WETLAND DELINEATION & FUNCTIONAL ASSESSMENT

Wetland Delineation & Functional Assessment for the Proposed Township Establishment on Portion 3 of the Farm Doornpan No. 193, Ventersdorp Local and Dr Kenneth Kaunda District Municipalities, North-West

A Project for Nkanivo Development Consultants

November 2021

triplo4 sustainable solutions

DOCUMENT DESCRIPTION

Client / Applicant: Nkanivo Development Consultants

Report name: Wetland Delineation & Functional Assessment for the proposed Township Establishment on Portion 3 of the Farm Doornpan No. 193, NW

Report type: Wetland Delineation & Functional Assessment (WD&FA)

Project name: Proposed Township Establishment on Portion 3 of the Farm Doornpan No. 193

Project number: E-BL01.210473

Version: Final03

Compiled and Authorised by:

Compiled By:	Date	Signature
Suheil Malek Hoosen Wetland Specialist *Pri Sci Nat*	17/11/2021	
Reviewed and Approved By:		**Signature**
Chen Read Senior Sustainability Consultant *EAPASA*	17/11/2021	

COMPILED FOR:
Nkanivo Development Consultants
Name: Mr. Samuel Chauke
Email: info@nkanivo.co.za

COMPILED BY:
Triplo4 Sustainable Solutions (Pty) Ltd
Address: Suite 5, The Circle, Douglas Crowe Ave, Ballito Business Pk, Dolphin Coast, 4420
Telephone: +27 (0)31 563 4422
Facsimile: +27 (0)31 940 9847
Email: hantie@triplo4.com
www.triplo4.com

1. EXECUTIVE SUMMARY

Triplo4 Sustainable Solutions (hereafter referred to as Triplo4) was appointed by Mr. Samuel Chauke (on behalf of Nkanivo Development Consultants) to conduct a Wetland Delineation and Functional Assessment (WDFA) for the proposed Township Establishment in town Ventersdopr, hereafter known as the proposed development, within Ventersdorp Local and Dr. Kenneth Kaunda District Municipalities, North-West.

The purpose of this Wetland Delineation and Functional Assessment (WD&FA) was to identify sensitivities on site in order to determine the developable land and associated environmental legal requirements. The report provides input to the Water Use License Application (WULA) and Basic Assessment (BA) or full EIA, should it be required, by identifying, classifying and presenting infield delineations of the watercourses within the 500 metre (m) assessment radius of the proposed development. Additionally, the specialist will present and provide quantitative data to justify his recommendations associated with the proposed development.

The proposed development was observed to fall within the Middle Vaal Water Management Area (WMA) and sub-WMA; within Quaternary Catchment C24E. The proposed development does not traverse any Freshwater Ecosystem Priority Area (FEPA) Rivers or Wetlands but an unnamed FEPA River exist on the extent of the site which might be indirectly impacted by constructional activities (Nel et al., 2011). Thus, cognizance of the FEPA River must be taken into consideration so that no construction activities occurs within it. One (1) vegetation unit occurs within the proposed development extent which is the Vaal-Vet Sandy Grassland (SANBI, 2018). The conservation status of this vegetation type is endangered (SANBI, 2018). Lastly, the proposed development was noted to fall within a CBA1 (Desmet and Schaller, 2015).

Delineated watercourses and watercourses at risk

A total of three (3) wetlands were identified within the 500m regulated buffer. These wetlands were classified as one (1) channelled valley bottom (CVB01) wetland and two (2) unchannelled valley bottom wetlands (UVB01 and UVB02). All of the aforementioned wetlands were determined to be at risk. Features which calculated a high and moderate risk in the initial risk assessment were assessed further using the appropriate assessment tools/methods. The following Table EX1 presents the at-risk watercourses (wetland systems) and the Present Ecological State (PES) scores that were calculated for each. The PES of all the at-risk wetland systems were assessed with the use of the WET-Health Tool (Macfarlane *et al.,* 2009).

Table EX1: Assessed at risk wetland systems associated with the proposed development

WET-HEALTH SCORES				
WATERCOURSE	HYDROLOGY	GEOMORPHOLOGY	VEGETATION	**OVERALL SCORE**
CVB01	4.0 (D) →	2.1 (C) →	4.8 (D) ↓	**3.7 (C) →**
UVB01	7.0 (E) →	3.0 (C) →	6.7 (E) ↓	**5.8 (D) →**
UVB02	4.0 (D) →	1.4 (B) →	5.1 (D) →	**3.6 (C) →**

Wetland Systems Functional Importance

The Ecosystem Services (ESS) and functionality of the at-risk wetland systems associated with the proposed development were assessed with the WET-Ecoservice tool developed by Kotze *et al.* (2009). These systems were considered of high importance in terms of assimilation of toxicant and nitrate removal, phosphate and sediment trapping, erosion control and flood attenuation. Conversely, these systems did not provide any socio-cultural ESS.

Ecological Importance and Sensitivity (EIS)

The EIS of the assessed wetlands systems were calculated utilising the EIS Tools developed by Rountree *et. al.* (2013) and Kleynhans (1999), respectively. The overall EIS scores calculated for CVB01, UVB01 and UVB02 was Moderate. This is due to these wetlands falling within a CBA1 at a desktop level (Desmet and Schaller, 2015) and CVB01 and UVB01 falling with a FEPA River at a desktop level (Nel *et al*., 2011).

Impact Statement

The wetlands that have been delineated within the study area have undergone moderate to large disturbances from historic and current land use practices. The overall PES scored for the at risk wetlands were primarily as a result of anthropogenic pressures in the catchment and wetland extent namely; construction of linear infrastructure (dirt and tar roads, overhead powerlines) within the catchment, increase in hardened surfaces in the catchment predominantly by informal development, ad hoc dumping, construction of WWTWs through wetland and proliferation of AIPs due to the aforementioned changes. This indicated that modifications have moderately and largely impacted the wetlands within the study area which has subsequently impacted on the habitat quality, diversity, and size.

The DWS Risk Assessment Matrix concluded that an aspect of the proposed development did not have the ability to be mitigated from a moderate to low risk rating. Thus, in line with GN509 of 26 August 2016, which was drafted in accordance with the NWA (No. 36 of 1998), as well as the specialist's opinion, the proposed development will require to undergo a full WULA process to obtain a Water Use Licence. As the proposed development falls within CBA1, the applicability and triggers of listed activities in term of the 2014 EIA Regulations (as amended) must also be investigated, to determine if an Environmental Authorisation is required.

Specialist's Recommendation

Following the site visit and conducting the assessments, the specialist is in support of the proposed development as long as no development occurs within the wetland and associated buffers. Furthermore, the mitigation measures outlined in this report are to be included in the EMPr, and must be followed.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 2

2. INTRODUCTION 1

2.1. BACKGROUND INFORMATION 1

2.2. SCOPE OF THE PROPOSED PROJECT 1

2.3. OBJECTIVES OF THE WD&FA 2

2.4. AUTHORS OF THE WD&FA 2

3. APPLICABLE LEGISLATION, GUIDELINES AND DOCUMENTATION 4

3.1. APPLICABLE ENVIRONMENTAL LEGISLATION 5

4. METHODOLOGY AND DATA 6

4.1. DESKTOP ASSESSMENT AND DELINEATION 6

4.2. INFIELD VERIFICATION AND DATA COLLECTION 7

4.3. ASSESSMENT METHODOLOGIES 10

5. ASSUMPTIONS AND LIMITATIONS 14

6. DESKTOP ASSESSMENT AND DELINEATION 15

6.1. STUDY AREA 15

6.2. DELINEATIONS & SCREENING 22

7. WETLAND SYSTEMS: LEVEL 1 WET-HEALTH ASSESSMENT 26

7.1. Channelled Valley Bottom Wetland 26

7.2. Unchannelled Valley Bottom (UVB) Wetlands 30

8. ECOSYSTEM SERVICES AND ECOLOGICAL IMPORTANTS AND SENSITIVITY 34

8.1. Ecosystem services of CVB01 34

8.2. Ecological Importance and Sensitivity of CVB01 34

8.3. Ecosystem services of UVB01 and UVB02 35

8.4. Ecological Importance and Sensitivity of UVB01 and UVB02 36

9. BUFFER ZONE DETERMINATION 37

10. IMPACT AND RISK ASSESSMENT 39

10.1. Impact Assessment 39

10.2. DWS Risk Assessment Matrix (RAM) 39

11. MITIGATION MEASURES 44

11.1. Pre-construction Mitigation Measures 45

11.2. Construction Mitigation Measures 46

11.3. Post Construction/Rehabilitation Phase 49

11.4. Operation Phase 51

12. MONITORING REQUIREMENTS 53

13. CONCLUSION 55

14. REFERENCES 56

LIST OF FIGURES

Figure 1: Locality and topographical map of the proposed development site 1
Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland (Kotze et al., 2009). 7
Figure 3: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF, 2008) 8
Figure 4: Image illustrating the classification of river channels using the frequency that each channel section contains baseflow (DWAF, 2008). 9
Figure 5: Dominant formation within the proposed development site 16
Figure 6: Map of the vegetation types within the proposed development 17
Figure 7: Critical Biodiversity Area within the proposed development site 18
Figure 8: Map of the WMA, sub-WMA and Quaternary Catchment that fall within the proposed development site 21
Figure 9: Map of the FEPA Rivers and Wetland in relation to the proposed development, from the NFEPA dataset 22
Figure 10: Final layout of the proposed development. 23
Figure 11 : Map of the in-field delineations of the wetlands identified at the proposed development and 500m regulated buffer 24
Figure 12: A - Dirt road through wetland impeding the natural flow, B – Eutrophic conditions observed approximately 50m north of the WWTW away, C – Construction of the WWTWs within the wetland wetness zones which is situated adjacent to the south of the proposed development, D- Stand of *Typha capensis* within CVB01. 29
Figure 13: A - Ad hoc dumping in close proximity to UVB02, B - Construction of dirt road through UVB02, C – Patches of *Typha capensis* and grassland within UVB01, D – Construction of dirt road through UVB01 which impedes the natural diffuse flow of wetland. 33
Figure 14: Diagram illustrating the direct and indirect benefits supplied by CVB01 34
Figure 15: Diagram illustrating the direct and indirect benefits supplied by UVB01 and UVB02 36
Figure 16: Map illustrating the calculated buffer segments for the wetlands delineated within the 500m regulated buffer 38
Figure 17: The mitigation hierarchy for dealing with negative impacts on biodiversity. Its application is intended to require companies to first strive to avoid disturbance of ecosystems and loss of biodiversity, and where they cannot be avoided altogether, to minimise, rehabilitate or offset any residual negative impacts on biodiversity (DEA, 2013). 44

LIST OF TABLES

Table 1: Applicable Environmental Legislation 5
Table 2: Current Environmental Legislation 5
Table 3: Current Provincial Legislation **Error! Bookmark not defined.**
Table 4: Utilised data, associated sources and significance to the proposed project 6
Table 5: Wetness zones, vegetation types and classification of plants occurrence in wetlands based on their relationship (Kotze et al., 2009) 9
Table 6: Frequency of wetland species plant occurrence within different wetness zones (Kotze et al., 2009) 10
Table 7: Health categories used by the WET-Health for describing the integrity of wetlands (Macfarlane et al., 2009) 10
Table 8: Category of score for the Present Ecological State (PES) 11
Table 9: Category of score for the Ecological Importance and Sensitivity (Rountree, 2013) 11
Table 10: The ratings associated with the assessment of the Ecological Importance and Sensitivity of the riverine areas 12
Table 11: Physical and socio-cultural ecosystem services 13
Table 12: Freshwater habitat screening 13
Table 13: Main attributes of the Highveld Eco-region (Kleynhans et al., 2005) 15
Table 14: Description of the dominant formation within the proposed development site 16
Table 15: CBA Descriptions for North-West Province (Desmet and Schaller, 2015). 18
Table 16: Criteria utilised to rank the delineated wetlands within the 500m regulated buffer around the proposed development 25
Table 17: Watercourse Risk Screening 25
Table 18: General and flow characteristics that influence the formation of CVB wetlands 26
Table 19: Characteristic of CVB01 26
Table 20: Presentation of the natural state, existing impacts and current state of CVB01 in relation to each WET-Health modules (Macfarlane *et al*., 2009). 27
Table 21: Presentation of the PES scores that was calculated for CVB01 associated with the proposed development (Macfarlane *et al*., 2009) 28
Table 22: General and flow characteristics that influence the formation of UVB wetlands 30
Table 23: Characteristics of UVB01 and UVB04 30
Table 24: Presentation of the natural state, existing impacts and current state of UVB01 and UVB02 in relation to each WET-Health modules (Macfarlane *et al*., 2009). 30
Table 25: Presentation of the PES scores that were calculated for UVB01 and UVB02 associated with the proposed development (Macfarlane et al., 2009). 32
Table 26: Summary of the Ecological Importance and Sensitivity scores for CVB01 35
Table 27: Summary of the Ecological Importance and Sensitivity scores for UVB01 and UVB02 36
Table 28: Recommended buffer zones for the wetlands that will be potentially impacted on by the proposed development (Macfarlane & Bredin, 2016). 37
Table 29: Evaluation of potential impacts of the proposed development on the surrounding watercourses (Presented in a summarised DWS RAM) 40
Table 30: Pre-Construction phase mitigation measures. 45
Table 31: Construction Phase Mitigation Measures 46
Table 32: Post-construction/rehabilitation phase measures 49
Table 33: Operational phase mitigation measures 51

GLOSSARY OF TERMS

Auger
An auger is a drilling device that usually includes a rotating screw to act as a screw conveyor to remove the drilled out material such as soils. The rotation of the blade causes the material to move out of the hole being drilled. A Dutch (or mud) auger has a unique open design for cutting through boggy, saturated and/or heavily rooted soils such as those found in wetlands.

Biodiversity
The variety of life in an area, including the number of different species, the genetic wealth within each species, and the natural areas which they are found.

Biophysical Environment
All aspects of the natural environment including physical features such as watercourses, groundwater and soils as well as the biological features such as plants and animals.

Buffer
A zone or area around a geographic feature measured in distance. Example: an assessment buffer is an area around a proposed development which needs to be assessed within the report.

Catchment
All the land area from mountaintop to seashore which is drained by a single river and its tributaries.

Chroma (Soil Colour)
The relative purity of the spectral colour, which decreases with increasing greyness.

Competent Authority
The national or provincial governmental department or body responsible for the environmental applications being placed. DWS, DEA, EDTEA and DMR are the most likely competent authorities to be associated with wetland delineations and functional assessments.

Delineation
To determine the boundary of a wetland based on soil, vegetation, and/or hydrological indicators (see definition of a wetland).

Ecosystem Services
Benefits people obtain from ecosystems including provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits.

Environment
The environment means the surroundings within which humans exist and that could be made up of water, air, soil, sand, plants and animals.

Environmental Impact
An impact or environmental impact is the change to the environment, whether desirable or undesirable, that will result from the effect of an activity. An impact may be the direct or indirect consequence of a construction, operational or decommissioning activity.

Environmental Consultant
An independent consultant that is appointed by the Client to compile an Environmental Management program and to undertake environmental audits or Control Officer functions.

Environmental Specifications
Instructions and guidelines for specific activities designed to help prevent, reduce and/or control the potential environmental implications of these activities during the operational, construction or decommissioning / closure phases of the facilities.

Fauna
Any and all animals identified within or outside of the operational or project areas. Animals may not be harmed in any way.

Flora
All species of plants that are found in a particular region, habitat, or time period within or outside of the operational or project areas.

Freshwater Systems / Habitats
A subset of Earth's aquatic ecosystems. They include wetlands, rivers, streams, ponds, dams and lakes.

Gleying (Soil Characteristic)
Soil material that has developed under anaerobic conditions as a result of prolonged saturation with water. Grey and sometimes blue or green colours predominate but mottles (yellow, red, brown and black) may be present and indicate localised areas of better aeration.

Hue (Soil Colour)
The dominant spectral colour (e.g. red).

Hydrogeomorphic (HGM)
A wetland classification/typology system based on the hydrological and landscape (geomorphic) characteristics of wetlands.

Hydrogeomorphic (HGM) Unit
A single "reach", segment or unit of a particular type of HGM wetland type.

Incident
The occurrence of a pollution or degradation event that will have a direct or indirect effect on the environment e.g. surface water, groundwater, soils, ambient air as well as plants, animals and humans.

Invasive Alien Plants (IAP)
An Alien Species is a species that has been intentionally or unintentionally introduced to a location, area, or region where it does not occur naturally. An Invasive Alien Plant is an alien species that causes, or has the potential to cause, harm to the environment, economies, or human health (Global Invasive Species Programme).

Land owner
The individual, company, entity, Tribal Authority, Local Municipality or District Municipality that legally owns the land.

Mitigation measures
Mitigation seeks to address poor or inadequate practices, procedures, systems and/ or management measures by the implementation of preventative and corrective measures to reduce, limit, and eliminate adverse or negative environmental impacts or improve the positive aspects.

Mottle (Soil Characteristic)
Soils with variegated colour patters are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as monies.

Permanent (Wetland Zone)
Soil which is flooded or waterlogged to the soil surface throughout the year, in most years.

Proposed Project / Development
The activities, footprint and structures proposed by the client.

Reference State
The natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development.

Rehabilitation
Rehabilitation is defined as the return of a disturbed area, feature or structure to a state that approximates to the state (where possible) that it was before disruption, or to an improved state.

Remediation
The management of a contaminated site to prevent, minimise, or mitigate harm to human health or the environment

Riparian
The area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).

Runoff
Total water yield from a catchment including surface and subsurface flow.

Seasonal (Wetland Zone)
Soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.

