – falls outside the study site	32m – extends onto a small section of the northernmost section of the site
Extent of modification anticipated	This watercourse and its associated buffer zones lie outside the site boundaries. Changed runoff characteristics in its catchment may result in erosion. Similar to the wetland, alien invasive plants may proliferate unless they are managed, and spills of sewage will affect local and downstream water quality	A small section of the construction phase buffer zone of the Unchannelled Valley Bottom wetland falls within the study site. Changes to the runoff intensity on the site may impact the wetland by causing erosion and sedimentation. Further densification of alien invasive plants and reduced water quality resulting from sewage spills may occur
Risk Assessment (GN 509)	The risk scores the construction and operational related impacts fall in the low category on condition that mitigation measures are effectively implemented. Particular care should be taken with the following: • Implement Best Practice with regards to the design, placement and maintenance of sewage infrastructure; • Implement an Alien Plant Control Plan; • Implement Sustainable Urban Drainage;	

Table of Contents

Figures

Tables

1 INTRODUCTION

Limosella Consulting was appointed by Elemental Sustainability to undertake a wetland and riparian assessment to inform the Water Use Licence Application from the Department of Water and Sanitation for the proposed Vryburg Mall. Fieldwork was conducted on the 20th and 21st of September 2021.

1.1 Terms of Reference

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- Discuss appropriate mitigation and management procedures relevant to the conserving watercourse on the site and downstream of the site.

1.2 Assumptions and Limitations

- 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 Water Use Licence application regulations. 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, were not included in the current study.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- Watercourse 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 Episodic Streams assessed during the site visit was dry at the time of the study and water samples could not be assessed and no water or SASS5 samples could be taken.

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 DHWS 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 should the Risk Assessment matrix (DWS, 2016) reflect a Low score. Activities that obtain a Medium or High risk score requires authorisation through a Water Use Licence (WUL) from the Department.

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)
- GN 320 (Procedures for Assessment and Minimum Criteria for Reporting on Environmental Themes in Terms Of 24(5)a and (h) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation

2 Locality of the study site

The study site is located just outside of Vryburg, North-West Province, and is bordered in the west by the N14 national road (Figure 1).

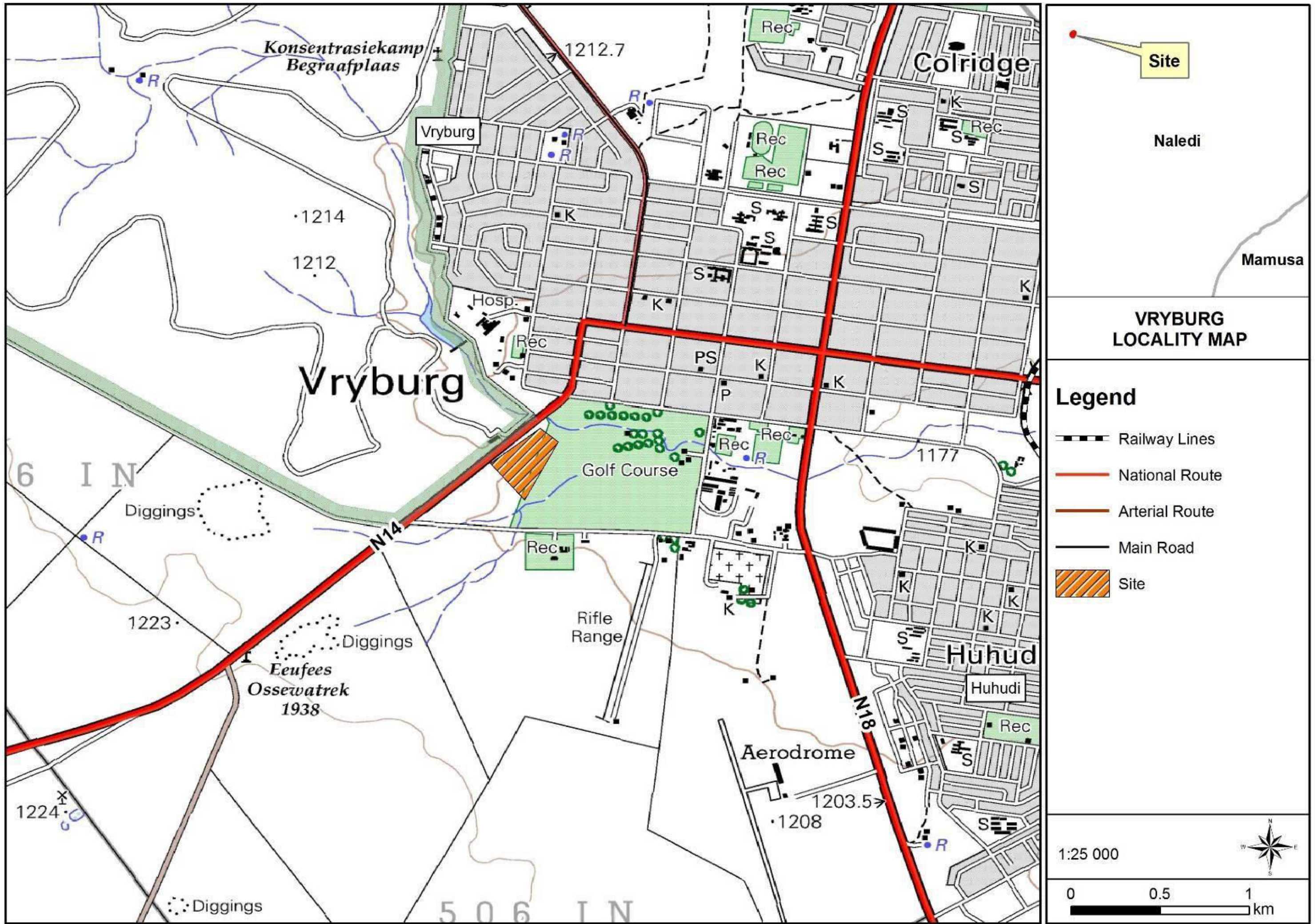


Figure 1: Locality Map

2.1 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. Table 1 below provides a summary of the important aspects.

Table 1: A summary of relevant site information obtained from a review of available spatial data

National screening Tool (Https://screening.environment .gov.za/screeningtool	
No Aquatic Sensitive Areas located on the study site or 500 m from the study site.	
General Description (Mucina & Rutherford, 2006)	
GPS Coordinates	26°57'51.32"S and 24°43'1.66"E
Broad Vegetation Units (Figure 2)	SVk 7 - Ghaap Plateau Vaalbosveld
Conservation Status	Least threatened
Topography	A flat plateau extends from around Campbell in the south, east of Danielskuil through Reivilo to around Vryburg in the north
Climate	Summer and autumn rainfall with very dry winters. MAP from about 300 mm in the southwest to about 500 mm in the northeast. Frost frequent to very frequent in winter
Hydrology and National Freshwater Ecosystem Priority Area (NFEPA) (2011) Database	
Important Rivers (CDSM, 1996) (Figure 2)	The Vryburg River flows 21m north of study site before flowing into the Leeuspruit River to form the Droe Harts River.
Quaternary Catchment	C32B
WMA (Government Gazette, 16 September 2016)	#5, Vaal Major: rivers include the Wilge, Liebenbergsvlei, Mooi, Renoster, Vals, Sand, Vet, Harts, Molopo and Vaal
DWAF (2014) http://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx	Reach 1924(PES=E), (EI=Low), (ES=Moderate)
NFEPA Wetlands	None within 500 m
Aquatic habitat	Aquatic habitat not suitable for a SASS5 and/or FRAI for majority of the year due to lack of surface water.
Strahler Stream Order (Figure 3)	The watercourse south of the study site is classified as a 1st order Episodic Drainage Line. Episodic Streams (which usually only flow as a result of rainfall events) are usually 1st or 2nd order streams while an increase in the stream order results in an increase in flow period.
North West Biodiversity Areas (Figure 6)	
• The Leon Taljaard Nature reserve is located directly across the street from the study site.	

Figure 2: Regional hydrology. *Please note the incorrect cadastral information was used and resulted in survey outside of the property boundary. The grey line indicated the approximate location of the correct eastern cadastral boundary.

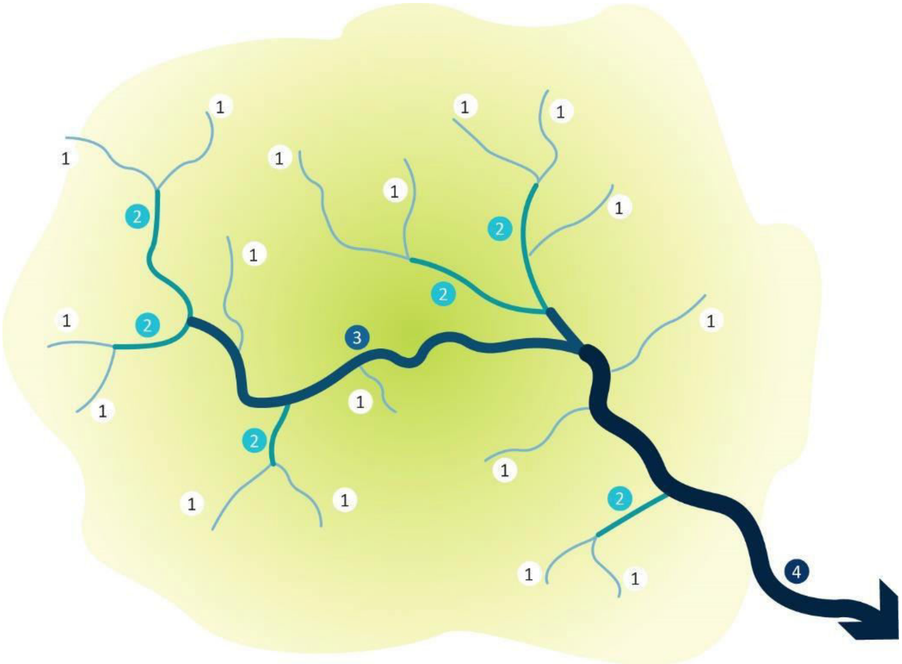


Figure 3: Visual representation of the Strahler stream order of rivers.

3 METHODOLOGY

The delineation method documented by the DWS in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), as well as the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*, 2013) was followed throughout the field survey. These guidelines describe the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms as well as the terrain unit indicator.
A hand held Garmin Montana 650 and/or a Samsung S10 smartphone was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey. Applications used on the smartphone includes GPX Viewer Pro and Google Earth.

Following a desktop assessment highlighting wetland areas to be groundtruthed in the field, soil and vegetation sampling on site informed a fine scale delineation. In the current study the watercourse areas were assessed using, VEGRAI (Kleynhans, 1999), Quick Habitat Integrity Assessment (Seaman *et al*., 2010), Present Ecological Status (PES) - WetHealth Version 2 (Kotze et al., 2020), Ecological Importance and Sensitivity (EIS) (DWAF, 1999) and WetEcoServices, (Kotze *et al*., 2020). In order to ease the legibility of the report, details regarding the methods used in each phase of the watercourse assessment are presented in Appendix A.

4 RESULTS

4.1 Land Use, Cover and Ecological State (Figure 4-6)

The study site is located directly south of Vryburg adjacent to the Vryburg golf course. The study site is located on previously undeveloped land. From early in 2009 a residential complex started development directly south of the study site with additional small to medium density housing following soon after. The Leon Taljaard Nature Reserve is located west of the study site. This nature reserve was proclaimed on 12 February 1972. Based on historical imagery the study area was undeveloped, although the dam in the wetland north of the study site (Vryburg River) and the town were already established in 1939. Digging was observed on the study site at the time of the field assessment.

It is important to note that the density of woody plants has increased along a section of the eastern border of the study site. It appears elevated soil moisture may support this change in vegetation (Figure 4-6). However, on-site investigation and historical imagery confirm that this is likely to an increase in stormwater input and leaking sewerage from Fairview Estate south of the study site, as well as from the road south of the study site. Drainage canals were dug here to convey runoff water, possibly, away from the golf course and into the wetland to the north. A natural episodic drainage line flows from this area north-east towards the northern wetland. Furthermore, the slope and on-site field observations suggests that a watercourse will not in normal conditions form here. We therefore conclude that, although in the current landscape water does move in this area, it is not due to natural processes. This artificially moist area is not classified as a watercourse in this report. However, it should be noted that it is likely that water may accumulate in this area, especially where stormwater is released. Furthermore, the release of this water into downslope watercourses may affect them through scouring and erosion, sedimentation or pollution. It is therefore important that the release of water from the proposed mall should be mindful of the bigger picture, and should be mitigated to ensure sustainability of the aquatic environment in the catchment.

Figure 4: A 1939 Map and 2006 Map indicating no discernible increase in woody species. *Please note the incorrect cadastral information was used and resulted in survey outside of the property boundary. The grey line indicated the approximate location of the correct eastern cadastral boundary.

Figure 5: 2020 and 2021 images showing clear evidence of water inputs into the landscape resulting in increased density of woody species. *Please note the incorrect cadastral information was used and resulted in survey outside of the property boundary. The grey line indicated the approximate location of the correct eastern cadastral boundary.

Figure 6: On-site investigation indicating increase in water inputs from the adjacent Fairview Estate and the surroundings from stormwater and sewerage leaks.

4.2 Watercourse Classification

Two watercourse types were recorded around the study site and are classified (following SANBI, 2013) as (Figure 7):

- Unchannelled Valley Bottom Wetland; and
- Non-Perennial Episodic (Drainage) Stream.

Although many woody trees can be seen in the watercourse north of the study site, these are predominantly Alien Invasive Species (AIS). This section of the watercourse is classified as a valley bottom wetland. The episodic stream located south of the study will only flow during rainfall events and does not provide specialised habitat for wetland species. Both the wetland and the episodic stream, including their operational phase buffer zone (15 m) are located outside of the study site. The operational phase buffer zone indicates an area in which the development footprint is precluded. The construction phase buffer zones are likely to encroach onto the study site (38 m for the episodic stream and 32 m for the wetland). However, these buffer zones do not preclude development but highlight a sensitive zone in which particular mitigation measures should be implemented to prevent impact to downslope watercourses.