Social Environment
Persons likely to be directly or indirectly affected by the day-to-day operations of the mill.

Solid Waste
Means all solid waste, including domestic and office waste (food, paper, plastic), waste from operations e.g. empty chemical containers, dried sludge as well as waste from the construction and / or decommissioning phases, chemical waste, excess cement/concrete, inert building rubble, packaging, timber, tins and cans.

Soil Profile
The vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).

Study Area
The proposed project/development's site and footprint as well as an assessment buffer. Assessment buffers are decided upon by the reports intended use, i.e. 500m for WULAs or 32m for BARs

Sustainable development / sustainability
The integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.

Temporary (Wetland Zone)
The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Terrain Unit Classes
Areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), midslope (3), footslope (4), and valley bottom (5).

Topsoil
The layer of soil covering the earth which provides a sustainable environment for the germination of seeds, allows water penetration, and is a source of micro-organisms and plant nutrients.

Value (Soil Colour)
The relative lightness or intensity of colour.

Waste
Any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered.

Watercourse / Water Resource
A river or spring; a natural channel or depression in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows; and any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse.

Watershed
A ridge of land that separates waters flowing to different rivers, basins, or seas. These split areas into different catchments.

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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).

GLOSSARY OF ACRONYMS

AIP(s)	Alien Invasive Plant(s)
BAR:	Basic Assessment Report
DEA:	Department of Environmental Affairs
(D)EDTEA:	(Department of) Economic Development, Tourism and Environmental Affairs
DMR:	Department of Mineral Resources
DOT:	Department of Transport
DWS:	Department of Water and Sanitation
EA:	Environmental Authorisation
ECA:	Environment Conservation Act
ECO:	Environmental Control Officer
EIA:	Environmental Impact Assessment
EIS:	Ecological Importance and Sensitivity
EMPr:	Environmental Management Programme
GA:	General Authorisation
HGM(U):	HydroGeoMorphic (Unit)
HSE:	Health, Safety and Environment.
NEMA:	National Environmental Management Act
NEM:BA:	National Environmental Management: Biodiversity Act
NFEPA:	National Freshwater Ecosystem Priority Area
NWA:	National Water Act
PE:	Project Engineer
PES:	Present Ecological State
PM:	Project Manager
PU:	Planning Unit
RAM:	Risk Assessment Matrix (in referral to the DWS RAM)
SEMA:	Specific Environmental Management Acts
S&EIA	Scoping and Environmental Impact Asessment
WUL(A):	Water Use License (Application)

2. INTRODUCTION

2.1. BACKGROUND INFORMATION

Triplo4 Sustainable Solutions (hereafter referred to as Triplo4) was appointed by Mr. Samuel Chauke (on behalf of Nkanivo Development Consultants) to conduct a Wetland Delineation and Functional Assessment (WDFA) for the proposed Township Establishment in town Ventersdopr, hereafter known as the proposed development, within Ventersdorp Local and Dr. Kenneth Kaunda District Municipalities, North-West.

The proposed development is approximately 92.44 hectares (ha) in extent and occurs in a piece of land that has been moderately transformed by anthropogenic activities namely; dirt and tar roads, historic sand mining, informal housing developments and adjacent Waste Water Treatment Works (WWTWs). The proposed development will occur on a gentle to moderate east sloping piece of land which is well vegetated with grassland and sporadic patches of trees. The central geographic co-ordinate of the proposed development is 26°18'11.73"S 26°47'26.86"E.

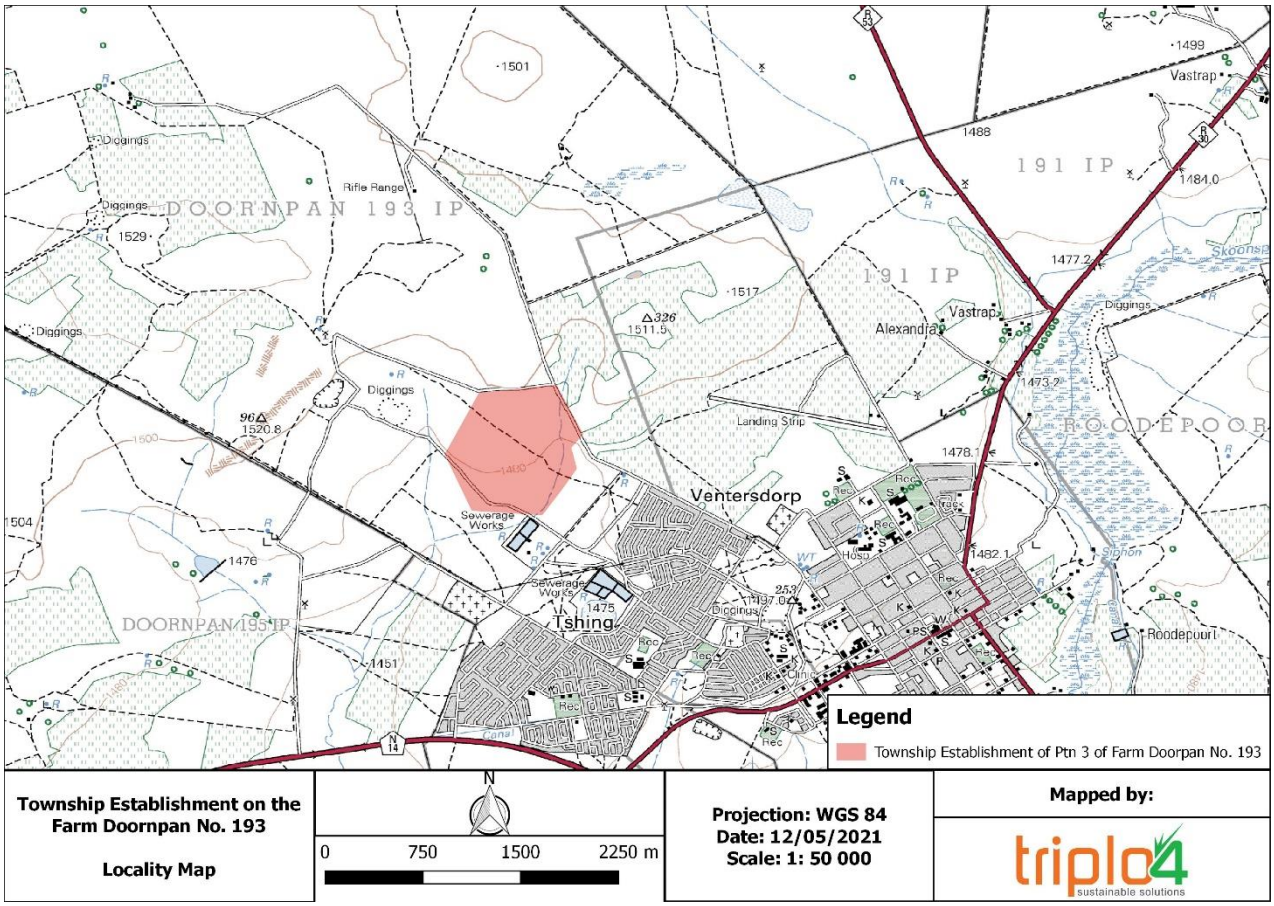


Figure 1: Locality and topographical map of the proposed development site

2.2. SCOPE OF THE PROPOSED PROJECT

The proposed development encompasses 8 different zonings namely;

- Residential (dwelling units) – 37.26 ha,
- Residential 3 (Flat/Group Units) – 0.82 ha,
- Business 1 (commercial use) – 0.40 ha,
- Institutional (school, creche and public worship) – 3.95 ha,
- Recreational (sports centre) – 1.93 ha,
- Government (clinic) – 0.42 ha,
- Municipal (municipal purposes) – 0.98 ha,
- Public open space – 23.44 ha, and

- Street – 19.11.

No information was provided regarding the provision of bulk water and wastewater services, and it is assumed that connection to the municipal systems is proposed.

2.3. OBJECTIVES OF THE WD&FA

The objective of the WD&FA for the proposed development as adopted from the specific terms of reference presented within the DWS Government Gazette No. 40713 of the 24th of March 2017:

- Desktop delineation and illustration of all watercourses within 500m regulated buffer of the proposed development utilising available site-specific data such as aerial photography, elevation data and regional water resource data.
- Risk screening assessment of the delineated watercourses to determine which watercourses will be significantly impacted upon by the proposed development. This was based on professional opinion which may be scientifically substantiated;
- Infield delineation and digital mapping of all watercourses in relation to the proposed development in accordance with the methods contained in the manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005);
- Classification of the delineated watercourses in accordance with the 'National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013), watercourses will be classified in terms of being artificial or natural and wetland or riverine;
- Identification of site-specific biophysical characteristics namely: the hydrological, geomorphological and vegetation modules;
- Assess the current health and functionality of the systems that were identified to be at risk in terms of:
    - Present Ecological State - Level 1 WET-Health Tool (Macfarlane *et al*., 2009)
    - Ecological Importance and Sensitivity (EIS) assessment (Rountree, 2013)
    - Functional Assessment – Level 2 WET-EcoServices (Kotze *et al*., 2009)
    - Ecological Importance and Sensitivity assessment for riverine systems (Kleynhans & Louw, 2007)
- Determine the type and degree of potential impacts which may affect these systems (qualitative assessment);
- Conduct a Risk Assessment Matrix (RAM) (DWS, 2016) analysis to determine whether the proposed development may be authorised under a GA or WULA process or exemption as per General Notice 509 of 2016 in accordance with Section 39 of the NWA (No. 36 of 1998);
- Determine appropriate buffer guidelines by utilising the tool composed by (Marcfarlane and Bredin, 2016);
- Specify mitigation measures to reduce the impacts of the proposed development.

2.4. AUTHOR OF THE WD&FA

This document was compiled by:

Mr Suheil Malek Hoosen - Masters in Environmental Science

Suheil Malek Hoosen is a Wetland Ecologist with Triplo4 Sustainable Solutions, who holds a Master's Degree in Environmental Science with approximately 5 years of environmental experience in Wetland Ecology. He has been responsible for conducting Wetland Delineation and Functional Assessments, Wetland Rehabilitation Plans and Vegetation Impact Assessments. He has previously worked as a Wetland Specialist at KSEMS Environmental Consulting and Aeon Nexus, being involved in overseeing approximately 90 specialist projects. He is a fully registered SACNASP professional (*Pr.Sci.Nat.)* within the Environmental Science field of practice.

Triplo4 has gained experience on a wide spectrum of projects, spanning from Greenfield Mixed Use developments to industrial (e.g. mining), hazardous waste management operational facilities and linear developments (pipelines, roads, bridges). Triplo4 has a balanced approach and sustainability perspective on

development and operations, understanding not only the need for environmental management, but also the requirements for socio-economic development. It is recognised that socio-economic development may require environmental compromises or trade-offs, as long as these are done responsibly and within the legislative frameworks.

Triplo4 is registered with the Green Building Council of South Africa (GBCSA) allowing to provide expertise and sustainability measures on Energy (Lighting, Heating & Cooling); Water; Stormwater; Waste; Biodiversity & Materials. Furthermore, Triplo4 is a member of and subscribes to various Codes of Ethics e.g. the International Association for Impact Assessment (IAIAsa), the Institute for Waste Management South Africa (IWMSA) and the Water Institute of South Africa (WISA). In addition, Triplo4 team consists of 5 registered EAPs with EAPASA and 4 registered consultants with SACNASP.

Experience, having been gained in mining and environmental consulting enables Triplo4 to provide a broad range of environmental consulting services, including:

- environmental authorisations and feasibility assessments;
- environmental management systems;
- environmental capacity building / training and awareness;
- waste and water management and pollution control;
- environmental control officer functions and auditing;
- wetland and vegetation assessments;
- carbon footprint analysis and sustainability reporting.

3. APPLICABLE LEGISLATION, GUIDELINES AND DOCUMENTATION

This document describes the role of specialist studies such as wetland and vegetation reports in IEM and planning for environmentally sustainable development within the framework of existing legislation and environmental management policies.

South Africa is a constitutional democracy, which means the constitution and Bill of Rights are the supreme law. Our Constitution guarantees certain human rights, and is one of the most progressive in the world. In line with a constitutional democracy everyone has responsibilities.

In terms of The Constitution of the Republic of South Africa (Act No. 108 of 1996) everyone has the right:

- to clean water;
- to an environment that is not harmful to their health or well-being and to have the environment protected, for benefit of present and future generations, through reasonable legislation and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The overarching legislative framework that governs all environmental activities is the National Environmental Management Act (No 107 of 1998). NEMA aims to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected therewith. NEMA can help deal with problems at a municipal level and enables one to determine whether proper IEM procedures have been followed.

Accompanying NEMA is a set of Specific Environmental Management Acts (SEMA's). Known by the abbreviation of SEMA's, Specific Environmental Management Acts all fall under the auspices of the overarching National Environmental Management Act (NEMA). To date five SEMA's have been promulgated, with the most recent one being Waste Act in 2008. The full list of SEMA's is:

1. National Environmental Management: Protected Areas Act (57 of 2003), known as the NEM:PAA
2. National Environmental Management: Biodiversity Act (10 of 2004), known as the NEM:BA
3. National Environmental Management: Air Quality Act (39 of 2004), known as the NEM:AQA
4. National Environmental Management: Integrated Coastal Management Act (24 of 2008), known as the NEM:ICM
5. National Environmental Management: Waste Act (59 of 2008), known as the NEM:WA

Section 28 of NEMA (Duty of care and remediation of environmental damage) states that every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

The Water Use License (WUL) is a legal process governed by The Department of Water and Sanitation (DWS) requiring the authorisation of all water uses defined in Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) [NWA]. Following the promulgation in July 2016 of the General Notice 509, Section 21 (c) and (i) water uses can be issued with a General Authorisation in terms of Section 39 of the NWA.

The NWA defines a Section 21 water uses as inter alia:

Section 21 (a) – Taking Water from a water resource
Section 21 (b) – Storing Water
Section 21 (c) - Impeding and diverting the flow of water in a watercourse
Section 21 (i) - Altering the bed, bank, course or characteristics of a watercourse
Section 21 (e) – engaging in a controlled activity
Section 21 (f) – discharging waste or water containing waste in a manner which may detrimentally impact on a water resource
Section 21 (g) – Disposal of waste

3.1. APPLICABLE ENVIRONMENTAL LEGISLATION

The following Environmental legislation was considered, in the evaluation of the activities of the proposed development, as applicable to the WD&FA. It must be noted that only relevant sections of Acts have been listed below, as these were deemed pertinent and specific to the scope of the proposed development. These Acts must be considered and adhered to in their entirety at all times.

The list of applicable legislation and permits provided is intended to serve as a guideline only and is not exhaustive.

Table 1: Applicable Environmental Legislation

Legislation	Section	Relates to
The Constitution (No 108 of 1996)	Chapter 2	Bill of Rights.
	Section 24	Environmental rights.
National Environmental Management Act (NEMA): EIA Regulations (2014, as amended)	Section 2	Defines the strategic environmental management goals and objectives of the government. Applies through-out the Republic to the actions of all organs of state that may significantly affect the environment.
	Section 24	Provides for the prohibition, restriction and control of activities which are likely to have a detrimental effect on the environment.
	Section 28	The entity has a general duty to care for the environment and to institute such measures as may be needed to demonstrate such care.
	Section 30	Deals with the control of emergency incidents, including the different types of incidents, persons responsible for the incidents and reporting procedures to the relevant authority.
National Environmental Management: Biodiversity Act (No 10 of 2004)		Provides for the management and conservation of biodiversity, protection of species and ecosystems, and sustainable use of indigenous biological resources
National Water Act (No 36 of 1998) and regulations	Section 19	Prevention and remedying the effects of pollution
	Section 20	Control of emergency incidents
	Section 21/40	Licenses for water use
Nation Veld & Forest Fire Act (No 101 of 1998)		Provides for a variety of institutions, methods and practices to prevent and combat veld, forest and mountain fires.
National Forests Act (No 84 of 1998)		Protects and controls certain vegetation types as well as specific species.

The potential environmental impacts associated with the current project are required to be considered in compliance with the 2014 EIA Regulations (as amended) as well as all the SEMA's. It must also be noted that the list of Acts and their associated regulations must be frequently updated to ensure that all assessments are done according to and comply with the most current legislation.

Table 2: Current Environmental Legislation

Regulations and Guidelines
2014 Environmental Impact Assessment Regulations (as amended)
The General Policy on Environmental Conservation (January 1994)

4. METHODOLOGY AND DATA

As a necessary part of any specialist impact assessment, the relevant methodologies required to determine and assess the proposed project as well as the data available for the area, must be described. The below section is divided into a methodology subsection, where all methodologies are discussed in relevant detail, and a data subsection, where the data utilised for this assessment are named.

4.1. DESKTOP ASSESSMENT AND DELINEATION

An initial desktop assessment was done utilising all relevant GIS data available for the proposed project's study area. This included, but was not limited to, Google Earth terrain models, contours, NFEPA datasets, vegetation units, and past and present satellite imagery. Utilising these data, a desktop assessment of the study area (500m for NWA WULAs, 32m for NEMA BA or S&EIA) was performed to identify wetlands, rivers, and other watercourses in the area. These were then delineated using the contours, terrain models, and past and present satellite imagery to as high an accuracy as possible. Table 4 below is a list of utilised data and their associated sources which was used for the proposed project.