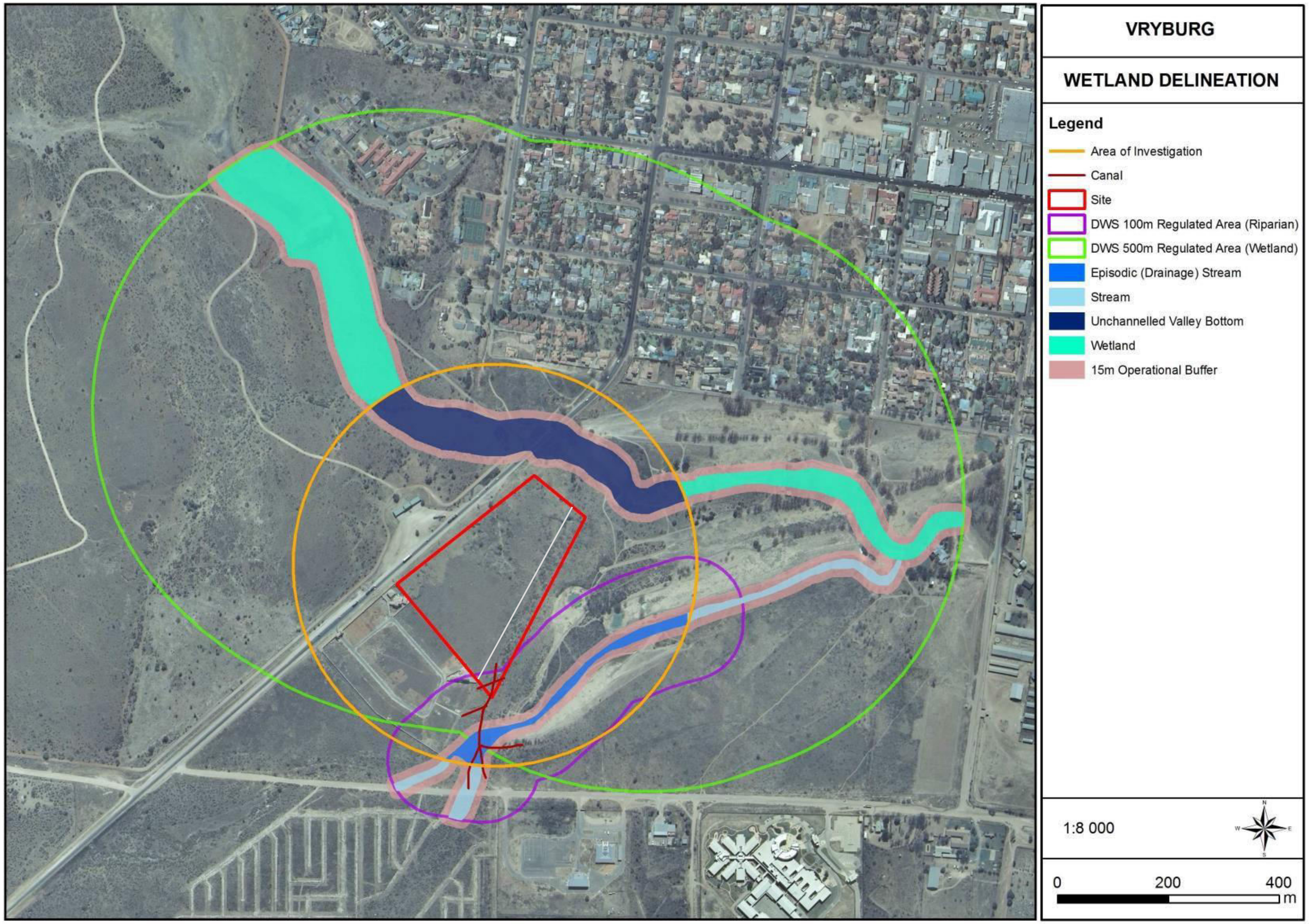


Figure 7: Watercourses associated with the study site. * Please note the incorrect cadastral information was used and resulted in survey outside of the property boundary. The grey line indicated the approximate location of the correct eastern cadastral boundary.

4.2.1 Vegetation and Soil Indicators

No rainfall was recorded for the season and although many winter flowering plants were recorded on the study site, the watercourses were very dry with desiccated clay recorded in the valley bottom wetland and very rocky soil on the study site itself.

The study site itself supported a diverse assemblage of terrestrial forb and grass species that should be characterised by a terrestrial ecologist. Woody plant species recorded in the watercourses adjacent to the site included *Vachellia karroo*, *Searcia lancea, Ziziphus mucronata* and *Asparagus africanus*. The non woody species recorded in the watercourses include *Persicaria sp, Eragrostis chloromela, Leersia hexandra.* The AIS included *Optunia spp, Quarces spp, Pennisetum clandestinum, Melia* azedarach and *Verbena aristigera* (Figure 8).

Figure 8: General characteristics of the episodic streams

.

4.3 Wetland Functional Assessment

The functionality of the watercourses is influenced by increased water inputs into the episodic stream (as discussed above), impoundments and the large number of AI species recorded. Finally, the golf course has changed the natural flow and drainage of both watercourses by mechanical changes including sloping and creation of dams, greens and fairways, sometime within the watercourses. Furthermore, anthropogenic activities including, road crossings and other infrastructure affected geomorphology and natural water flow of the watercourses (Figure 9).

Figure 9: Impacts associated with the watercourses include invasive species and small-scale erosion of watercourses at road crossings.

4.3.1 Integrity Scores

The integrity and function scores calculated for the two watercourses adjacent to the study site are presented in the section below. Table 2 presents a summary of the assessment methodologies applied to determine scores for the components of watercourse function and integrity. Since no aquatic habitat was recoded in the watercourses associated with the site, no instream aquatic parameters were assessed.

Table 2: Summary of the methodologies used to determine function and integrity scores for the watercourses associated with the study site.

Unchannelled Valley Bottom Wetland north of the study site (Vryburg River)	Episodic Stream south of the study site
WetHealth V2 (EC/PES) (Macfarlane *et al.*, 2020)	Riparian Vegetation Response Assessment Index (VEGRAI), (Kleynhans et al, 2008)
Environmental Importance and Sensitivity category (EIS) (Kotze *et al.*, 2020)	Quick Habitat Integrity (QHI), (Seaman *et al.*, 2010)
WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)	WetEcosystem Services V2 (ES) (Kotze *et al.*, 2020)
Recommended Ecological Category (REC) Rountree *et al.*, (2013)	Recommended Ecological Category (REC) Rountree *et al.*, (2013)

4.3.1.1 Riparian Vegetation Response Assessment Index (VEGRAI) & Quick Habitat Integrity (QHI)

VEGRAI and the Quick Habitat Integrity (QHI) assessment were done do determine the Ecological Category (EC) of the watercourses associated with the study area (Table 3 - 4). An EC of **D** was calculated for the Episodic Streams. This score refers to watercourses that are **Largely modified.** A large loss of natural habitat, biota and basic ecosystem functions has occurred (Kleynhans, 1996 & Kleynhans, 1999).

Table 3: Results of the VEGRAI scores obtained by the Episodic Stream (Kleynhans *et al*, 2008).

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGHTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	60.0	17.1	2.5	2.0	40.0
NON MARGINAL	53.3	38.1	2.5	1.0	100.0
	2.0				140.0
LEVEL 3 VEGRAI (%)				55.2	
VEGRAI EC				**D**	
AVERAGE CONFIDENCE				2.5	

Table 4: QHI for the Episodic Stream (Seaman *et al*, 2010).

QUATERNARY CATCHMENT	RIVER	Bed modification	Flow modification (0-5)	Inundation (0-5)	Riparian/Bank condition (0-5)	Water quality modification (0-5)	DESKTOP HABITAT INTEGRITY	INSTREAM EC%	INSTREAM EC	Vegetation Rating (0-5)	ECOSTATUS %	ECOSTATUS EC	CONFIDENCE (1-5)
C32B	Episodic Stream	3	4	2	3	3	**50.0**	**50.**	**D**	2	**56.7**	**D**	3

4.3.1.2 Present Ecological Status (PES) - WetHealth Version 2 (Kotze et al., 2020).

The results of the Wet-Health (Version 2) assessment indicate that the integrity of the wetland falls in a combined EC Category D, having obtained a combined impact score of 4.2 (Present Ecological Status 58%) (Table 5). Wetlands in this category are considered to be Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred. (Kotze *et al*., 2020). The wetland condition is likely to remain stable over the next 5 years.

Table 5: Summary of hydrology, geomorphology, water quality and vegetation health assessment for the unchannelled valley bottom wetland associated with the site (Macfarlane *et al.,* 2020).

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	4.2	4.0	2.7	5.7
PES Score (%)	58%	60%	73%	43%
Ecological Category	D	D	C	D
Trajectory of change	→	→	→	→
Confidence (revised results)	Medium	Medium	Medium	Medium
Combined Impact Score	4.2			
Combined PES Score (%)	58%			
Combined Ecological Category	D			

4.3.1.3 Ecological Importance and Sensitivity (EIS)

Integrating the following ecosystem service scores to determine the ecological importance (EI) category for the section of the wetland as proposed in Kotze *et al*., (2020) reflect a score of 1.0 - Moderate EI category:

- ***Biodiversity maintenance importance***: 1.0
- ***Regulating services importance***: 1.3
- ***Provisioning and cultural services importance:*** 0.7

Wetlands in this category are 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).

4.3.1.4 Ecosystem Services (ES)

The ecosystem services (Kotze *et al.,* 2020) provided by the episodic stream and the wetland adjacent to the study site are summarised in Tables 6 & 7 as well as figures 10 & 11 below. Although the overall scores for ecosystem services are very low, the watercourses support the local community by not only providing water, cultivated foods and wood, but also grazing for livestock.

Table 6: Results of the current Ecosystem Services provided by the Episodic Streams

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0.3	0.0	0.0	Very Low
	Stream flow regulation	-	-	#VALUE!	#VALUE!
	Sediment trapping	1.3	0.0	0.0	Very Low
	Erosion control	0.2	0.0	0.0	Very Low
	Phosphate assimilation	1.3	0.0	0.0	Very Low
	Nitrate assimilation	1.3	0.0	0.0	Very Low
	Toxicant assimilation	1.4	0.0	0.0	Very Low
	Carbon storage	0.3	No scores	No scores	No scores
	Biodiversity maintenance	0.5	0.0	0.0	Very Low
PROVISIONING SERVICES	Water for human use	0.0	0.0	0.0	Very Low
	Harvestable resources	1.0	0.0	0.0	Very Low
	Food for livestock	1.0	0.0	0.0	Very Low
	Cultivated foods	3.0	0.0	1.5	Moderately Low
CULTURAL SERVICES	Tourism and Recreation	0.5	0.0	0.0	Very Low
	Education and Research	0.0	0.0	0.0	Very Low
	Cultural and Spiritual	2.0	0.0	0.5	Very Low

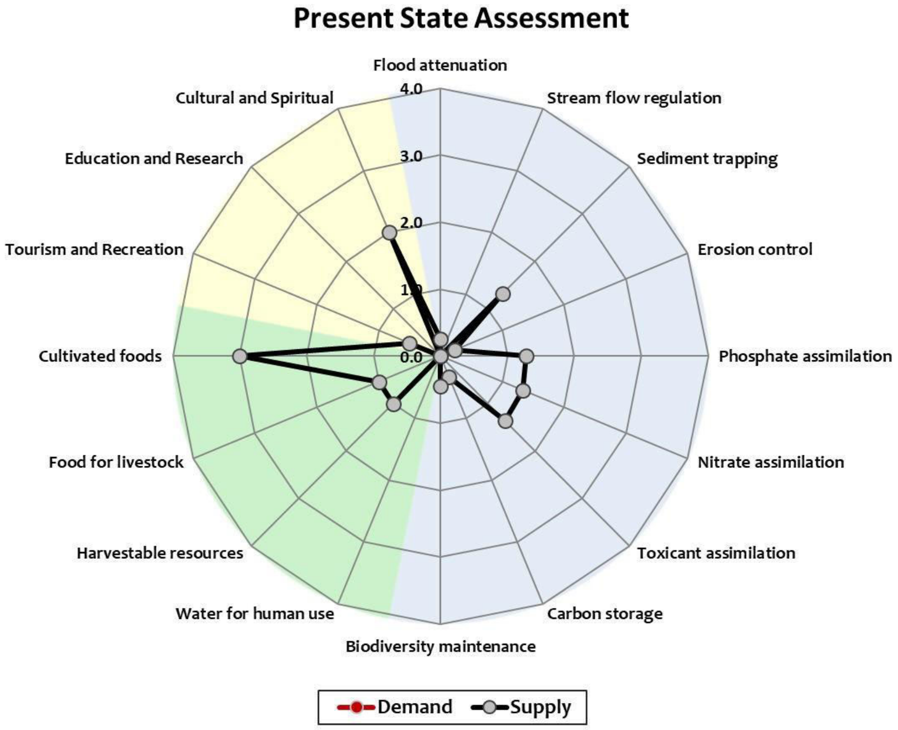


Figure 10: Ecosystem Services of the current state of the Episodic Streams.

Table 7: Results of the current Ecosystem Services provided by the Unchannelled Valley Bottom.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0.4	0.0	0.0	Very Low
	Stream flow regulation	0.8	0.0	0.0	Very Low
	Sediment trapping	2.4	0.0	0.9	Low
	Erosion control	0.6	0.0	0.0	Very Low
	Phosphate assimilation	2.4	0.0	0.9	Low
	Nitrate assimilation	2.3	0.0	0.8	Very Low
	Toxicant assimilation	2.3	0.0	0.8	Low
	Carbon storage	0.5	No scores	No scores	No scores
	Biodiversity maintenance	0.5	0.0	0.0	Very Low
PROVISIONING SERVICES	Water for human use	0.6	0.0	0.0	Very Low
	Harvestable resources	0.5	0.0	0.0	Very Low
	Food for livestock	0.0	0.0	0.0	Very Low

	Cultivated foods	3.0	0.0	1.5	Moderately Low
CULTURAL SERVICES	Tourism and Recreation	0.6	0.0	0.0	Very Low
	Education and Research	0.0	0.0	0.0	Very Low
	Cultural and Spiritual	2.0	0.3	0.7	Very Low

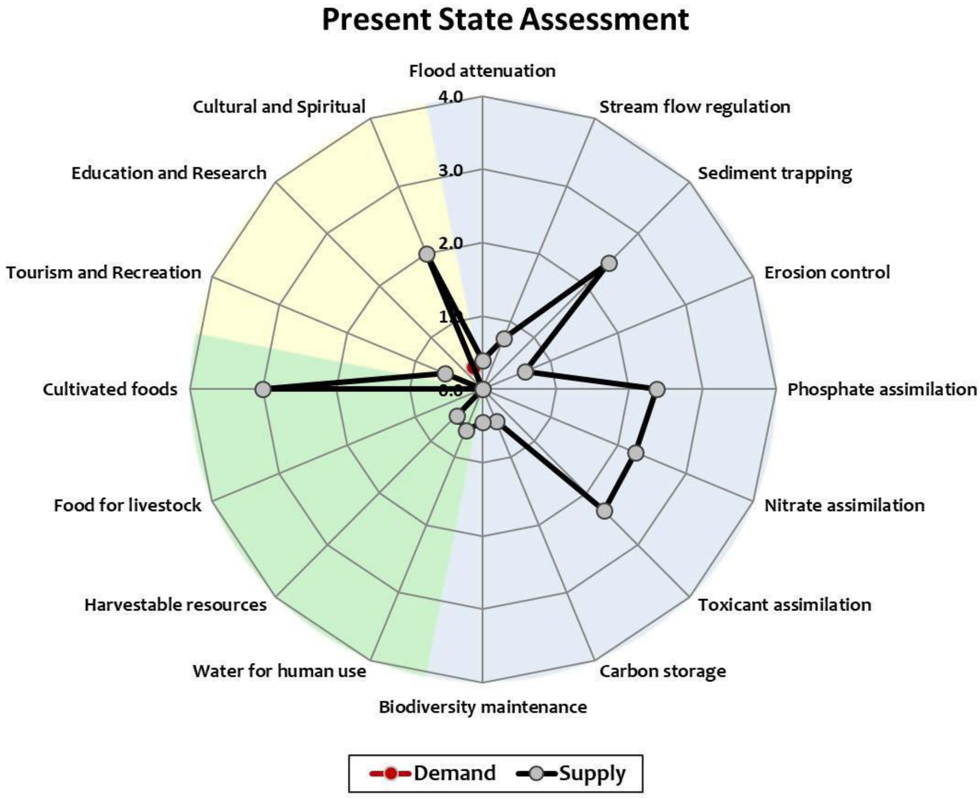


Figure 11: Ecosystem Services of the current state of the Unchannelled Valley Bottom

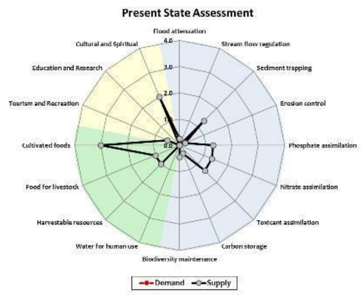
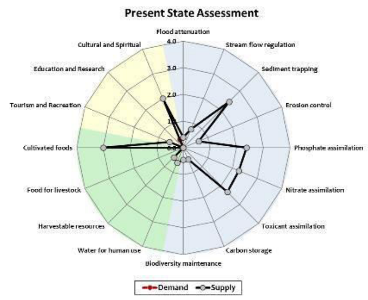
4.3.1.5 Recommended Ecological Category (REC)

Following the method set out in Rountree et al., (2013), the PES value of D and Moderate EIS class, leads to the identification of an REC of D (Table 7). This means that the development should be done in such a way as to at a minimum maintain the EC values as D.

4.4 Summary of Findings

Table 8 provides a summary of the results recorded for each watercourse unit discussed in this report.

Table 8: Summary of scores obtained for the watercourse on the study site

Classification (SANBI, 2013)		Non-Perennial Episodic Stream	Unchannelled Valley Bottom (Vryburg River)
PES/EC Scores		QHI (Seaman *et al.*, 2010) VEGRAI (Kleynhans, 1999) (EC) - **D – Largely modified.** A large loss of natural habitat, biota and basic ecosystem functions has occurred	Present Ecological Status (PES) - **D - Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred
WetEcoServices (Kotze et al, 2020) –		Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low 	Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low. Sediment Trapping, Phosphate and Toxicant Assimilation scored Low 
REC (Rountree *et al,* 2013)		D – The Ecological Category of the watercourses should be maintained	
Calculated Buffer Zone (Macfarlane *et al,* 2015)	Operational Phase (Development footprint is precluded	15m – falls outside the study site	15m – falls outside the study site
	Construction Phase (Should be viewed as an environmentally sensitive zone in which mitigation measures should be applied	38m – falls outside the study site	32m – extends onto a small section of the northernmost section of the site

5 DWS (2016) Impact Register and Risk Assessment

No proposed layout was available at the time of the watercourse assessment. The entire site falls within the DWS regulated area around the wetland to the north of the site and the stream to the south. We assume that activities include retail infrastructure, including parking areas, access roads, stormwater, sewage and water reticulation. The Risk Assessment assumes that, although potential impacts to the watercourses adjacent to the study site could occur as a result of the proposed mall, implementation of the mitigation hierarchy and strict adherence to measures set out below will assist in minimising the significance of impacts. Potential impacts to the wetland and the episodic stream include the following:

- Changes to runoff characteristics of the catchment of the watercourses leading to a cumulative increase in high energy runoff which may result in erosion and sedimentation;
- Disturbance of soil is likely to result in further densification of Alien Invasive species; and
- Unintended spills of sewage from new infrastructure will significantly affect water quality and consequent loss of aquatic habitat and ecological structure.