Table 3: Utilised data, associated sources and significance to the proposed project

DATA	SOURCE	APPLICATION TO PROPOSED DEVELOPMENT
DWS Eco-regions (Geographic Information System (GIS) data)	DWS (2005)	Local eco-region classification.
Google Earth Pro™ Imagery	Google Earth Pro™ (2018)	Up-to-date satellite imagery of the proposed development, area (size) determination, desktop watershed determination, desktop identification of catchment and HGM impacts.
Interactive catchment CD	Frank Sokolic of GISolutions in the WET-Health package by Macfarlane et al. (2009)	Determine primary, secondary, tertiary and quaternary catchments applicable to the study area and their climate.
National Biodiversity Assessment (NBA) Threatened Ecosystems (GIS Coverage)	South African National Biodiversity Institution (SANBI) (2011)	Determine the national threat status of the terrestrial and aquatic vegetation types.
National Freshwater Ecosystem Priority Areas (NFEPA) river and wetland inventories (GIS Coverage)	Council for Scientific and Industrial Research (CSIR) (2011)	Identify potentially important river and wetland systems at a local and regional scale.
NEFPA river, wetland and estuarine FEPAs (GIS Coverage)	CSIR (2011)	Indicates national aquatic ecosystem conservation priorities.
South African Vegetation Map (GIS Coverage)	Mucina & Rutherford (2006/2012)	Determine the national vegetation type of the study area.
South African Geological Map (GIS Coverage)	Geological Survey (1988)	Determine regional and study site geology and soil types.

The desktop assessment allowed for certain watercourses within the study area to be excluded from further investigation based on whether these systems were likely to be impacted upon by the proposed development. Reasons for exclusion will be justified for any system not further assessed within the screening sections (Section 6.2.2) of this report but some factors (amongst others) which were taken into consideration include:

- Whether the system is found within the same catchment as the proposed development. Systems found in different catchments will be excluded as they will not be impacted.

- The distance and location of system from the proposed development. Systems found at a suitably distant location upstream from the proposed development will be excluded as a result of the low likelihood of being impacted.
- The degree to which natural or currently present infrastructure buffers are present between the system and the proposed development. If these are deemed sufficient to shield the system from impact, they will be excluded from further investigation.

4.2. INFIELD VERIFICATION AND DATA COLLECTION

Following the completion of the desktop assessments, the watercourse delineations had to be verified infield in which a site visit was conducted on the **10th of May 2021**. Infield verification used field work techniques to more accurately determine the limits of the watercourses temporary zones, confirm the wetland type classification according to the Department of Water Affairs delineation manual (DWAF, 2005), and record information to be utilised in the functional assessment of all potentially impacted systems.

Wetland delineation verification requires the use of wetland indicators: measurable parameters that confirm the presence and type of wetland systems.

Four specific wetland indicators were used to confirm the presence of wetlands, including the:

- **Terrain Unit Indicator** which uses topography to identify the landscape features where wetland systems may develop;
- **Vegetation Indicator** (the NWA primary indicator) which takes the vegetation located in the area and determines the likelihood to which they are found in wetland soils (Obligate, Facultative Wetland, Facultative, or Facultative Dryland species);
- **Soil Indicator** that classifies certain soil forms according to the degree and regularity to which these soils are saturated; and
- **Soil Saturation Indicator** where soil features such as mottles and gleying were identified within the soil profile to indicate fluctuating saturation level.

Soil saturation indicators are obtained by observing soil characteristics in samples taken from soil cores using a Dutch soil auger. Samples were taken from depths of 0 -10cm and 30-50cm to determine the degree of saturation of the soils at these levels within potential wetland areas. In cores where indicators are present, and depending on the combination of which indicators are present at which depth, the zonation (permanent, seasonal, and temporary zone) can be determined.

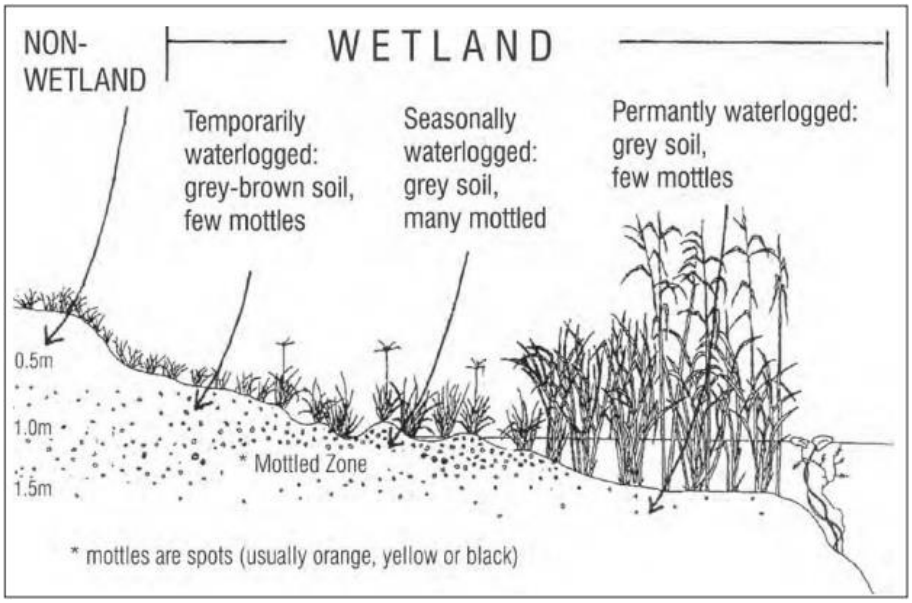


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland (Kotze et al., 2009).

Similarly, riverine delineation verification has its own set of indicators to confirm the location of the instream and riparian zones. The three indicators include:

- **Topography Indicator** whereby riverine systems will only be present at the lowest point within a valley profile and likely be restricted to being within the macro-channel of the stream;
- **Soil Indicator** in which alluvium and recently deposited soils are likely to be present within the riverine zones;
- **Vegetation Indicator**, as with wetland areas, vegetation species composition can be used to determine and confirm the extent of the riverine zone.

The classification of river channels is associated with the type of channel that is identified within a certain section of the channel network. There are three channel types, namely: "A", "B" and "C" sections and the difference between the three is their position relative to the zone of saturation within the system (DWAF, 2008). Figure 4 illustrates two levels of the water table; the line marked "wet" depicts the highest level that the water table would reach during a period of heavy rainfall when the zone of saturation has taken place, while the one marked "dry" depicts the level of the water table at its lowest after a dry period (DWAF, 2008). The zone of saturation must be in contact with the channel network for baseflow[1] to take place at any point in the channel.

(A) channel streams are those streams that have presumable flow three months of the year due to rainfall events and do not have baseflow, these are also considered as ephemeral streams.

(B) channel streams are those streams that have presumable flow six – nine months of the year and those that sometimes have baseflow.

(C) channel streams are those streams that have flow throughout the year and always have baseflow (DWAF, 2008).

This classification was adopted because it is based on the changing frequency of saturation of soils in the riparian zone; from very seldom (A), to quite often (B), and to always (C) (DWAF, 2008).

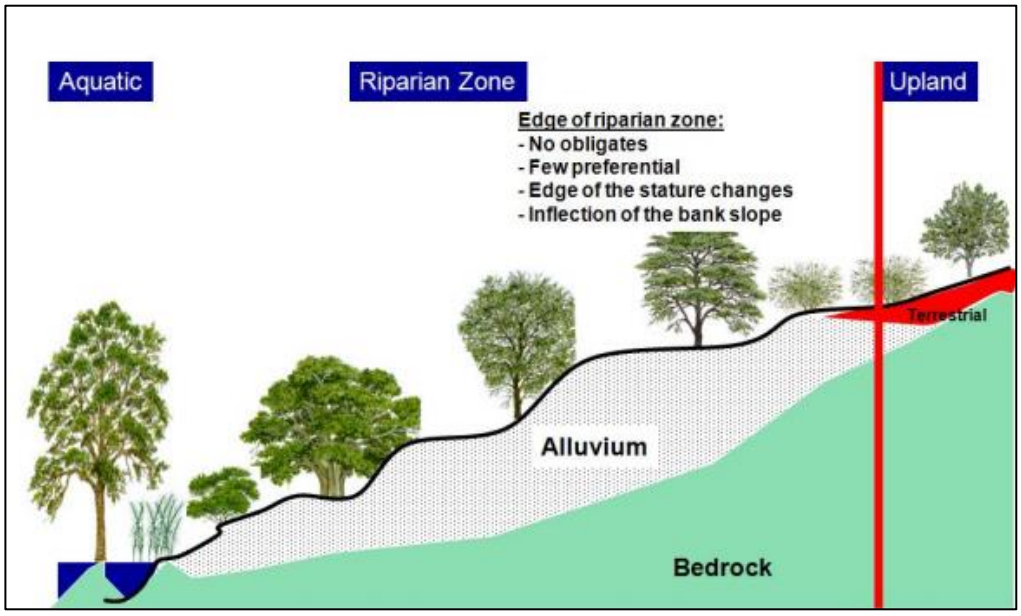


Figure 3: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF, 2008)

[1] Baseflow: Long-term flow in a river that continues after storm flow has passed (DWAF, 2008).

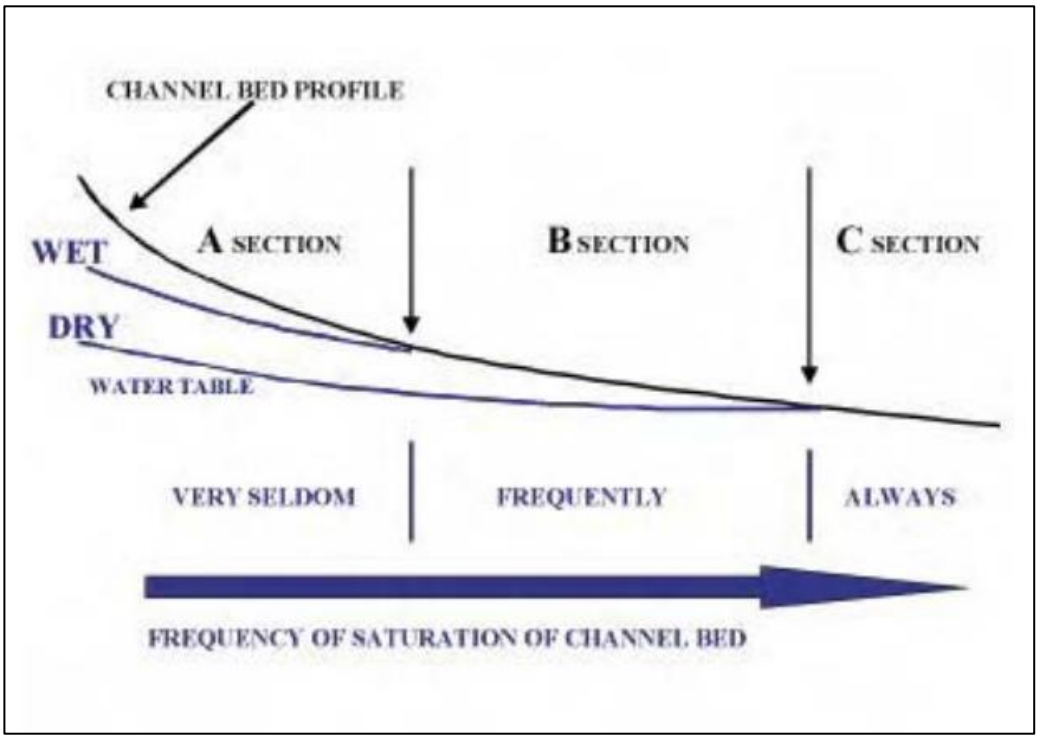


Figure 4: Image illustrating the classification of river channels using the frequency that each channel section contains baseflow (DWAF, 2008).

As per the NWA primary indicator, hydrophytic vegetation species are utilised to guide the delineation of wetness zones within watercourses. The relationship between the wetness zones, vegetation type and classification of occurrence of plants in wetlands can be seen in Table 5 below. Table 6 presents the frequency of plant species occurrence in wetlands within different wetness zones.

Table 4: Wetness zones, vegetation types and classification of plants occurrence in wetlands based on their relationship (Kotze et al., 2009)

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).

Table 5: Frequency of wetland species plant occurrence within different wetness zones (Kotze et al., 2009)

SYMBOL	HYDRIC STATUS	DESCRIPTION/OCCURRENCE
Ow	Obligate wetland species	Almost always grow in wetlands (> 90 % occurrence)
F+	Facultative positive wetland species	Usually grow in wetlands (67-99 % occurrence) but occasionally found in non-wetland areas
F	Facultative wetland species	Equally likely to grow in wetlands (34-66 % occurrence) and non-wetland areas
F-	Facultative negative wetland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34 % occurrence)
D	Dryland species	Almost always grow in drylands

4.3. ASSESSMENT METHODOLOGIES

4.3.1.PRESENT ECOLOGICAL STATE (PES)

Wetland Systems

To determine the PES of the systems affected by the proposed development, a WET-Health Level 2 assessment, as developed by Macfarlane et al. (2008), was performed on all potentially impacted systems. WET-Health assessments evaluate the current state of health for 3 main components of wetland systems, namely: Hydrology, Geomorphology, and Vegetation. The assessment involves the evaluation of several measureable aspects of each component in a series of steps to determine that component's current health. The 3 components are then combined in a weighted average (3:2:2) to gain a final state of health score. The overall health score was classified into a health category. Finally, a health projection was assigned to the score to indicate the projected health of the system within the next 5 years, with the proposed development taking place, based on the specialist's opinion.

The impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table 7 below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 6: Health categories used by the WET-Health for describing the integrity of wetlands (Macfarlane et al., 2009)

IMPACT CATEGORY	DESCRIPTION	RANGE	PES CATEGOR
None	Unmodified, natural.	0 – 0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features	6 – 7.9	**E**
Critical	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**

Riverine Systems

Evaluations of the riverine systems utilised a different methodology which was developed in 1999 by the then Department of Water Affairs and Forestry (DWAF), the previous incarnation of the DWS and DAFF. The methodology, known as the Index of Habitat Integrity (IHI), breaks down riverine systems into instream and riparian zone areas. It then breaks these down further into various aspects associated with the instream and riparian zone habitat which are rated infield on an increasing scale of severity from 0 (no impact) to 25 (highest impact). The instream and riparian zone final scores are classified into Habitat Integrity categories.

The Index of Habitat Integrity, 1996, version 2 (Kleynhans, 2012) was used to obtain a habitat integrity class for the instream habitat and riparian zone. This tool compares the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state (in the absence of anthropogenic impacts). This involved the assessment and rating of a range of criteria for instream and riparian habitat scored individually (from 0-25) using Table 8 as a guide.

Table 7: Category of score for the Present Ecological State (PES)

RATING SCORE	IMPACT SCORE	DESCRIPTION
0	A: Natural	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
1-5	B: Good	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
6-10	C: Fair	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
11-15	D: Poor	The modification is generally present with a clearly detrimental impact on habitat quality, diversity size and variability. Large areas are, however, not influenced.
16-20	E: Seriously Modified	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
21-25	F: Critically Modified	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

4.3.2.ECOLOGICAL IMPORTANCE AND SENSITIVITY

Wetland Systems

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2013). The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 9 below.

Table 8: Category of score for the Ecological Importance and Sensitivity (Rountree, 2013)

Ecological Importance and Sensitivity categories	Range of EIS score
Very High: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very	>3 and <= 4

sensitive to flow and habitat modification. They play a major role in moderating the quantity and quality of water of major rivers	
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these system may be sensitive to flow and habitat modification. 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 systems is not usually sensitive to flow and habitat modification. They play a small role in moderating the quantity and quality of water of major rivers	>1 and <= 2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers	>0 and <= 1

Riverine Systems

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh, *et. a*l., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. The scores assigned to the criteria of the assessment are used to rate the overall EIS of each mapped unit according to Table 10 below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane *et al*., 2008).

Table 9: The ratings associated with the assessment of the Ecological Importance and Sensitivity of the riverine areas

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Several elements sensitive to changes in water quality/ hydrological regime

4.3.3.Ecosystem Services (EcoServices)

Wetland systems are subjected to a further assessment which measures the types and levels of ecosystem services each wetland provides to the area. Ecosystem services are evaluated using the Level 2 WET-EcoServices assessment tool (Kotze *et al.,* 2009). This tool quantitatively scores both physical and socio-cultural aspects of the wetland system and produces a score and graph for several services provided by the wetland. The services which are scored can be seen below in Table 11.

Table 10: Physical and socio-cultural ecosystem services

Category	Service
Physical	Flood attenuation Stream flow regulation Sediment trapping Phosphate assimilation Nitrate assimilation Toxicant assimilation Erosion control Carbon storage
Socio-Cultural	Biodiversity maintenance Provision of water for human use Provision of cultural floods Cultural significance Tourism and recreation Education and research

4.3.4.BUFFER ASSESSMENT

A buffer zone assessment was performed using the DWS Buffer Zone Tool developed by MacFarlane and Bredin (2016). This tool takes into account the type of water resources, its condition and ecological importance and determines an appropriate buffer to prevent it from being significantly impacted upon. Within the buffer zone, no construction, movement, waste or ablutions may occur or be situated, either temporarily or permanently.

4.3.5.RISK ASSESSMENT MATRIX

Assessing the risk of all the proposed development impacts, and associated consequences on watercourses was performed utilising the DWS's Aspects and Impact Register/Risk Assessment for Watercourses including Rivers, Pans, Wetlands, Springs, and Drainage Lines tool, otherwise known as the Risk Assessment Matrix or RAM. The RAM assessed different activities and aspects of the development and scores were determined for factors, such as magnitude of the impact, length of time of the activity, length of time for the impact to persist, and geographical scale, to determine an overall risk rating of each impact. Table 7 illustrates the different risk ratings, their classes, and the management descriptions.