An extract from the Risk Matrix spreadsheet as promulgated in General Notice 509 (2016) is presented in Table 9. Risk scores for the construction and operational phases of the proposed establishment of the Vryburg Mall fall in the Low risk score.

Table 9: The DWS (2016) risk assessment matrix for the proposed mall construction and operation. Risk is determined after considering all listed control / mitigation measures

RISK MATRIX (Based on DWS 2016 publication: Section 21 c and I water use Risk Assessment Protocol): Proposed Vryburg Mall Development

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+Vegetation)	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 phase of the Shopping Centre	Preparation for construction, including vegetation clearing, access roads and crew camps	• Increased runoff and erosion, and thus increased sedimentation. • Disturbance of soil leading to potential increased alien vegetation • Potential deteriorated water quality, including dust generation and spills of construction-related material such as cement and hydrocarbons from vehicles	2	0	2	1	1	1	1	3	1	1	0	2	**4**	**13**	**L**	**80%**	•During the detailed design phase, the footprint and design of structures should aim to have the least impact on habitat quality and hydrology of the watercourse. • Design should take into account soil properties, slopes and runoff energy. • Implement the principles of Sustainable Urban Drainage (SUDS) • Excavated materials (from any trenching) should not be contaminated and it should be ensured that the minimum surface area is taken up • Implement Best Practice with regards to concrete mixing on site and control of waste and pollution • Any excavated soil/ stockpiles may not exceed 1 m in height. Mixture of the lower and upper layers of the excavated soil should be kept to a minimum, so as for later usage as backfill material. • All manholes are to be raised above the 1:100 year floodline • Manholes should be constructed to SANS 1200 specification with maximum spacing of 80 m	N	PES: D EIS: Low ES: Very Low REC: D
		Groundbreaking, excavation of foundations and other construction related earthworks		2	0	2	1	1	1	1	3	2	2	0	2	**6**	**20**	**L**	**80%**		N	
		Installation of service infrastructure through trenching (water and sewage pipelines) upslope of the watercourses		2	2	2	2	2	2	2	6	2	1	5	2	**10**	**60**	**L**	**80%**		N	
		Storm Water Management during the construction phase		2	2	2	2	2	2	2	6	2	1	5	2	**10**	**60**	**L**	**80%**		N	

O	Operation of the Shopping Centre	Day to day activities of the shopping centre including stormwater managament and services	• Possible permanent changes to the runoff in the catchment may alter hydrology of the watercourse and cause unintended downstream effects such as erosion and sedimentation. • Potential failure of infrastructure and waste management systems (e.g. sewage infrastructure) resulting in leakages and possible contamination of surface water	2	2	2	1	2	2	2	6	2	1	5	2	**10**	**58**	**L**	**80%**	• During the detailed design phase the footprint and design of structures should aim to have the least impact on habitat quality and hydrology of the watercourse • Control of alien invasive plants should form part of the maintenance plan for the proposed mall • Implement Sustainable Urban Drainage principles with a focus on environmentally sensitive stormwater management • Ensure that sewage infrastructure include emergency measures to contain spills, for example emergency by-pass lines It should be ensured that regular maintenance takes place to prevent failure of any infrastructure associated with the proposed development; • The managing authority should test the integrity of the sewer pipelines at least once every five years or more often should there be any sign or reports of a leak. •Maintenance activities should follow best practice	N	PES: D EIS: Low ES: Very Low REC: D
		Maintenance of infrastructure		1	1	2	1	1	1	1	3	1	1	5	2	**9**	**29**	**L**	**80%**		N	

6 Conclusion and Recommendations

Two watercourse types were recorded around the study site and are classified (following SANBI, 2013) as (Figure 7):

- Unchannelled Valley Bottom Wetland; and
- Non-Perennial Episodic (Drainage) Stream.

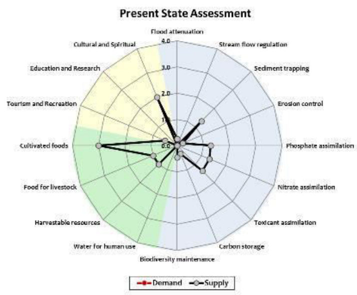
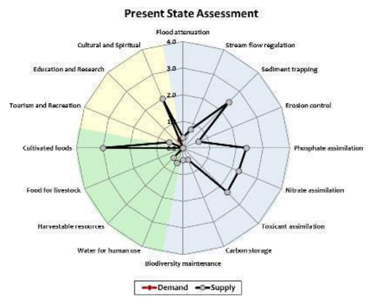
Although many woody trees can be seen in the watercourse north of the study site, these are predominantly Alien Invasive Species (AIS). This section of the watercourse is classified as a valley bottom wetland. The episodic stream located south of the study will only flow during rainfall events and does not provide specialised habitat for wetland species. Both the wetland and the episodic stream, including their operational phase buffer zone (15 m) are located outside of the study site. The operational phase buffer zone indicates an area in which the development footprint is precluded. The construction phase buffer zones are likely to encroach onto the study site (38 m for the episodic stream and 32 m for the wetland). However, these buffer zones do not preclude development but highlight a sensitive zone in which particular mitigation measures should be implemented to prevent impact to downslope watercourses

No proposed layout was available at the time of the watercourse assessment. The entire site falls within the DWS regulated area around the wetland to the north of the site and the stream to the south. We assume that activities include retail infrastructure, including parking areas, access roads, stormwater, sewage and water reticulation. The Risk Assessment assumes that, although potential impacts to the watercourses adjacent to the study site could occur as a result of the proposed mall, implementation of the mitigation hierarchy and strict adherence to measures set out below will assist in minimising the significance of impacts. Potential impacts to the wetland and the episodic stream include the following:

- Changes to runoff characteristics of the catchment of the watercourses leading to a cumulative increase in high energy runoff which may result in erosion and sedimentation;
- Disturbance of soil is likely to result in further densification of Alien Invasive species; and
- Unintended spills of sewage from new infrastructure will significantly affect water quality and consequent loss of aquatic habitat and ecological structure.

An extract from the Risk Matrix spreadsheet as promulgated in General Notice 509 (2016) is presented in Table 9. Risk scores for the construction and operational phases of the proposed establishment of the Vryburg Mall fall in the Low risk score. Table 10 below presents a summary of the findings of this assessment'.

Table 10: Summary findings relevant to Environmental Authorisation

	Quaternary Catchment and WMA areas	
	A63C, #1, Limpopo	
Classification (SANBI, 2013)	**Non-Perennial Episodic Streams south of the site**	**Unchannelled Valley Bottom north of the site (Vryburg River)**
PES/EC Scores	QHI (Seaman *et al.*, 2010) VEGRAI (Kleynhans, 1999) (EC) - **D – Largely modified.** A large loss of natural habitat, biota and basic ecosystem functions has occurred	Present Ecological Status (PES) - **D - Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred
WetEcoServices (Kotze et al, 2020) –	Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low 	Generally Very Low. The highest score was for Cultivated Foods which scored Moderately Low. Sediment Trapping, Phosphate and Toxicant Assimilation scored Low 
REC (Rountree *et al*, 2013)	D – The Ecological Category of the watercourses should be maintained	
Calculated Buffer Zone (Macfarlane *et al*, 2015) – **Operational Phase** (Development footprint is precluded	15m – falls outside the study site	15m – falls outside the study site
Calculated Buffer Zone (Macfarlane *et al*, 2015) – **Construction Phase** (Should be viewed as an environmentally sensitive zone in which mitigation measures should be applied	38m – falls outside the study site	32m – extends onto a small section of the northernmost section of the site
Extent of modification anticipated	This watercourse and its associated buffer zones lie outside the site boundaries. Changed runoff characteristics in its catchment may result in erosion. Similar to the wetland, alien invasive plants may proliferate unless they are managed, and spills of sewage will affect local and downstream water quality	A small section of the construction phase buffer zone of the Unchannelled Valley Bottom wetland falls within the study site. Changes to the runoff intensity on the site may impact the wetland by causing erosion and sedimentation. Further densification of alien invasive plants and reduced water quality resulting from sewage spills may occur

Risk Assessment (GN 509)	The risk scores the construction and operational related impacts fall in the low category on condition that mitigation measures are effectively implemented. Particular care should be taken with the following: • Implement Best Practice with regards to the design, placement and maintenance of sewage infrastructure; • Implement an Alien Plant Control Plan; • Implement Sustainable Urban Drainage;

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APPENDIX A: Detailed Methodology

The delineation method documented by the DHWS in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), and the Minimum Requirements for Biodiversity Assessments (GDACE, 2009) as well as the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al.,* 2013) was followed throughout the field survey. These guidelines describe the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms as well as the terrain unit indicator.