Table 11: Freshwater habitat screening

Rating	Class	Management Description
1 – 55	*Low Risk*	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	*Moderate Risk*	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	*High Risk*	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

5. ASSUMPTIONS AND LIMITATIONS

- According to the SANBI guidelines, specialist assessments should be performed during the rainfall season of assessed area. In this case, North West Province is a summer rainfall area and therefore assessments should be performed between October and April. Fieldwork for this project was conducted on the 10th of May 2021, which is approximately 10 days away from the rainfall season.
- Accessibility to certain portions of the landscape where watercourses were present was difficult due to the dense vegetation in the area which made these areas inaccessible.
- A construction method statement was not provided by the engineer and therefore the potential impacts on the watercourses that may arise as a result of the construction activities were determined using the specialist's knowledge and experience with similar projects.
- Bulk services such as stormwater, sewer and water details were not provided. The specialist used his knowledge and experience with similar projects regarding those details.
- Only those wetland/riverine habitats which will be significantly impacted by the proposed development were accurately delineated in the field. The remaining watercourses within a 500m regulated buffer were delineated at a desktop level and broadly verified in the field to obtain an extent of the wetland/riverine areas, and to facilitate an understanding of the dynamics of the systems.
- This is a once off assessment which can only take into consideration the current condition with some speculation of historical events based on evidence observed in the area and satellite imagery. As vegetation and habitats may vary both temporally and spatially, there must be recognition of fact that certain aspects or features may be missed if they do not present themselves on the day.
- All delineation verification is done using a GPS system. The precision of such systems is generally limited to 5m and therefore this error must be taken into account when utilising the GPS coordinates.
- Only vegetation which was present within at risk watercourses were assessed in the field, all other systems were assessed at desktop level and visually confirmed on site.
- While the assessment techniques utilised in this report are used in order to standardise and 'objectify' the assessment of the systems' function, potential impacts and services, it must be noted that much of the information is subjectively collected based on the assessor's previous experience and training. The assessor will, if additional information or counter arguments are provided and verified, hold the right to amend the report if need be.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological issues identified during the infield assessment and based on the assessor's working knowledge and experience with similar development projects.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures are to be included in the project-specific Environmental Management Programme report (EMPr).

6. DESKTOP ASSESSMENT AND DELINEATION

6.1. STUDY AREA

6.1.1.ECOREGION

According to DWS (previously DWA), the proposed development falls into the Highveld (11) Level 1 Ecoregion (Kleynhans *et al.*, 2005). Level 1 ecoregions are derived primarily from terrain and vegetation, along with altitude, rainfall, runoff variability, air temperature, geology and soil. This region can predominantly be broken down into the following characteristics:

- Mean annual precipitation: Rainfall varies from low to moderately high, with an increase from west to east.
- Coefficient of variation of annual precipitation: Moderately high in the west, decreasing to low in the east.
- Drainage density: Mostly low, but medium in some areas.
- Stream frequency: Low to medium.
- Slopes <5%: >80%, but 20-50% in a few hilly areas.
- Median annual simulated runoff: Moderately low to moderate.
- Mean annual temperature: Hot in the west and moderate in the east.

Table 12: Main attributes of the Highveld Eco-region (Kleynhans et al., 2005)

Main Attributes	Description
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains; Low Relief;** **Plains; Moderate Relief;** Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Secondary)	Mixed Bushveld (limited); Rocky Highveld Grassland; **Dry Sandy Highveld Grassland;** Dry Clay Highveld Grassland**; Moist Cool Highveld Grassland;** Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (above mean sea level – a.m.s.l)	1100-2100, 2100-2300 (very limited)
MAP (mm)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max. temp. (°C): February	20 to 32
Mean daily max. temp. (°C): July	14 to 22
Mean daily min. temp. (°C): February	10 to 18
Mean daily min temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

6.1.2.GEOLOGY

The proposed development is located on over the Reitgat Formation which falls under the Ventersdorp Super Group. An explanation of this deposit is provided in Table 14.

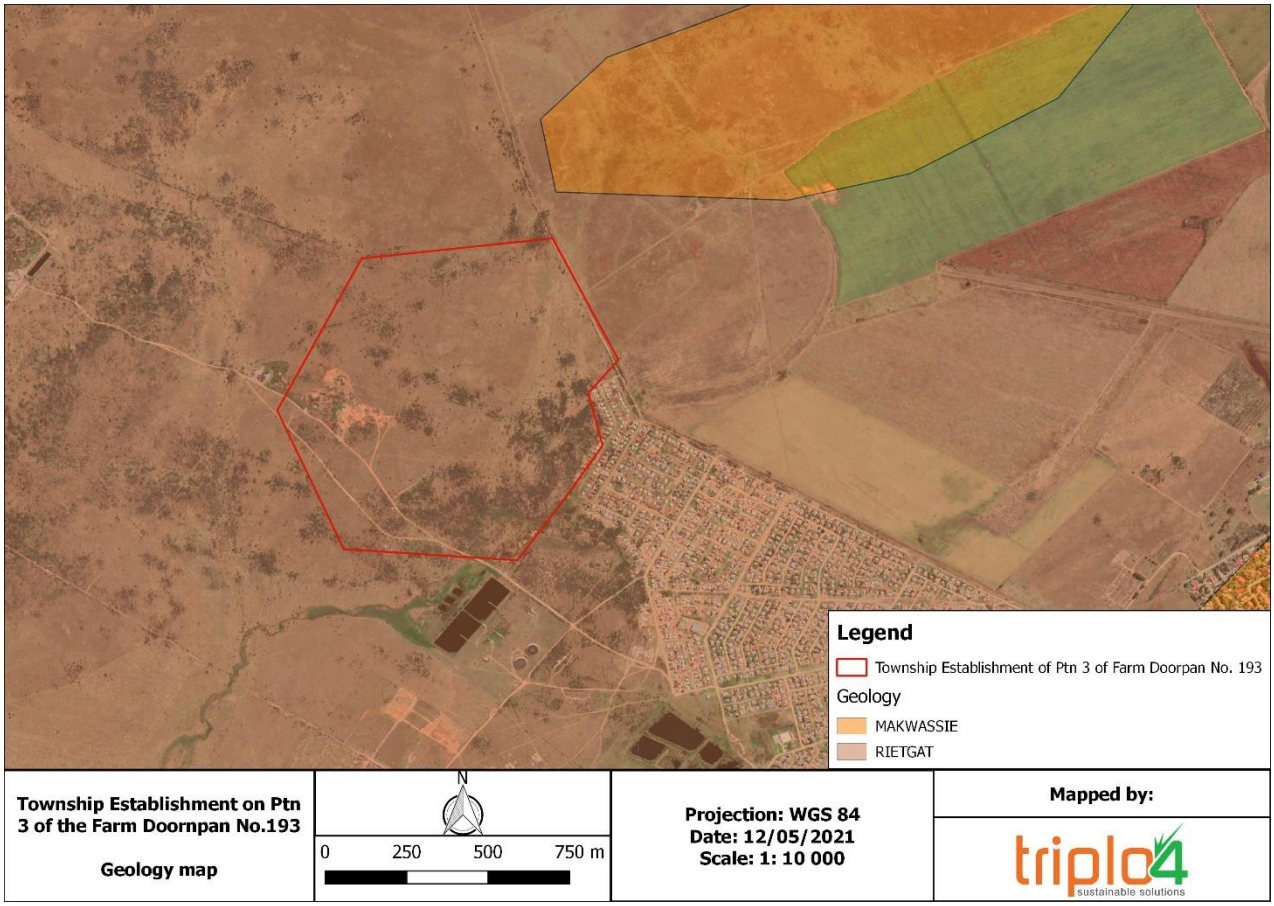


Figure 5: Dominant formation within the proposed development site

Table 13: Description of the dominant formation within the proposed development site

No.	Estimates % of Proposed Development	Formation	Description
1	100%	Rietgat	The Rietgat Formation consists of lava flows, volcaniclastics and sedimentary. The formation area consists of a poorly sorted conglomerate with no associated lavas. This formation typically consist of andesite to dacitic lava, minor conglomerate, greywacke and shale. The formation falls on the Platberg Group which all fall under the Ventersdorp Super Group (Geosciences, 2011).

6.1.3.SOILS

The soil textures within the study area ranged from clay loam in the watercourses to sandy in the catchment areas. The entire study area was recorded to contain soils that display characteristics associated with C class soils (Schultze et al., 2010). These soils were calculated to exhibit characteristics of a slow infiltration rate and restrictive permeability. According to Schultze (1992), soils within the study area have a moderate erosion potential factor of 0.38, indicating that these soils presumably exhibit a moderate level of sandy clay content, are not entirely easily detachable, dependent on surface roughness of an area, thus exhibiting moderate erosion potential of soils in the catchment.

6.1.4. VEGETATION TYPES

The South African National Biodiversity Institute (SANBI) (2018) delineated vegetation units throughout southern Africa. The purpose of this exercise was to map the extent of various vegetation types across the country and to identify their conservation status. Utilising SANBI (2018) data, the natural state of the vegetation unit that were recorded within the study area associated with the proposed development were determined. In doing so, a comparison could be conducted between the current state and recorded natural state of the vegetation unit to divulge what the primary impacts may have been on the floral habitats. This will allow for more refined analysis of the floral composition within each of the at-risk watercourses.

The proposed development extends over 1 vegetation unit at a desktop level namely the Vaal-Vet Sandy Grassland (Figure 6). The conservation status this vegetation type is endangered (NBA, 2018). The identified vegetation type has been transformed on site due to anthropogenic changes namely; construction of dirt and tar roads, historic sand mining, ad hoc dumping and construction of WWTWs adjacent to the site in a southerly direction, which have led to the proliferation of alien invasive vegetation (AIP) within the site boundary.

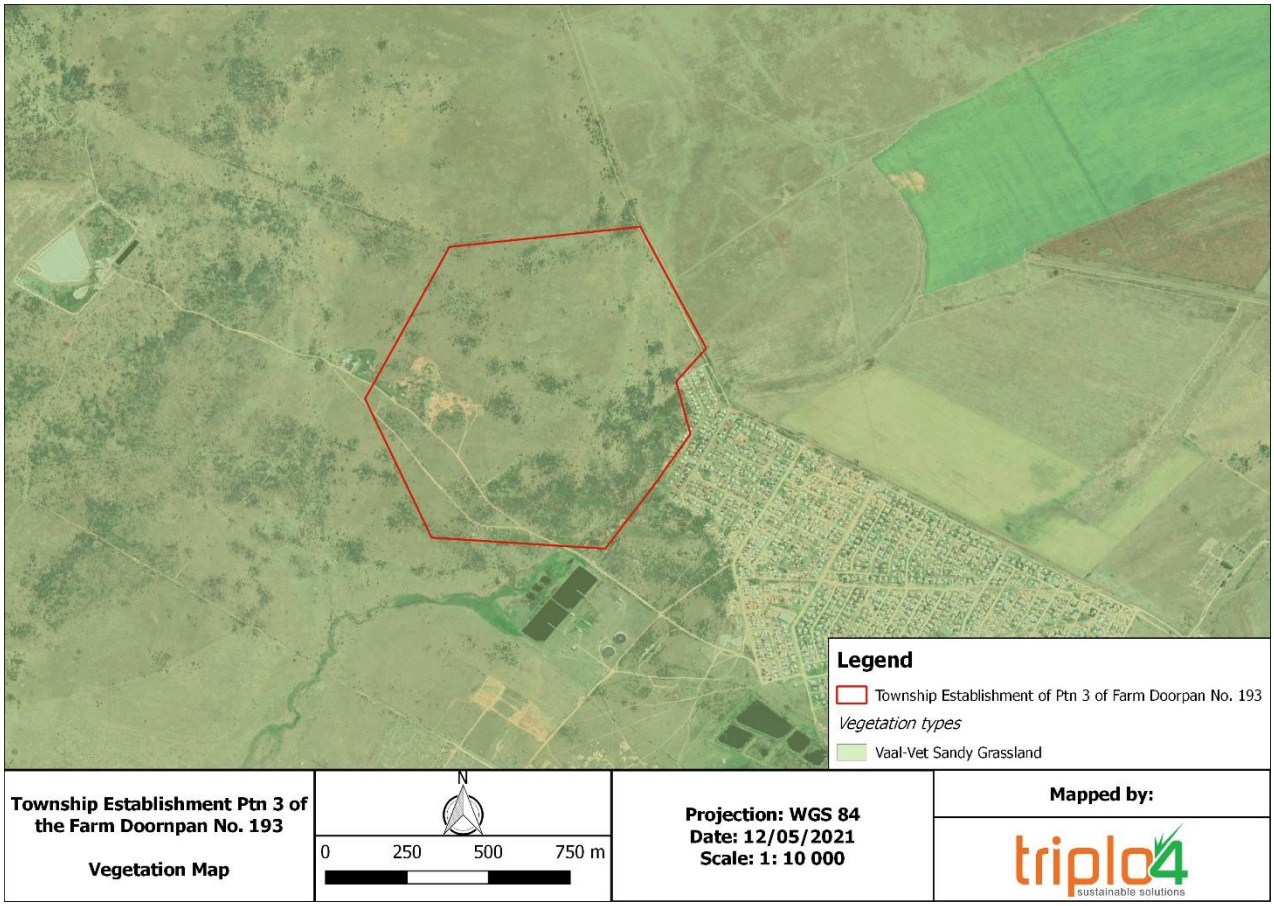


Figure 6: Map of the vegetation types within the proposed development

6.1.5. CRITICAL BIODIVERSITY AREA

The Rural, Environment and Agricultural Development (READ) Department developed and implemented the Critical Biodiversity Areas (CBAs) file for the planning domain through integrating existing and new data (Desmet and Schaller, 2015). The plan identified areas as Critical Biodiversity Areas (CBAs) which cannot be lost if conservation goals are to be met. Furthermore, Ecological Support Areas (ESAs) were also established as these areas are required to support the functioning of CBAs and ecosystems. The guidelines of the North-West CBA planning domain for each CBA and ESA category are outlined in Table 15.

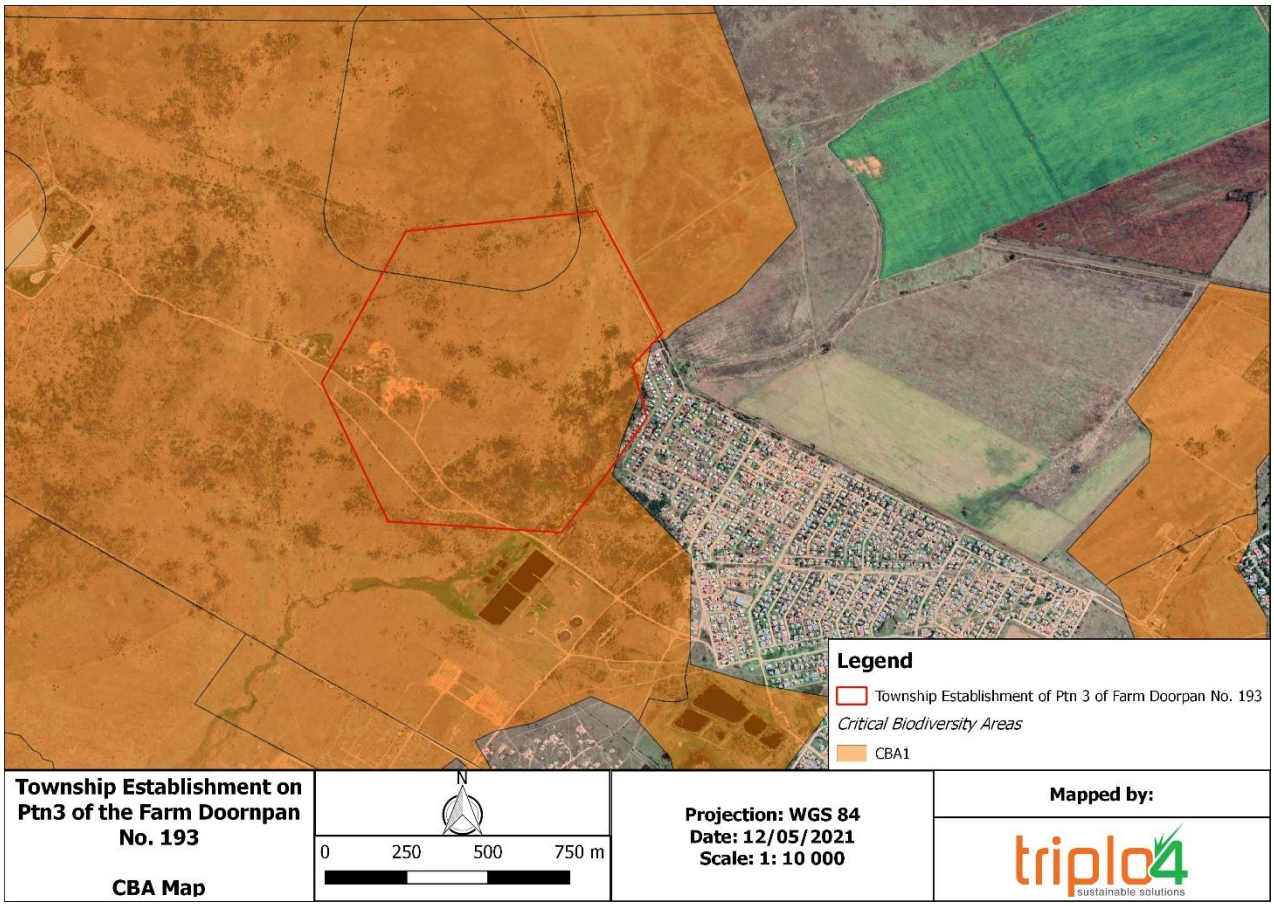


Figure 7: Critical Biodiversity Area within the proposed development site

The CBA associated with the proposed development is CBA1 at a desktop level. This means that the propose development potentially occurs in areas considered critical for meeting biodiversity targets and thresholds, which are required to ensure the persistence of viable populations of species and the functionality of ecosystems. CBA1 includes areas such as critically endangered ecosystems, irreplaceable sites, critical biodiversity corridor linkages and; Important Terrestrial Habitats: Expert Areas and Kloofs (Desmet and Schaller, 2015).

Table 14: CBA Descriptions for North-West Province (Desmet and Schaller, 2015).

CBA Map Category and Criterion Name	Description of biodiversity features used to define CBA Map Category	Map Codes
Terrestrial Critical Biodiversity Area Level 1		
Critical Patches: Ecosystem Status - Critically Endangered Ecosystems	Remaining patches larger than 3 ha of provincially Critically Endangered ecosystems (vegetation types), i.e. the amount of vegetation remaining intact (of these ecosystems) is less than the representation/biodiversity target, therefore all remaining patches of these vegetation units are of the highest conservation priority and further impacts on natural habitat should be avoided.	

Irreplaceable Sites	Planning units with high irreplaceability values based on the provincial MARXAN analysis, i.e. areas or sites that are mandatory if biodiversity targets are to be achieved.	CBA1
Critical Biodiversity Corridors Linkages	Critical linkages in the provincial biodiversity corridor network where existing conversion of natural landscapes to other land uses has severely restricted options for maintaining connectivity in the natural landscape. Critical linkages that are not in a natural state are categorised as ESA 2	
Important Terrestrial Habitats: Expert Areas	Areas in the terrestrial environments less than 10 000 ha in extent identified by experts as being important for biodiversity conservation.	
Important Terrestrial Habitats: Kloofs	All medium to large kloofs identified as an important habitat for climate change adaptation.	
Terrestrial Critical Biodiversity Areas Level 2		
Critical Patches: Ecosystem Status - Endangered and Vulnerable Ecosystems	Remaining patches larger than 5 ha of provincially Endangered and Vulnerable ecosystems (vegetation types), i.e. the amount vegetation remaining intact (of these ecosystems) is less than 60%. Any further modification of these vegetation types should be limited to existing irreversibly modified or heavily degraded areas.	CBA2
Critical Patches: Endemic Vegetation Types	Remaining patches larger than10 ha of endemic vegetation types to the province. These are vegetation types whose biodiversity target can only be achieved in the NW Province.	
Important Habitats: Features	Important natural features (habitats, springs, scenic landscapes) used in the 2008 biodiversity conservation assessment (DACERD, 2009).	
Important Habitats: Focus Wildlife Areas	Areas identified as being important for maintaining species of conservation concern (free-ranging red hartebeest (*Alcelaphus buselaphus*), black-footed cat (*Felis nigripes*), vulture nesting areas, Important Bird Areas).	
Terrestrial Ecological Support Areas Level 1 and Level 2		

Important Habitats: Hills and Ridges	Hills and ridges identified as sensitive habitats in the existing provincial SDF dataset. The hill and ridges layer was developed to address the special biodiversity significance of these topographic features in the province. The layer was re-developed from scratch using the GIS modelling approach used in Gauteng Province and modified for the North West.	ESA1 if natural ESA2 if not natural
Biodiversity Corridors		
Existing or Proposed Protected Area Development Corridors	Existing protected area development corridors identified in previous studies and the provincial protected area expansion strategy. Expansion of land uses not compatible with protected areas/beneficial green economy activities can severely degrade the economic potential of this valuable resource if allowed to expand into these zones. 1. Pilanesberg-Madikwe Heritage Park 2. Highveld Grassland corridor 3. Vredefort Dome World Heritage Site 4. Kgalagadi 5. Magaliesberg Protected Environment 6. SA Lombard/Bloemhof Lower Vaal node	
Protected Area Buffers	The 1 km radius buffer around all formal protected areas.	

6.1.6.WATER MANAGEMENT AREAS

The proposed development was observed to fall within the Water and Sub-Water Management Area (WMA): Middle Vaal and the quaternary catchment C24E. The aforementioned WMA is drained by several parallel rivers which flow in an easterly and south-easterly direction. The rivers which contribute to the highest flow within this WMA are the Schoonspruit, Rhenoster, Vals, Vet and Vaal Rivers with several smaller rivers and wetlands that feed the aforementioned larger rivers (Net *et al*., 2011).

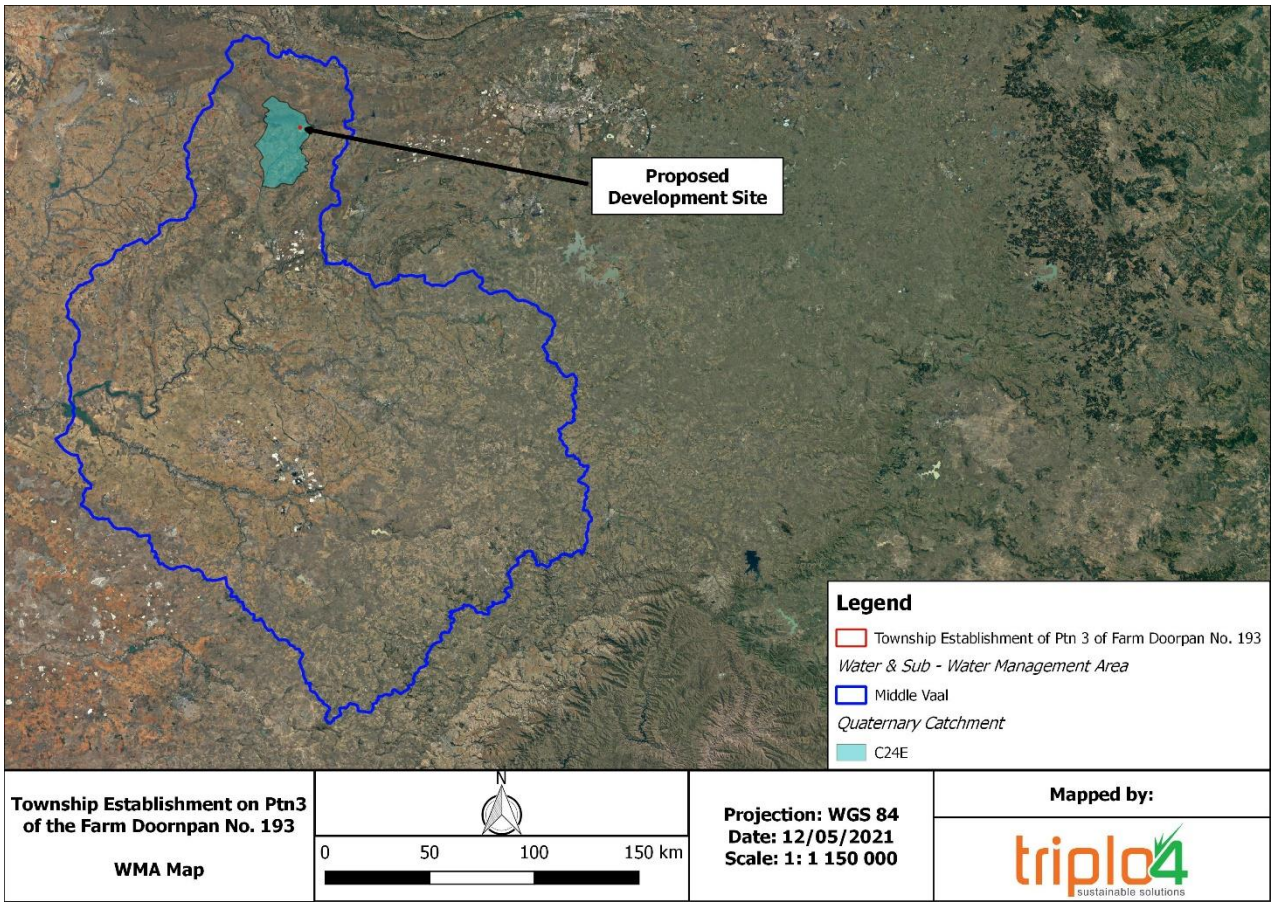


Figure 8: Map of the WMA, sub-WMA and Quaternary Catchment that fall within the proposed development site

6.1.7.NFEPA

The National Freshwater Ecosystem Priority Areas (or NFEPA), are a selection of rivers, wetlands and estuaries which have been identified as systems of strategic importance to the hydrological functioning of South Africa. These systems have been identified using scientific methodologies as well as consensus amongst researchers, government entities and the general public (Nel *et al*., 2011).

According to the NFEPA dataset, an unnamed FEPA River occurs through the site which will potentially be indirectly impacted upon by the proposed development. The natural FEPA wetland map at a desktop level, south east of the proposed development site, does not exist anymore and has been completed disturbed by the construction of the WWTWs. Thus, the location of the unnamed FEPA River must be taken into cognizance when any construction activity will occur.

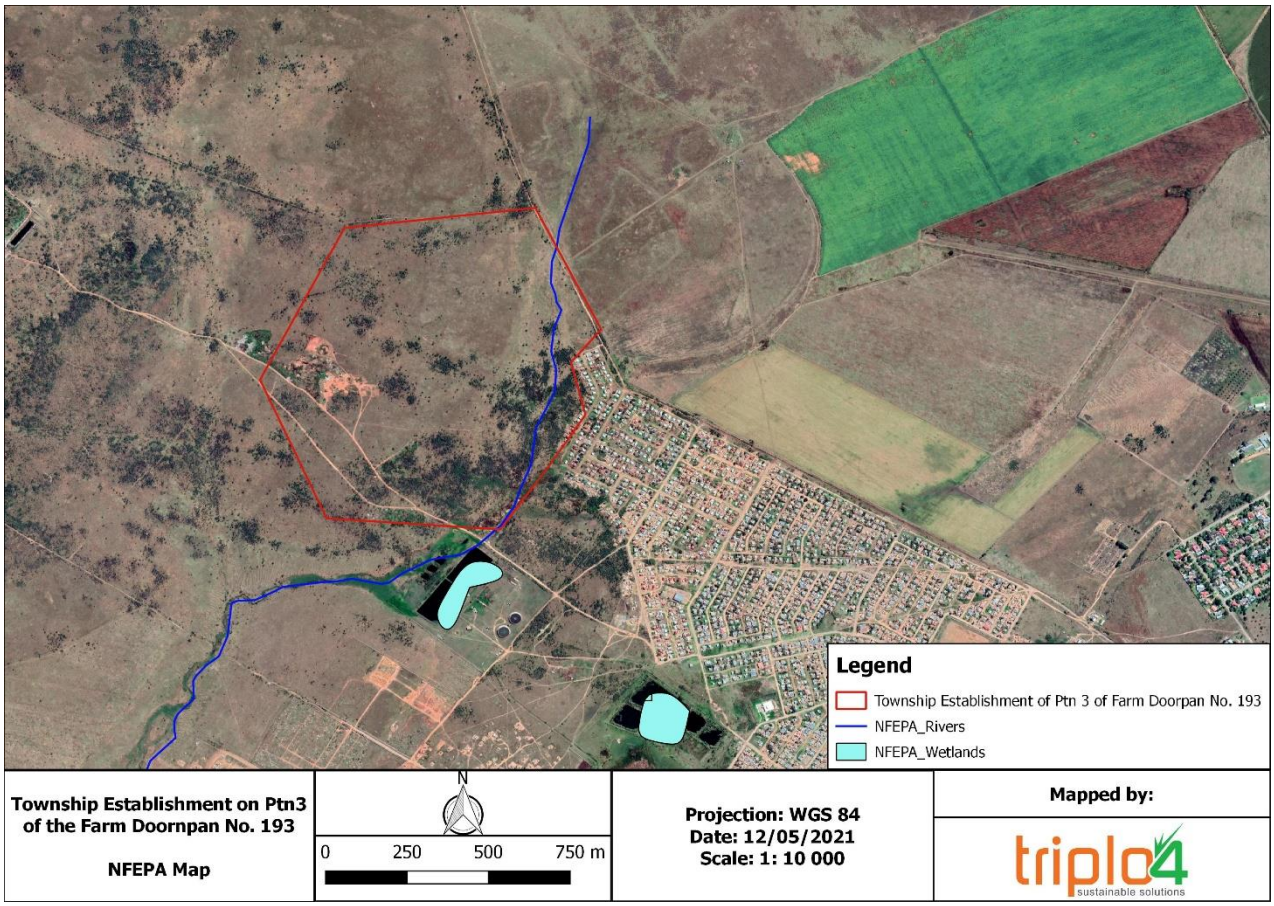


Figure 9: Map of the FEPA Rivers and Wetland in relation to the proposed development, from the NFEPA dataset

6.2. DELINEATIONS & SCREENING

6.2.1.WETLAND DELINEATIONS

The watercourses within the study area were identified on a desktop level, classified and delineated in-field and subsequently mapped utilising GIS (QGIS 2.14 and Google™ Earth Pro) and available spatial data. Figure 10 below is the layout of the proposed development, whereas Figure 11 demonstrate the delineated watercourses identified within the study area during the field assessment.

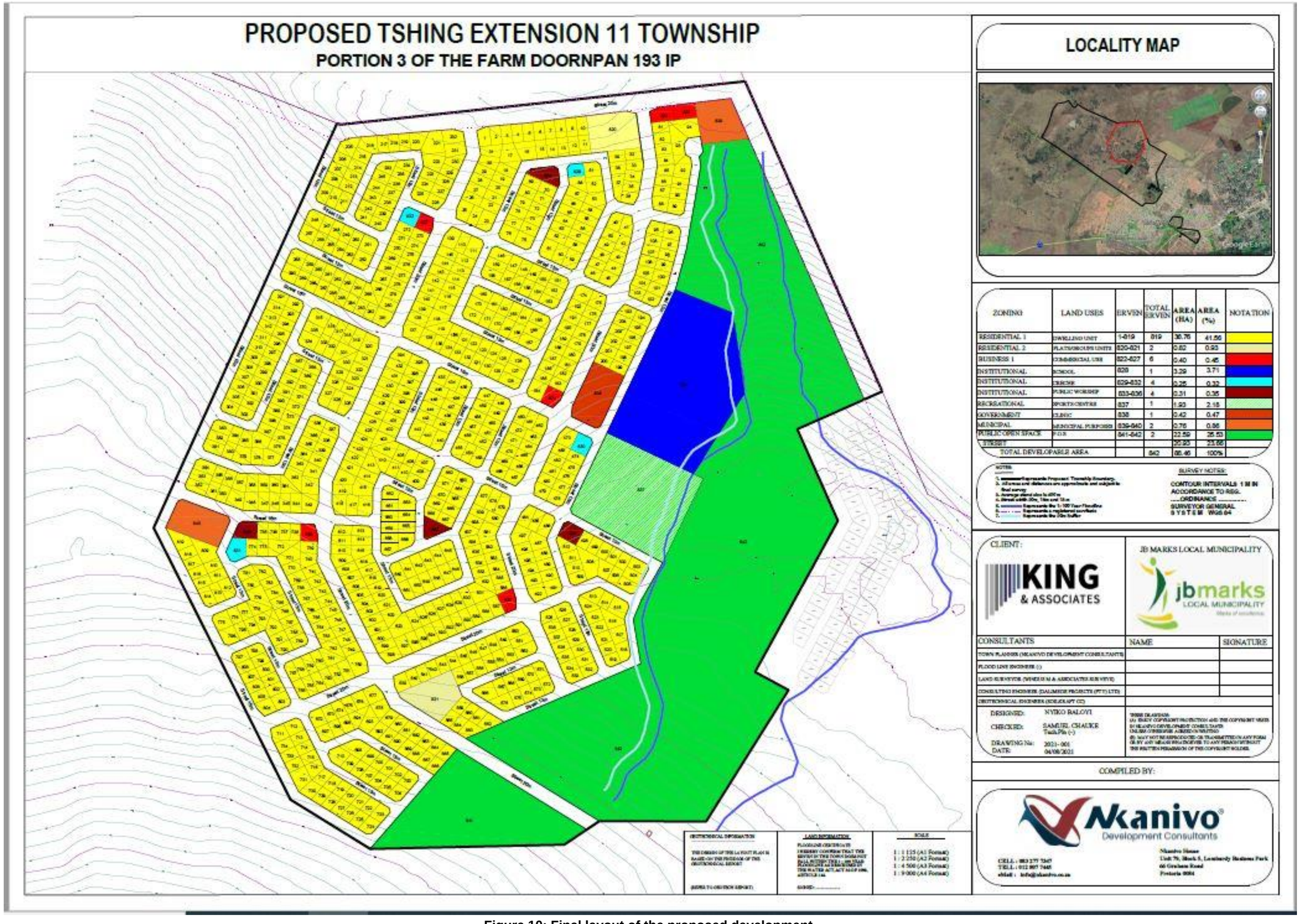


Figure 10: Final layout of the proposed development.