A hand held Garmin Montana 650 was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey.

Wetland and Riparian Delineation

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

Desktop Delineation

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

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

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

Ground Truthing

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figure 12):

- 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 50cm of the soil surface.

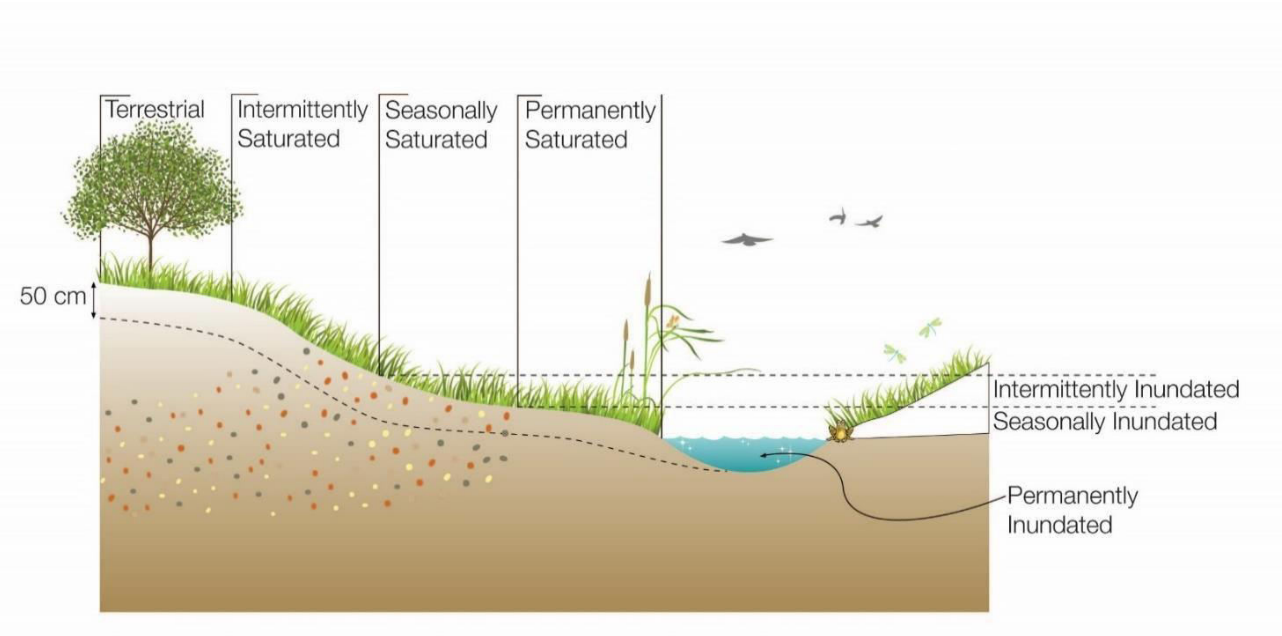


Figure 12: Typical cross section of a wetland (Ollis, 2013)

The Terrain Unit Indicator

The terrain unit indicator (Figure 13) 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 14).

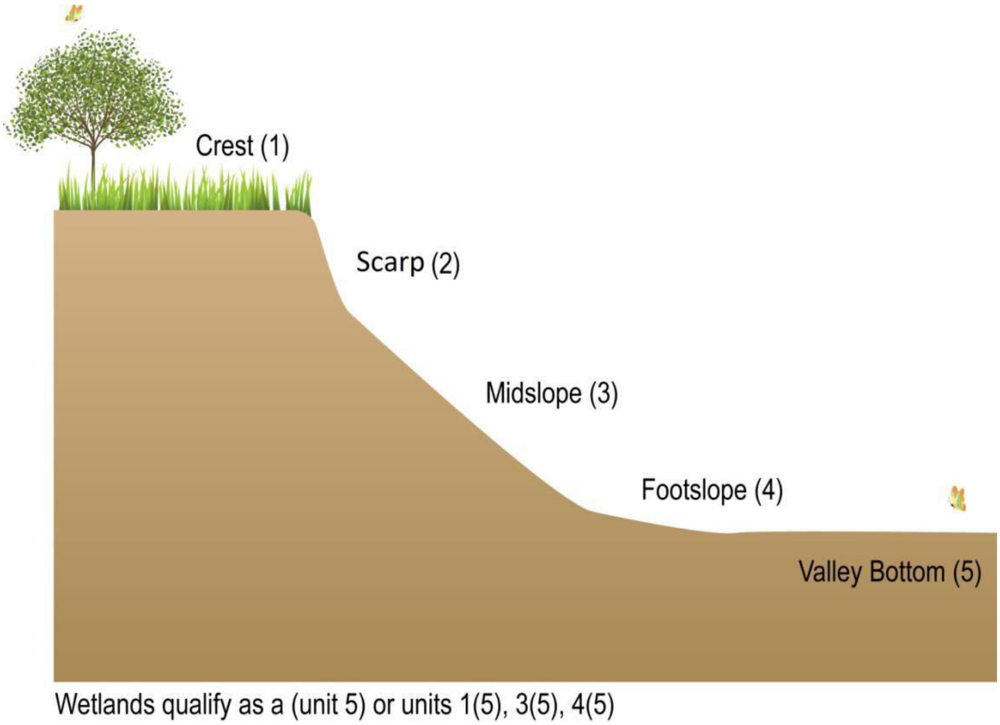


Figure 13. Terrain units (DWAF, 2005).

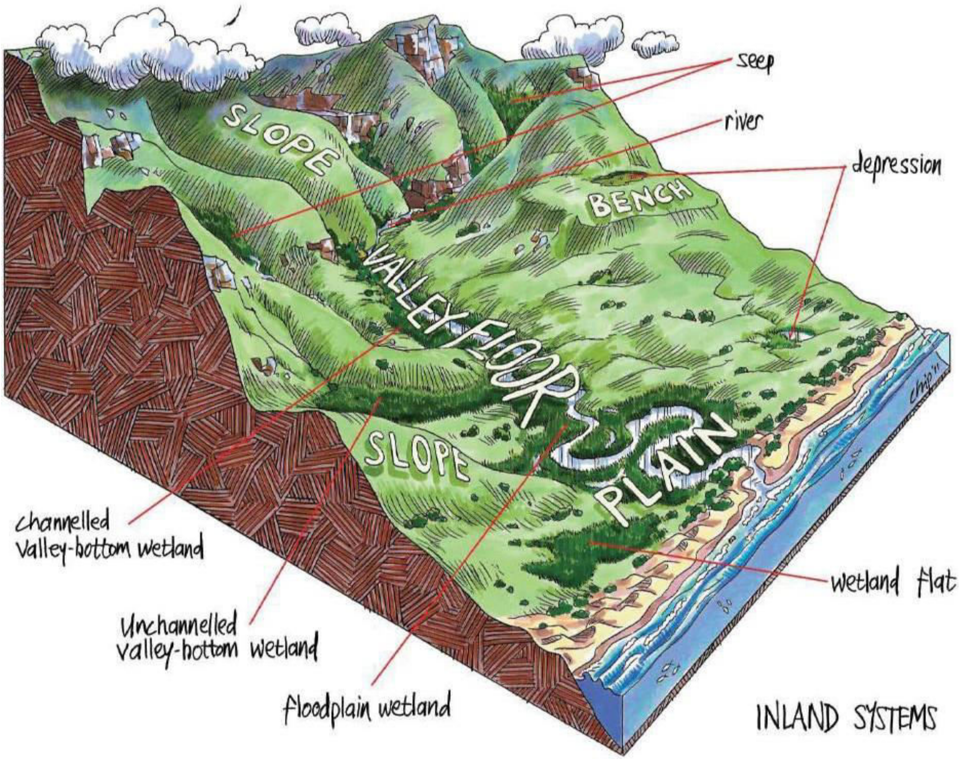


Figure 14: Wetland Units based on hydrogeomorphic types (Ollis *et al.,* 2013)

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 15).