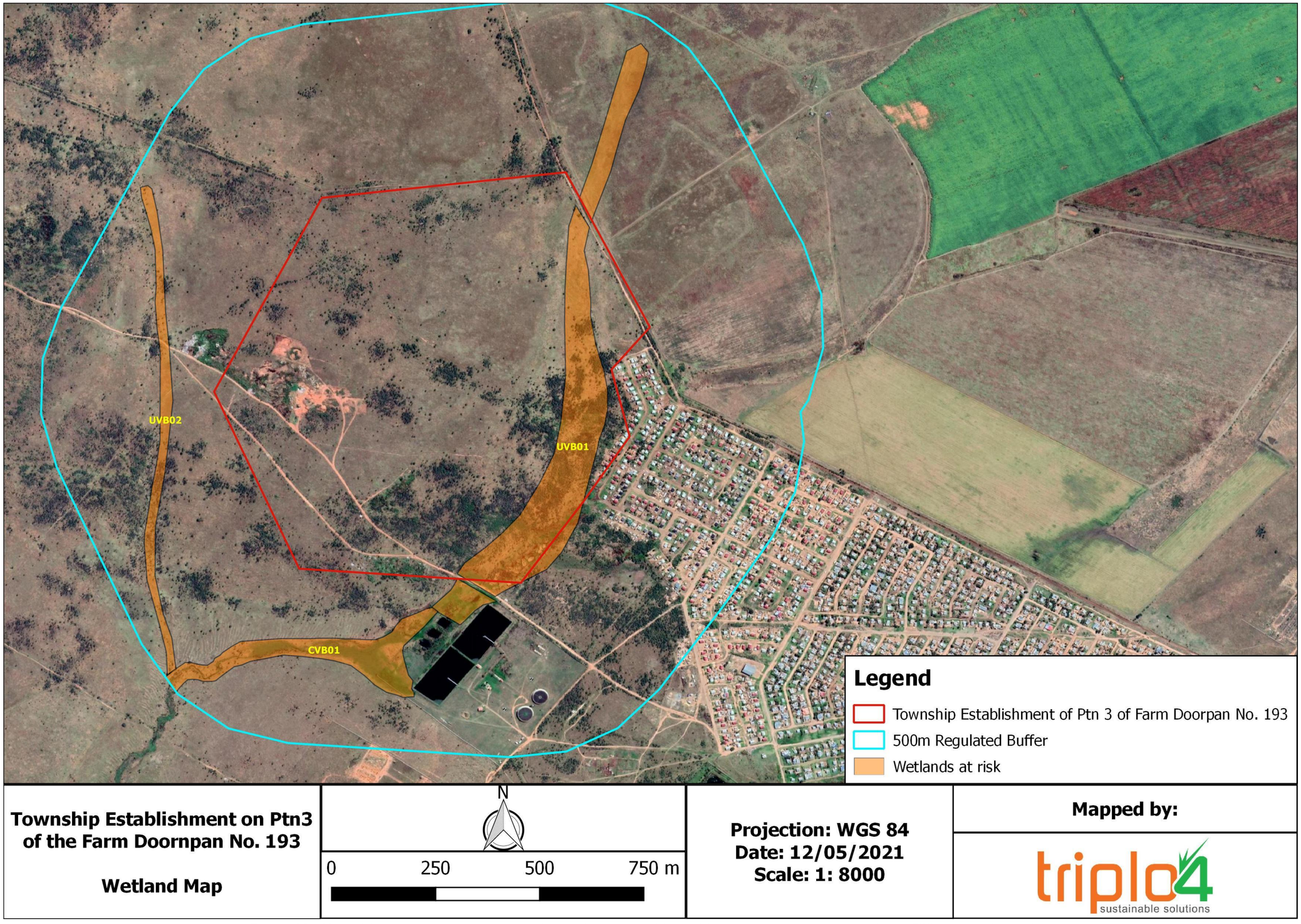


Figure 11 : Map of the in-field delineations of the wetlands identified at the proposed development and 500m regulated buffer

6.2.2.INITIAL IMPACT SCREENING

The infield field assessment phase confirmed the location and extent of the watercourses and subsequent screening provided an indication of which of the watercourses that may potentially be impacted upon by the proposed development. There are several factors which influence the level a watercourse will be impacted upon such as; type of system, position of the system in relation to the proposed construction and position in which the system is located in the landscape. Table 16 below presents the criteria that was used to rank the various wetlands in terms of risk. It must be noted that the criteria provided in Table 16 is utilised as a guideline to identify at risk wetlands and is not indefinite in terms of risk status of wetlands. Table 17 presents the wetlands delineated within the 500m regulated buffer and their respective risk status.

Table 15: Criteria utilised to rank the delineated wetlands within the 500m regulated buffer around the proposed development

RISK RATING	CRITERIA/DESCRIPTION
High	The watercourse/wetland is situated directly within or in close proximity to, or within the same minor catchment area as, the proposed development footprint. Therefore, the aquatic habitat, biota present within, water quality of and/or the hydrological regime through the watercourse/wetland are highly likely to be impacted on by aspects of the proposed development.
Moderate	The watercourse/wetland is situated directly upstream, or within a medium distance (32m to 54m) downstream of the proposed development within the same minor catchment area. This may result in the aquatic habitat, biota present within, water quality of and/or the hydrological regime through the watercourse/wetland being indirectly impacted on by aspects pertaining to the proposed development (e.g. sedimentation, pollution and/or a change in the hydrological characteristics of the system).
No Risk	The watercourse/wetland is situated a significant distance (>54m) upstream or downstream of the proposed development, or within a landscape that prevents any direct/indirect impacts that have been determined to originate from the activity from reaching it, and thus is not likely to be impacted on by the proposed development.
	The watercourse/wetland is situated within a completed different minor catchment area to the proposed development, and thus is highly unlikely to be affected by direct or indirect impacts that have been determined to originate from the proposed development.

Table 16: Watercourse Risk Screening

Code	System Type	At risk status	Impacted (High, Moderate, Low, Very)	Reasoning
CVB01	Channelled Valley Bottom Wetland	Yes	Moderate	The following wetlands occur different distances away from the proposed developable area. CVB01 occurs adjacent to the development, UVB01 occurs within the development extent earmarked as open space, whereas UVB02 occurs 42m west of the proposed development. Thus, these wetlands will potentially be indirectly impacted upon by the proposed development.
UVB01 UVB02	Unchannelled Valley Bottom Wetland			

7. WETLAND SYSTEMS: LEVEL 1 WET-HEALTH ASSESSMENT

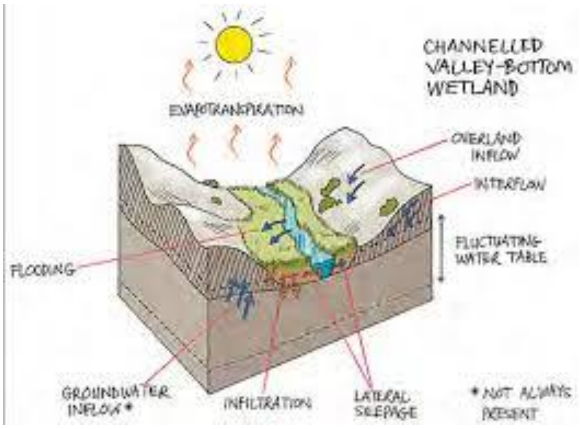
The assessment of the condition or PES of each HGM unit is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and vegetation composition and structure. The WET-Health tool was used to calculate the PES scores, involves a comparison between a wetland in its current PES in relation to its natural/reference condition (Macfarlane *et al*., 2009).

It must be noted that the PES assessment conducted for the at risk wetlands only applies to the portion of the wetland delineated in the vicinity of the proposed development and not the entire HGM unit. Thus, the PES of the entire HGM unit can be substantially different from that which I assessed on site

7.1. Channelled Valley Bottom Wetland

The following will describe the general characteristics and flow of CVB wetlands.

Table 17: General and flow characteristics that influence the formation of CVB wetlands

HGM Unit	Description	Source of Water Maintaining the Wetland	
		Surface	Sub-surface
	Valley-bottom areas with defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel during heavy storm events when the channel overtop and from adjacent slopes.	***	*/***

Key: *** = Contribution usually large; */*** = Contribution may be small or important depending on the local circumstances

Table 19 below presents the overall characteristics namely: area of wetland, slope of system and minor catchment area of CVB wetland that were identified to be at risk as a result of the proposed development.

Table 18: Characteristic of CVB01

HGM Unit	Area of System (ha)	Slope of System (%)	Area of Minor Catchment (ha)
CVB01	5.06	0.8	457.92

7.1.1. Natural and current state

Table 20 below represents the natural state, current impacts and their present state. The information presented in the table was drafted in accordance with the WET-Health tool modules (Macfarlane *et al*., 2009).

Table 19: Presentation of the natural state, existing impacts and current state of CVB01 in relation to each WET-Health modules (Macfarlane *et al*., 2009).

MODULE	NATURAL STATE	EXISTING IMPACTS	CURRENT STATE
Hydrology	A channelled wetland driven by a moderate level of diffuse flow fed by the subsurface and lateral inputs of other wetlands and the surrounding slopes.	- Increased velocity of storm water runoff due to moderate changes in the catchment that reduce surface roughness such as: construction of linear activity (dirt and tar roads, overhead powerlines), agricultural activities and construction of WWTWs. - Eutrophic conditions observed at discharged point from WWTWs and further downstream of the wetland. - Reduction in the water quality due to potential discharge of waste water not within the ambit of DWAF (1996) standards for aquatic ecosystem and DWS limits.	CVB wetland with both seasonal and permanent wetness zones present with minor portion of the temporary zone still present. A wetland with an increase in wetness zone and flow velocity due to continuous discharge of treated waste water into the wetland.
Geomorphology	Gentle and gradual slope with natural slight undulation with the system attributed to areas of alluvial deposits and dense vegetation. Dominated by a centralised channel.	- Destruction of the geomorphological zone for the construction of WWTWs within the wetland extent. - Minor sedimentation in the wetland as a result of anthropogenic changes in the catchment. - Compaction of wetness zones. - Minor evidence of depositional and erosional features within the wetland as a result of anthropogenic pressures.	CVB wetland with moderately incised channel with areas of minor gully erosion and depositional features evident. This system was considered aggredational in nature.
Vegetation	100% native vegetation dominated by a mixture of obligate wetland plants, hydrophilous poacaea species and sparsely distributed woody vegetation.	- Anthropogenic disturbances namely; removal of hydric vegetation due to construction in wetness zones, resulting in the proliferation of AIPS. - Infill and excavation for development (e.g. construction of WWTWs). - Decrease in wetness zones due to proliferation of woody type AIPS.	CVB wetland that have been encroached upon by opportunistic weeds, pioneer species and AIPS due to changes within the wetland and the surrounding catchment. Altered florist composition within the wetness zones.

7.1.2.Present Ecological State (PES)

Utilising the estimated natural state of the at-risk channelled valley bottom wetland and comparing it to the current state of the wetland, the PES score was calculated for this wetland. The overall PES score that was calculated for CVB01 was 3.7, an overall PES C (moderately modified).

7.1.3. Overall trajectory of change of the PES score

In determining the trajectory of change the following question is posed: “is the current state of the wetland system likely to change in the future as a result of the proposed development and if so, by how much and in

which direction?" The arrows that are depicted in Table 21 below indicate the estimated trajectory of change that may be observed in each system over the next five years following the proposed development, post mitigation. Taking this into consideration, it is expected that the trajectory of change score for CVB01 will **remain the same** over the next five years as a result of the proposed development in conjunction with the existing impacts recorded within the surrounding catchment areas.

Table 20: Presentation of the PES scores that was calculated for CVB01 associated with the proposed development (Macfarlane *et al*., 2009)

WET-HEALTH SCORES				
WATERCOURSE	HYDROLOGY	GEOMORPHOLOGY	VEGETATION	**OVERALL SCORE**
CVB01	4.0 (D) →	2.1 (C) →	4.8 (D) ↓	**3.7 (C) →**

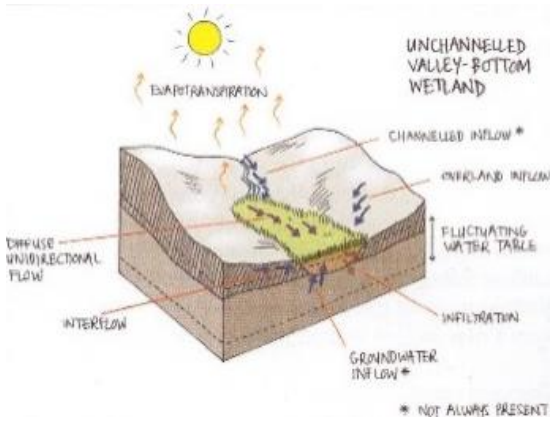
Figure 12: A - Dirt road through wetland impeding the natural flow, B – Eutrophic conditions observed approximately 50m north of the WWTW away, C – Construction of the WWTWs within the wetland wetness zones which is situated adjacent to the south of the proposed development, D- Stand of *Typha capensis* within CVB01.

7.2. Unchannelled Valley Bottom (UVB) Wetlands

UVB01 and UVB02 were grouped due to these wetlands occurring within the same quaternary catchment and minor catchment; which are experiencing similar impacts due to the land use changes in the catchment and in-situ of the wetlands.

The following will describe the general characteristics and flow of UVB wetlands.

Table 21: General and flow characteristics that influence the formation of UVB wetlands

HGM Unit	Description	Source of Water Maintaining the Wetland	
		Surface	Sub-surface
	Unchannelled valley bottom wetlands are defined by 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.	*/**	***

Key: ***= Contribution is typically small; ***= Contribution is typically large.

Table 23 below presents the overall characteristics namely: area of wetland, slope of system and minor catchment area of UVB wetlands that was identified to be at risk as a result of the proposed development.

Table 22: Characteristics of UVB01 and UVB04

HGM Unit	Area of System (ha)	Slope of System (%)	Area of Minor Catchment (ha)
UVB01	14.1	0.3	466.8
UVB02	3.3	1.8	476.1

7.2.1.Natural and current state

Table 24 below represents the natural state, current impacts and their present state of the unchannelled valley botom wetlands. The information presented in the table was drafted in accordance with the WET-Health tool modules (Macfarlane *et al*., 2009).

Table 23: Presentation of the natural state, existing impacts and current state of UVB01 and UVB02 in relation to each WET-Health modules (Macfarlane *et al*., 2009).

Module	Natural State	Existing Impacts	Current State
Hydrology	A gentle sloping unchannelled valley bottom wetland with various areas of wetness zones ranging from permanent to seasonal wetness fed by the subsurface and	- Increased velocity of storm water runoff due to reduced surface roughness in the catchment and neighbouring terrestrial zones, as a result of anthropogenic pressures namely; dirt and tar roads, agricultural farming, ad hoc dumping and informal dwellings.	UVB01 - The hydrological characteristics can be described as wetland with a permanent and seasonal zone, but predominantly a temporary zone. Loss of wetness zones due to anthropogenic pressures

	lateral inputs which diffuses through the different wetness zones of the wetlands.	- Dirt roads acting as impeding features. - Decrease in wetness zones due uptake of water from AIPs.	such as construction of dirt roads and WWTWs within portions of the wetland which have intercepted the natural diffuse flow and caused ponding of upstream of the wetland. UVB02 - The hydrological characteristics can be described as wetland with predominantly a temporary zone and portions of seasonal zones. Loss of wetness zones due to anthropogenic pressures such as construction of dirt roads within portions of the wetland which have intercepted the natural diffuse flow of this wetland.
Geomorphology	Gently sloping wetland with a uniform flow gradient which consist of presumably permanent and seasonal wetness zones that are characterised by gleying and mottling and a temporary zone that is semi-saturated.	- Destruction of the geomorphological zone for the construction of dirt roads and WWTWs (specifically within UVB01). - Sedimentation in wetlands as a result of poor veld conditions due to anthropogenic pressures in the catchment namely. - Compaction of wetness zones. - Evidence of depositional and erosional features within the wetlands as a result of anthropogenic pressures.	UVB01 & UVB02 - The geomorphological aspect can be described as an aggregational systems that has experienced destruction of geomorphological extent due to constructional activities within it. Depositional and erosional features were present as a result of in-situ activities (construction of roads and human footpaths) within the wetland and poor veld conditions in the catchment.
Vegetation	100 % native vegetation dominated by a mixture of obligate wetland plants, hydrophilous poacaea species and sparsely distributed woody vegetation.	- Anthropogenic disturbances namely; removal of hydric vegetation due to construction in wetness zones, resulting in the proliferation of AIPS. - Decrease in wetness zones due to proliferation of woody type AIPS.	UVB01 & UVB02 - The vegetation aspect has been encroached upon by opportunistic weeds, pioneer species, AIP. Small patches of secondary and degraded grassland were present within this wetland.

7.2.2.Present Ecological State (PES)

Utilising the estimated natural state of the at-risks unchannelled valley bottom wetlands and comparing it to the current state of the wetland, the PES score was calculated for these wetlands. The overall PES score that was calculated UVB01 and UVB02 is 5.8 and 3.6, respectively. This is an overall PES of D (largely modified) and C (moderately modified), for these wetlands.

7.2.3.Overall trajectory of change of the PES score

In determining the trajectory of change the following question is posed: “is the current state of the wetland system likely to change in the future as a result of the proposed development and if so, by how much and in

which direction?" The arrows that are depicted in Table 25 below indicate the estimated trajectory of change that may be observed in each system over the next five years following the proposed development, post mitigation. Taking this into consideration, it is expected that the trajectory of change score for UVB01 and UVB04 will **remain the same** over the next five years as a result of the proposed development in conjunction with the existing impacts recorded within the surrounding catchment areas.

Table 24: Presentation of the PES scores that were calculated for UVB01 and UVB02 associated with the proposed development (Macfarlane et al., 2009).