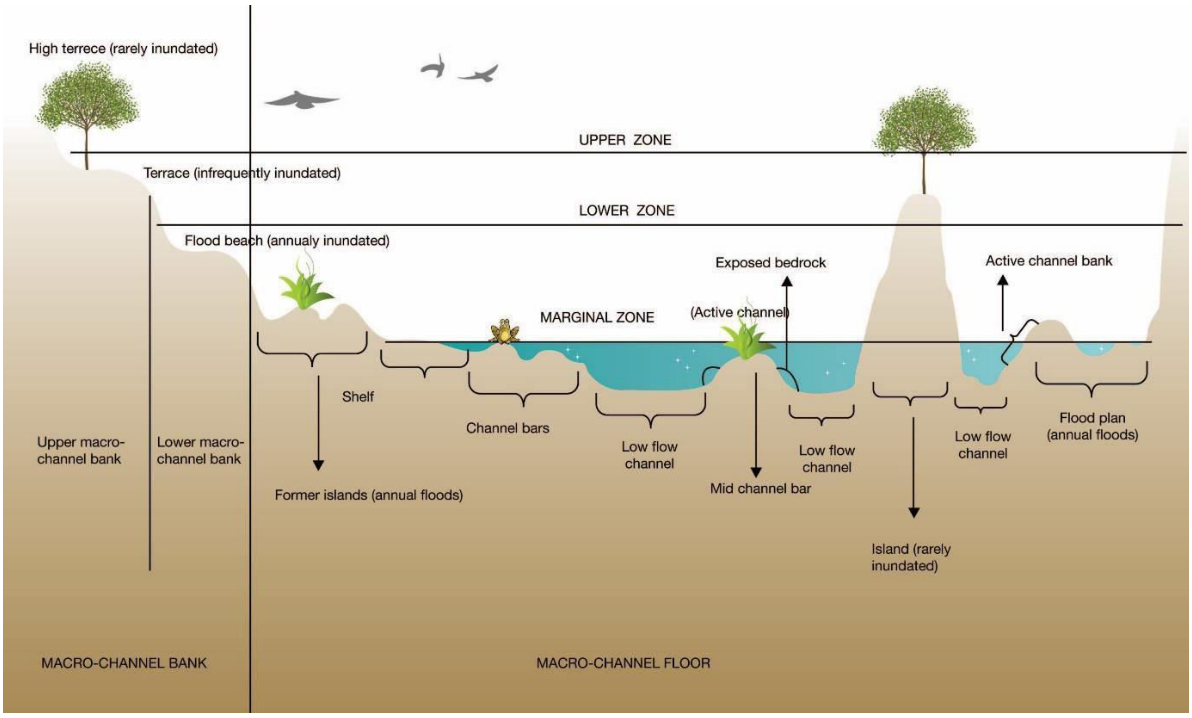


Figure 15: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

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

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 (Kotze, 1999).

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 16). 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.

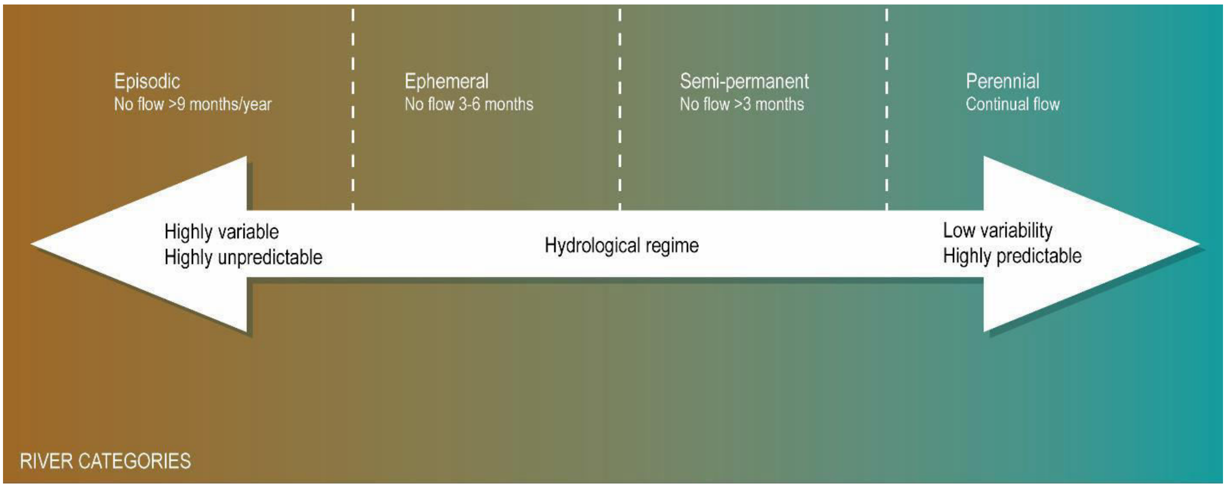


Figure 16: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al.*, 2010).

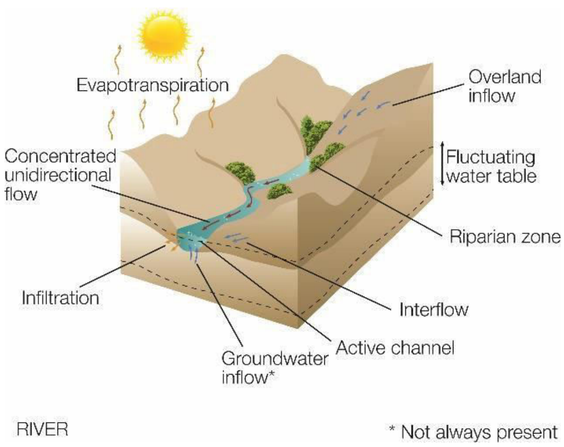
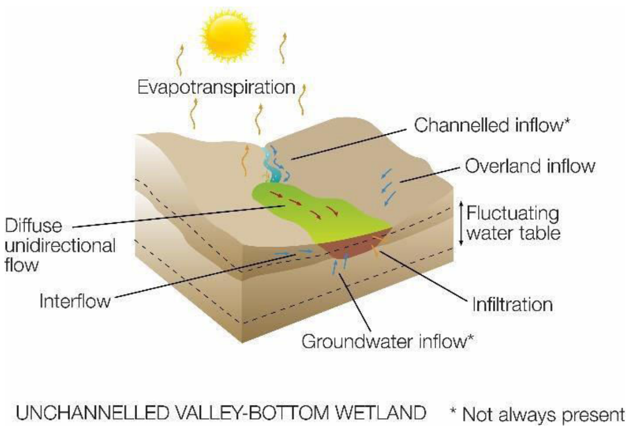
Watercourse Classification and Delineation

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

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

The classification of watercourse 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 11):

Table 11: Watercourse Types and descriptions

Watercourse Type:	**Description:**
Riparian habitat 	Linear fluvial, eroded landforms which carry channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone.
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.

Buffer Zones and Regulated Areas

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWAF, 2005). A development has several impacts on the surrounding environment and on a 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.

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 were developed and 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. The minimum accepted buffer for low-risk developments are 15 meters from the edge of the watercourse (Macfarlane, *et al.,* 2015).

It should be noted that the buffer calculation tool does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments.

Figure 17 images represent the buffer zone setback for the wetland types discussed in this report.