WET-HEALTH SCORES				
WATERCOURSE	HYDROLOGY	GEOMORPHOLOGY	VEGETATION	**OVERALL SCORE**
UVB01	7.0 (E) →	3.0 (C) →	6.7 (E) ↓	**5.8 (D)** →
UVB02	4.0 (D) →	1.4 (B) →	5.1 (D) →	**3.6 (C)** →

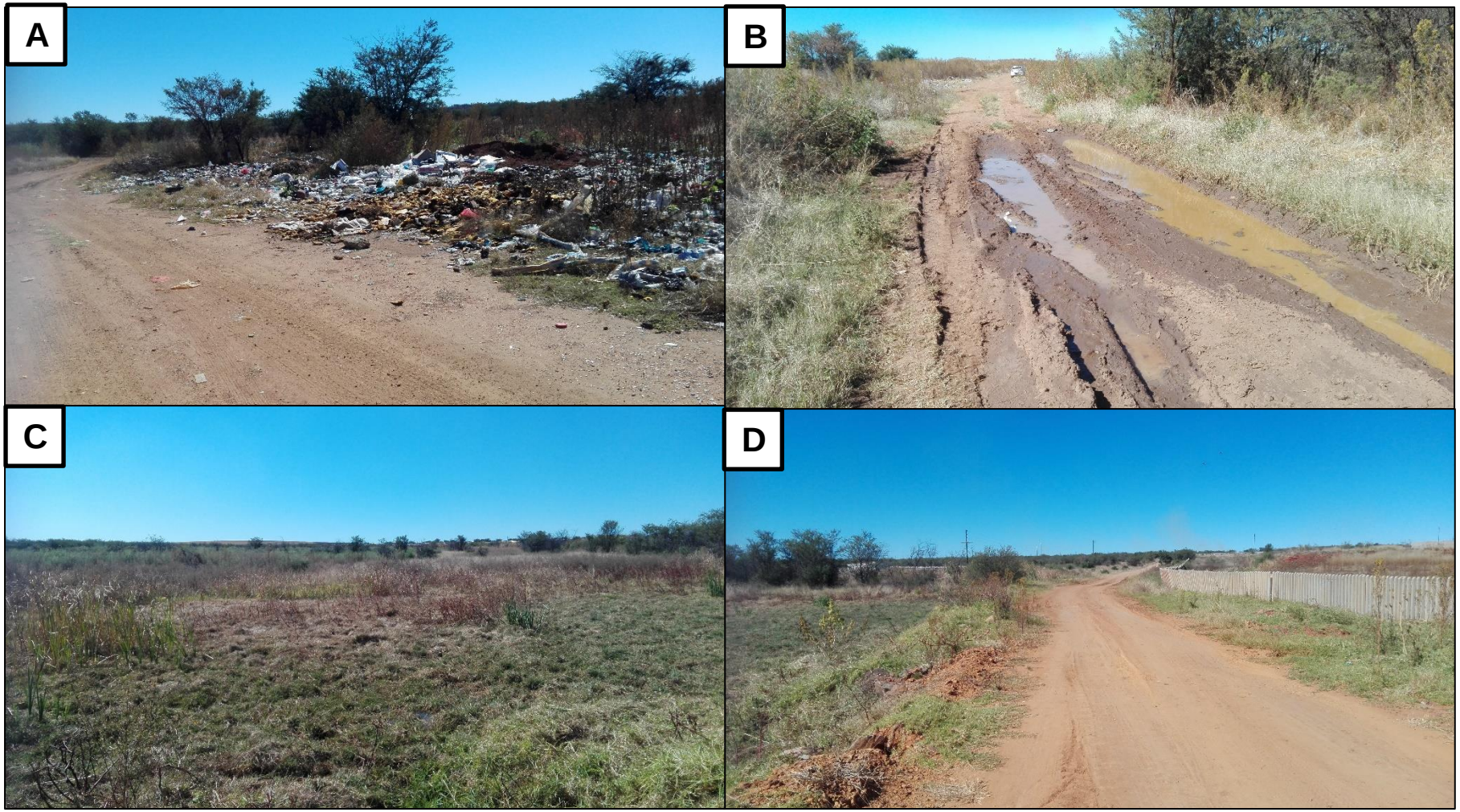


Figure 13: A - Ad hoc dumping in close proximity to UVB02, B - Construction of dirt road through UVB02, C – Patches of *Typha capensis* and grassland within UVB01, D – Construction of dirt road through UVB01 which impedes the natural diffuse flow of wetland.

8. ECOSYSTEM SERVICES AND ECOLOGICAL IMPORTANTS AND SENSITIVITY

8.1. Ecosystem services of CVB01

CVB01 calculated to be moderately level at the removal of toxicants and nitrates, trapping of phosphates and sediment and a also a moderate level of attenuating floods of the water flowing into, through and out of it to ensure adjacent properties are at a reduced risk of getting flooded. The aforementioned ESS can be attributed to these CVB systems exhibiting a diverse flow regime, with the inflow being supplied by both the channel and lateral surface runoff and subsurface leaching from the adjacent catchment. As a result of the upstream catchment being altered, there is great opportunity for toxicant, sediments, nitrates and phosphates to enter the systems through the lateral and channelled flow due to poor veld conditions. What makes the system effective at supplying the aforementioned ESS are its perennial flow regimes, moderately high vegetation cover and the alluvial deposits and clay loam soil present within it, which are recorded to filtrate/absorb toxicants and nutrients that may be detrimental to the health and functionality of downstream systems. Furthermore, CVB01 provided a moderate level of erosion control and carbon storage. Carbon storage in this wetland was determined by the amount of peat present in the soils and the indigenous wetland vegetation which both act as a sink for carbon. The socio-cultural services provided by this wetland was low to moderately low.

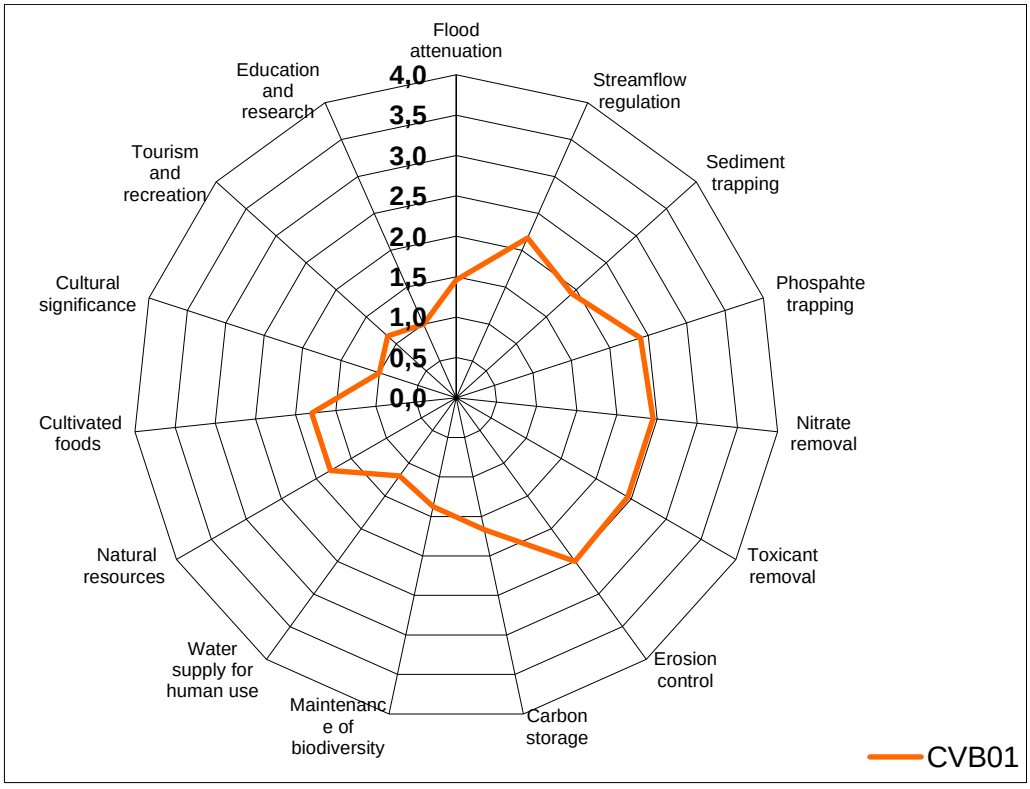


Figure 14: Diagram illustrating the direct and indirect benefits supplied by CVB01

8.2. Ecological Importance and Sensitivity of CVB01

CVB01 calculated to have a Moderate EIS primarily due to this system being identified as a FEPA River as per the NFEPA dataset (Nel *et al*., 2011) and a CBA1 as per the (Desmet and Schaller, 2015) dataset. Additionally, this system is rated highly in terms of hydrological and functional importance as a result of supplying valuable regulatory ESS to the surrounding environment. Its Ecological Importance was observed to be High as a result of this wetland being identified as important at a National Level. Lastly, all development that is proposed to be constructed adjacent to the wetland should adhere to the NEMA (Act no 107 of 1998)

principles, one of which states that all development should occur sustainably with an end-goal of no net-loss of biodiversity.

Table 25: Summary of the Ecological Importance and Sensitivity scores for CVB01

SUMMARY	CVB01	
	SCORE	RATING
Ecological Importance	2.50	High
Functional/Hydrological Importance	2.63	High
Direct Benefits to Society	0.38	Low
Overall Importance	**1.83**	**Moderate**

8.3. Ecosystem services of UVB01 and UVB02

UVB01 and UVB02 calculated to be moderate at the removal of toxicants and nitrates, trapping of phosphates and sediment. Flood attenuation and streamflow regulation calculated to be at a moderately level due to water flowing into, through and out of it. Erosion control was calculated to be at a moderate level due to the high surface roughness in the wetlands, whereas carbon storage was calculated to be moderately low due to the lack of the amount of peat present in soil which act as a sink for carbon. The ecosystem services provided by the unchannelled valley bottom wetlands can be attributed to their nature to exhibiting a diffuse flow regime throughout the different wetness zones, being supplied by both the lateral surface runoff from the catchment and subsurface flow. As a result of the upstream catchment being substantially change by linear activities and informal development, there is great opportunity for toxicant, nitrates and phosphates to enter the systems through the lateral input. What makes this system effective at supplying the aforementioned ESS are their diffuse flow regime and clay loam soil present within it, which are recorded to filtrate/absorb toxicants and nutrients that may be detrimental to the health and functionality of downstream systems. Furthermore, socio-cultural services provided by all unchannelled valley bottom wetlands were moderately low to low.

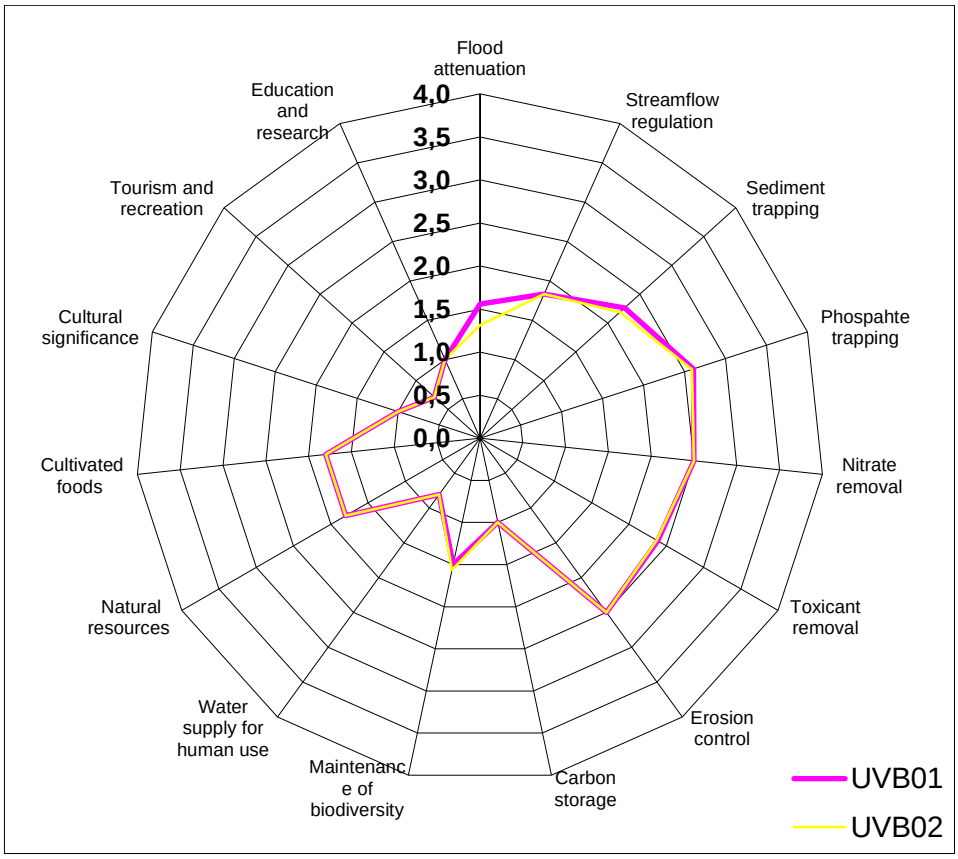


Figure 15: Diagram illustrating the direct and indirect benefits supplied by UVB01 and UVB02

8.4. Ecological Importance and Sensitivity of UVB01 and UVB02

UVB01 and UVB02 calculated to have a Moderate EIS primarily due to UVB01 falling within a FEPA River at a desktop level (Nel *et al*., 2011) and; UVB01 and UVB02 falling within a CBA1 (Desmet and Schaller, 2015). Additionally, UVB01 is rated High in terms of its Ecological Importance, whereas UVB02 is rated Moderate for its Ecological Importance. The hydrological/functional importance was rated as Moderate for both these systems, as a result of these systems supplying valuable regulatory ESS to the surrounding environment. The proposed development will occur adjacent to UVB01 and UVB02, thus all development that is proposed to be constructed adjacent to these wetlands should adhere to the NEM:BA (Act no 107 of 1998) principles, one of which states that all development should occur sustainably with an end-goal of no net-loss of biodiversity.

Table 26: Summary of the Ecological Importance and Sensitivity scores for UVB01 and UVB02

SUMMARY	UVB01		UVB02	
	SCORE	RATING	SCORE	RATING
Ecological Importance	2.25	High	1.83	Moderate
Functional/Hydrological Importance	1.56	Moderate	1.41	Moderate
Direct Benefits to Society	0.71	Low	0.13	Low
Overall Importance	**1.33**	**Moderate**	**1.12**	**Moderate**

9. BUFFER ZONE DETERMINATION

It is recommended that the buffer zone, which was calculated for the at-risk wetlands which may potentially be impacted on by the proposed development utilising the best practice buffer zone tool (Macfarlane *&* Bredin, 2016) be applied. The following activities should not be conducted within the calculated buffer zones: no ablution facilities, washing of vehicles, stockpiling, waste dumping (organic or artificial), access roads, haulage roads, site camps and any other activities which may be detrimental to the health and functionality of the wetlands. Additionally, any unauthorised, or potentially detrimental activities, which occur in the direct vicinity, or upstream, of the wetlands should be rehabilitated according to the site EMPr, and preventative or mitigation strategies. Table 28 and Figure 15 below provide the recommended buffer zone relative to the study area.

Table 27: Recommended buffer zones for the wetlands that will be potentially impacted on by the proposed development (Macfarlane & Bredin, 2016).

WATERCOURSE	CONSTRUCTION PHASE (M)	OPERATIONAL PHASE (M)
CVB01	20	15
UVB01, UVB02	15	15

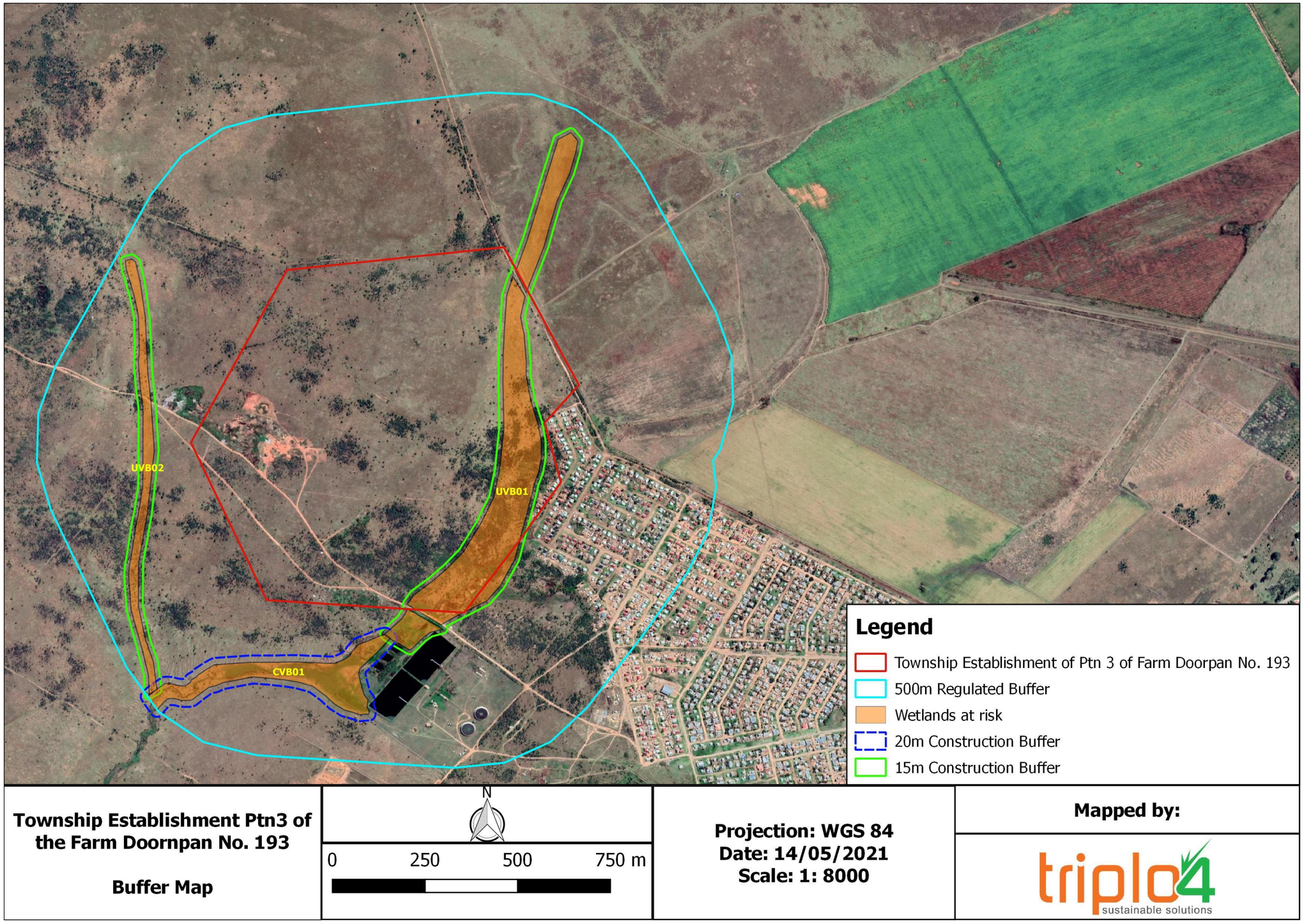


Figure 16: Map illustrating the calculated buffer segments for the wetlands delineated within the 500m regulated buffer

10. IMPACT AND RISK ASSESSMENT

10.1. Impact Assessment

An understanding of the relationship between the landscape and the dynamic characteristics of watercourses is vital for the accurate assessment of watercourse functions and values. Watercourses are adjusting to disturbance occurring within them and within the greater landscape, on a continuous basis. The recognition to what extent these various disturbances have on watercourses and their associated PES and EIS is vital when assessing disturbance and impact and when considering mitigative measures.