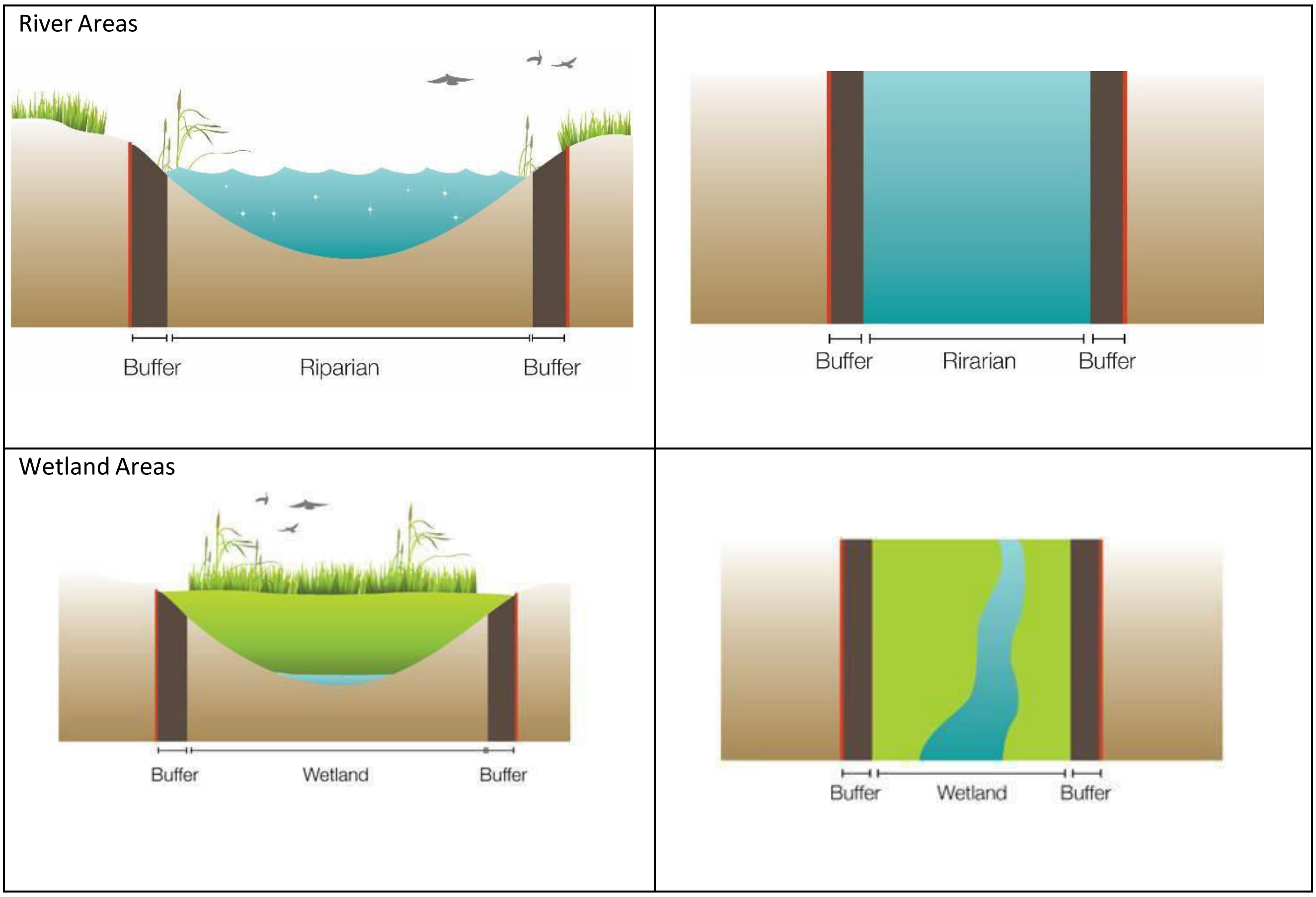


Figure 17: The buffer zone setback for the watercourse types discussed in this report

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

Impact Assessments

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

Table 12: An extract from DWS (2016) indicating the risk scores and classes as well as the implication for the appropriate authorization process

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

Watercourse 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 watercourse unit associated with the study site, to provide an Ecological Category (EC). 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) watercourse unit. The aspects of functionality and integrity that are predominantly addressed include hydrological and geomorphological function (subjective observations) and the integrity of the biodiversity component (mainly based on the theoretical intactness of natural vegetation) as directed by the assessment methodology.

Present Ecological Category (EC): Riparian

In the current study, the Ecological Category of the riparian areas was assessed using a level 3 VEGRAI (Riparian Vegetation Response Assessment Index) (Kleynhans et al, 2007) and QHI (Quick Habitat Integrity) to calculate the ecological category of the river system (Table 13).

Table 13: Generic ecological categories for EcoStatus components (modified from Kleynhans, 1996 & Kleynhans, 1999).

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

Quick Habitat Integrity Model

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

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

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 14. 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 14: 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 15

Table 15: 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	(↓↓)

Ecosystem Services (ES)

The DWS authorisations related to wetlands are regulated by Government Notice 267 published in the Government Gazette 40713 of 24 March 2017. Page 196 of this notice provides a detailed "terms of reference" for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed. This requirement is addressed through the WetEcoServices toolkit (Kotze *et al*. 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. Scores are ranked as High, Moderate or Low.

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 16.

Table 16: 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

Recommended Ecological Category (REC)

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 DWS. In such cases the REC must automatically be increased to a D.

Where the PES is in the A, B, C, D or E the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the 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 (Table 17).

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)

Table 17: Generic Matrix for the determination of REC and RMO for water resources

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

APPENDIX B: Abbreviated CVs Of Participating Specialists

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
ID Number	7604250013088
Name of Firm:	Limosella Consulting
Position:	Director - Principal Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology

EDUCATIONAL QUALIFICATIONS

- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- Short course in wetland soils, Terrasoil Science (2009)
- MSc Ecology, University of South Africa (2010 – submitted 2016). Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management

PUBLICATIONS

- A.A. Boostma, S. Elshehawi, A.P. Grootjans, P.L Grundling, S. Khosa, M. Butler, L. Brown, P. Schot. *In Press.* Anthropogenic disturbances of natural ecohydrological processes in the Matlabas mountain mire, South Africa. South African Journal of Science
- P.L. Grundling, A Lindstrom., M.L. Pretorius, A. Bootsma, N. Job, L. Delport, S. Elshahawi, A.P Grootjans, A. Grundling, S. Mitchell. 2015. Investigation of Peatland Characteristics and Processes as well as Understanding of their Contribution to the South African Wetland Ecological Infrastructure Water Research Comission KSA 2: K5/2346
- A.P. Grootjans, A.J.M Jansen , A, Snijdewind, P.C. de Hullu, H. Joosten, A. Bootsma and P.L. Grundling. (In Press). In search of spring mires in Namibia: the Waterberg area revisited
- Haagner, A.S.H., van Wyk, A.A. & Wassenaar, T.D. 2006. *The biodiversity of herpetofauna of the Richards Bay Minerals leases.* CERU Technical Report 32. University of Pretoria.
- van Wyk, A.A., Wassenaar, T.D. 2006. *The biodiversity of epiphytic plants of the Richards Bay Minerals leases.* CERU Technical Report 33. University of Pretoria.
- Wassenaar, T.D., van Wyk, A.A., Haagner, A.S.H, & van Aarde, R.J.H. 2006. *Report on an Ecological Baseline Survey of Zulti South Lease for Richards Bay Minerals*. CERU Technical Report 29. University of Pretoria

KEY EXPERIENCE

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

- More than 250 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape. 2007, ongoing.
- Scoping level assessment to inform a proposed railway line between Swaziland and Richards Bay. April 2013.
- Environmental Control Officer. Management of onsite audit of compliance during the construction of a pedestrian bridge in Zola Park, Soweto, Phase 1 and Phase 2. Commenced in 2010, ongoing.
- Fine scale wetland delineation and functional assessments in Lesotho and Kenya. 2008 and 2009;
- Analysis of wetland/riparian conditions potentially affected by 14 powerline rebuilds in Midrand, Gauteng, as well submission of a General Rehabilitation and Monitoring Plan. May 2013.
- Wetland specialist input into the Environmental Management Plan for the upgrade of the Firgrove Substation, Western Cape. April 2013
- An audit of the wetlands in the City of Johannesburg. Specialist studies as well as project management and integration of independent datasets into a final report. Commenced in August 2007
- Input into the wetland component of the Green Star SA rating system. April 2009;
- A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- As assessment of wetlands in southern Mozambique. This involved a detailed analysis of the vegetation composition and sensitivity associated with wetlands and swamp forest in order to inform the development layout of a proposed resort. May 2008.
- An assessment of three wetlands in the Highlands of Lesotho. This involved a detailed assessment of the value of the study sites in terms of functionality and rehabilitation opportunities. Integration of the specialist reports socio economic, aquatic, terrestrial and wetland ecology studies into a final synthesis. May 2007.
- Ecological studies on a strategic scale to inform an Environmental Management Framework for the Emakazeni Municipality and an Integrated Environmental Management Program for the Emalahleni Municipality. May and June 2007

Name:	**RUDI BEZUIDENHOUDT**
ID Number	880831 5038 081
Name of Firm:	Limosella Consulting
Position:	Wetland Specialist
SACNASP Status:	Reg. No. 008867)

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

- **<u>Wetland Specialist - Limosella Consulting</u>**
  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 (Reg. No. 008867)

APPENDIX C: 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