The types of impacts on watercourses can be categorised into three (3) broad categories, namely; direct, indirect and cumulative impacts. Direct impacts are associated with disturbances occurring within the system such as canalisation, infilling, removal of vegetation and infrastructure development. Indirect impacts include disturbances outside the system, such as increased surface water and sediment, loss of recharge area, changes in local drainage patterns. Cumulative impacts include disturbances resulting from combined direct and/or indirect impacts to the system over time. However, as this study was conducted over 1 day in the field the cumulative impacts on the assessed resources cannot be documented with confidence within this report. A more in-depth study over several seasons will need to be conducted to accurately determine the relevant cumulative, and/or downstream impacts.

The impacts of the proposed development are described in Table 29 DWS Risk Assessment Matrix.

10.2. DWS Risk Assessment Matrix (RAM)

The DWS has published an amendment of the GN 509 Section 21 (c) and (i) activities in terms of the NWA (No. 36 of 1998). The purpose of the authorisation is as follows:

> *"This General Authorisation replaces the need for a water user to apply for a license in terms of the National Water Act (No.36 of 1998) ("the Act") provided that the water use is within the limits and conditions of this General Authorisation."*

The reason for this amendment is to streamline the WULA process by allowing projects that are calculated to pose a low risk of impacting on the surrounding aquatic environment to be granted under a GA instead of having to undergo a full WULA process. The risk rating of each aspect pertaining to all the construction activities associated with the proposed development is calculated using the DWS RAM (DWS, 2016). Any aspect that is assessed to pose a moderate or high risk of impacting on the surrounding watercourses will trigger the need for the proposed development to undergo a full WULA process. However, if all the aspects are calculated to be of negligible-to-low risk the proposed development may be authorised under a GA, as per GN509 (26 August 2016), which was drafted under the NWA (No. 36 of 1998).

The strength of the revised DWS RAM is that the critical components of each impact, namely duration, extent, magnitude, probability and significance, are carefully considered, allowing a balanced perspective of each impact to be gained. It was concluded that there is an aspects associate with the proposed development that are unable to be mitigated from a moderate to low risk rating of impacting on the surrounding watercourses. Thus, in terms of Section 21 (c) and (i) of the NWA (Act no. 36 of 1998), the proposed development will have to undergo a full WULA process.

This conclusion is mirrored by the specialist's opinion as it was observed that the proposed development will contain certain activities that could not be mitigated from a moderate to low risk rating. Thus, the proposed development should be authorised under a full WULA process, as per GN509 of 26 August 2016, which was drafted in accordance with the NWA (Act no. 36 of 1998). Table 29 below is a summarized version of the DWS RAM (2016) for the proposed development.

Table 28: Evaluation of potential impacts of the proposed development on the surrounding watercourses (Presented in a summarised DWS RAM)

Nr.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Type Watercourse
1	Pre-C	Establishment of a construction site camp and erection of ablution facilities within a previously disturbed area, 50m away from any delineated watercourses.	Increase in surface-area of hardened surfaces	Potential encroachment by AIPs; Potential destruction of native and/or indigenous plant species; Disruption to soil profile and consequent creation of excess sediment; Compaction of the soil profile; Potential alteration to the physcio-chemical properties of the downstream watercourses; Potential pollution of groundwater and surrounding watercourses if erected ablution facilities are poorly maintained.	1,25	3,25	**8**	**26**	Low			**No Watercourse**
	Pre-C		Clearing and grubbing		1	3	**8**	**24**	Low			
	Pre-C & C		Potential application of herbicide to clear land		1,375	3,375	**8**	**27**	Low			
2	Pre-C	Demarcation of buffer zones and no-go areas and the allocation/preparation of spoil sites (topsoil separate from subsoil), waste dump sites and construction vehicle routes	Erection of silt fencing around all waste dumps (including coverage sails).	Disruption of the soil profile and thus creation of excess sediment; Potential noise and air pollution as a result of onsite waste dump sites; The potential increase of preferential drainage parts as a result of construction vehicles creating unauthorised pathways; Compaction of topsoil as a result of construction vehicles baring excess weight on soil; Removed topsoil and subsoil which will be utilised for rehabilitation purposes contaminated by AIPs and loss due to natural wind mechanism.	1	3	**8**	**24**	Low			**No Watercourse**
	Pre-C & C		The dumping of waste and spoil at the designated sites using haulage routes		1,375	3,375	**8**	**27**	Low			
	Pre-C & C		Input of dropper, or wooden poles to extend danger tape on, or paint poles		1	3	**8**	**24**	Low			
3	Pre-C & C	Construction vehicle movement throughout the constructional period	Movement of construction vehicles over loose soil particles.	Increased surface runoff and reduction in soil infiltration/permeability; Potential increase in risk of contamination of downstream watercourses due to oil leakages from construction vehicles; Compaction of topsoil by construction vehicles; Potential creation of preferential drainage paths by construction vehicles	1,625	3,625	**9**	**32,625**	Low			**CVB01, UVB01, UVB02**
	Pre-C & C		Different soil structures baring excess weight of the large construction vehicles.		1,25	3,25	**8**	**26**	Low			
	Pre-C & C		Accidental spills (e.g. hydrocarbons,		1,5	3,5	**10**	**35**	Low			

			chemicals, oil etc.).	coupled with heavy rainfall events.									
4	Pre-C & C	Construction of new stormwater infrastructure	Trenching for stormwater infrastructure	Disruption of the soil profile, and thus potential sedimentation of downstream systems; Concentrated flow entering the adjacent environment; Increased frequency, velocity and volume of stormwater flow into the downstream watercourses.	1,875	4,875	**9,5**	**46,3125**	Low			**CVB01, UVB01, UVB02**
	Pre-C & C		Concrete batching		1,375	3,375	**8,5**	**28,6875**	Low			
	Pre-C		Construction of the relevant stormwater attenuation area		1,625	4,625	**9**	**41,625**	Low			
5	Pre-C & C	Direct destruction of vegetation and topsoil layer within the developable footprint	Loss of biodiversity within the site and disruption and/or destruction of faunal habitats.	Disruption of the soil profile and thus potential sedimentation of downstream systems; Increased risk of erosion due to exposure of bare-ground and reduced soil cohesion; Reduction in infiltration and increased risk of splash and rill erosion developing down the slope.	1,5	4,5	**8**	**36**	Low			**CVB01, UVB01, UVB02**
	Pre-C & C		Reduction of groundcover and increased surface-area of exposed bare-ground and impermeable-surfaces.		1,375	4,375	**8,5**	**37,1875**	Low			
	Pre-C & C		Reducing the soil cohesion created by the plant roots.		1,5	4,5	**8,5**	**38,25**	Low			
6	C	Construction of the mixed-use development (i.e. apartments, amenities and open spaces).	Setup a concrete batch plant onsite (if contractor does not utilise a commercial ready mix concrete supplier)	Contamination of the surrounding terrestrial and aquatic environments by concrete mix or hydrocarbons; Sedimentation of downstream resources; Increased hardened surfaces and thus higher energy surface and stormwater runoff into the downstream resources; Potential loss of habitat for species within the area; Potential contamination of sediment and groundwater due to continuous cement spills and poor	1,25	3,25	**9**	**29,25**	Low			**CVB01, UVB01, UVB02**
	C		Piling and creation of footings (depending on soil baring capacity).		1,5	3,5	**9**	**31,5**	Low			
	C		Construction of new sewer lines		1,25	4,25	**9**	**38,25**	Low			

	C		Construction of new water mains	construction ethics; Potential direct destruction of aquatic environment; Potential diversion of the natural flow of water during rainfall events; Potential loss of water being transported to downstream watercourses.	1,375	4,375	**8,5**	**37,1875**	Low			
	C		Construction of roads, public facilities, social facilities and other mixed use facilities away from watercourses and their associated buffer		1,75	5,75	**10**	**57,5**	Moderate	No heavy machinery must be utilised within the watercourse. No dumping or allowance of foreign material should occur within the watercourse. Any erosional and depositional features created during the constructional phase must be reinstated to the natural state of the environment. If there is any direct destruction of watercourses, a Wetland Rehabilitation Plan should be conducted to assist with the rehabilitation of watercourses on site and potential other watercourses downstream which have been degraded.	Low	
7	R	De-establishment of the site camp, spoil sites, waste dumps etc. and the rehabilitation of the temporary access/haulage roads.	Tillage of areas of bare-soil and revegetation using a mixture of indigenous grass species.	**Positive impacts**: Increase surface roughness and reduce the velocity of the surface runoff; Decrease erosion potential; Increase biodiversity; Remove all potential contaminants; Reinstate natural topography.	1	3	**8**	**24**	Low			**No Watercourse**
	R		Reshape local topography to natural slope if necessary.		1	3	**8**	**24**	Low			
8	O	Use of the Township Establishment on Ptn3 of the Farm Doornpan No. 193 (i.e: roads, sewer, water, electricity, stormwater and built facilities)	Increased risk of pollution and change in watercourse characteristics (e.g. litter, leakage from sewer and water pipelines, poor maintenance of stormwater infrastructure)	Removal of vegetation cover and loss of biodiversity; Destruction of aquatic and terrestrial habitats and loss of faunal species; Soil compaction and thus increased surface runoff and decreased infiltration/permeability; Increased friction against rainfall and surface runoff with the addition of vegetation; Increased opportunity for groundwater and watercourse contamination as a result of leaks from sewer lines and leakages from residentially vehicles;	2,5	7,5	**13**	**97,5**	Moderate	Ensure that all sewage infrastructure are constructed outside from all delineated watercourses and their associated buffer zones. If leaks occur, these should be immediately reported to municipality and repaired in rapid succession before sewer pollutes nearby watercourses and groundwater.	Moderate	**CVB01, UVB01, UVB02**
	O		Increased risk of the regional population harvesting local fauna and flora from the surrounding environment.		1	3	**8**	**24**	Low			

	O		Increased risk of vehicles creating unauthorised tracks.	Increased potential of erosional features if stormwater is not managed in terms of discharge velocity and discharge area.		1,125		3,125		**9**	**28,125**	Low			

11. MITIGATION MEASURES

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation requires proactive planning that is enabled through a mitigation hierarchy (Figure 16). Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA, 2013).

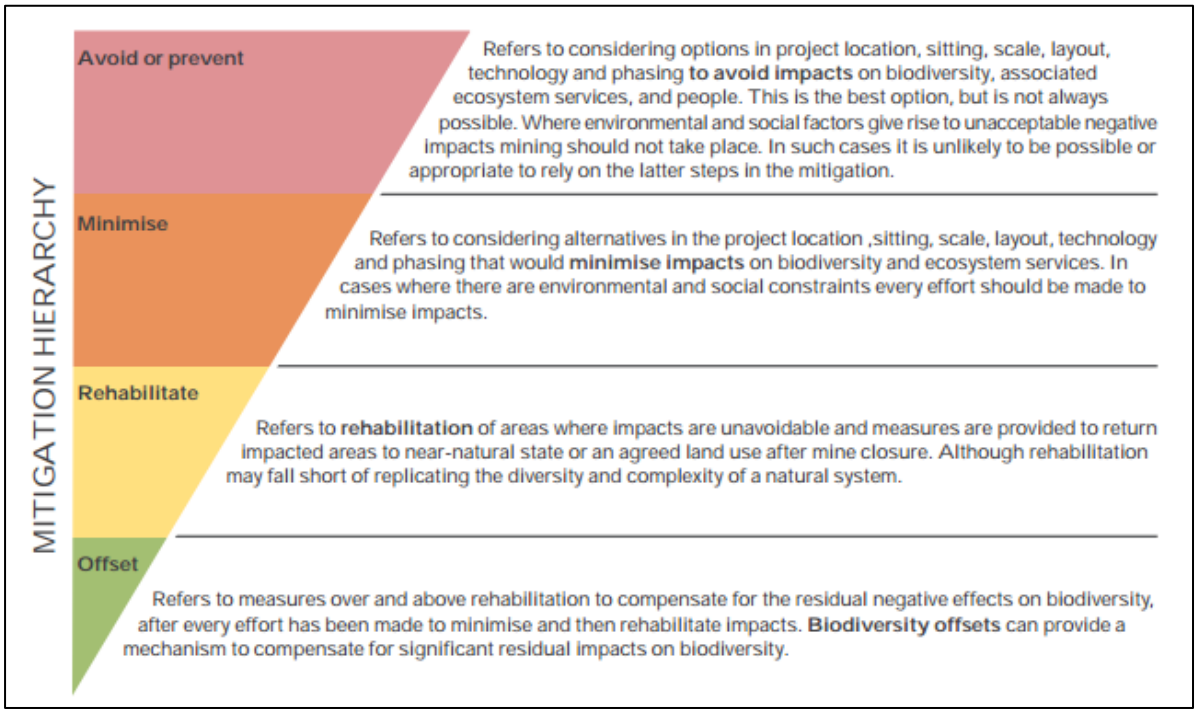


Figure 17: The mitigation hierarchy for dealing with negative impacts on biodiversity. Its application is intended to require companies to first strive to avoid disturbance of ecosystems and loss of biodiversity, and where they cannot be avoided altogether, to minimise, rehabilitate or offset any residual negative impacts on biodiversity (DEA, 2013).

11.1. Pre-construction Mitigation Measures

Table 29: Pre-Construction phase mitigation measures.

MITIGATIVE MEASURES	PHASE OF PROPOSED DEVELOPMENT - PRE-CONSTRUCTION
Generic/Broad	- The footprint of the site camp and the construction footprint must be kept to a minimum, to ensure there is no unnecessary intrusion into any watercourses. - All access points, roads and turning areas must be agreed by the engineer and Environmental Control Officer (ECO) prior to commencement of construction. No ad hoc haulage roads or turning areas may be created. - Stockpile areas of raw materials and other construction material must be clearly identified and demarcated prior to materials being brought onto site. None of these areas must be on or near slopes or watercourses. All stockpiling areas must be approved by the ECO before stockpiling occurs. - All stormwater infrastructure along the road must be sufficiently incorporated into the planning and design stages to ensure no excess surface runoff, and consequent erosion, occurs. All drainage infrastructure must be implemented at the lowest point along the road footprint. - Detailed planning, positioning and demarcation of onsite waste dump sites must be completed prior to any waste handling occurring (this includes rubbish) and the waste areas must not occur in the demarcated water resources and associated buffer zones. All onsite personal must also be trained in proper waste management techniques and shown the appropriate waste dumps for specific materials prior to any construction activities occurring (including site establishment). - The contractor must utilize a Stormwater Control Plan (which may form part of the construction method statement) to ensure that all construction activities do not cause, or precipitate, soil erosion which may result in sediment input into the surrounding environment. The designated responsible person on site, as indicated in the stormwater control plan (usually the contractor/ECO) must ensure that no construction work takes place before the stormwater control measures are in place and must include post-construction/operational phase stormwater requirements. - The drainage plan must ensure no downslope erosion occurs through increased stormwater inputs and that the stormwater system has sufficient capacity for water inputs and drainage. - Soft engineering (grassed swales (Teff Grass or Red Grass ideal for this climate)) instead of hard gutters should be used where possible. - All staff are to be trained on their environmental responsibilities before commencing work. This should be adequately covered within the site-specific EMPr and should not require input from a wetland assessment (above what is detailed within this report). - No-go areas must be determined and demarcated and agreed upon by contractors, engineers and ECO before any construction activities occur onsite. Special attention must be given to the identified wetland systems (and their associated buffers) in the vicinity of the development activities. Unnecessary intrusion into these systems is prohibited. These areas must be clearly demarcated onsite and indicated to all construction workers onsite before any construction activities (including site establishment) takes place. Where intrusion is required, the working corridor must be kept to a minimum and identified and demarcated clearly before any construction commences to minimize the impact.

Site/Project Specific	- Existing access/haulage routes must be utilised during construction as far as possible. - Stormwater infrastructure must be positioned at areas where concentrated flows will enter the systems. The flow from stormwater infrastructure should not enter a system directly but should rather flow into an area of vegetated land, or dissipation area. - Crossing structures utilised be wide enough to allow diffuse, unhindered through-flow of the wetland systems and avoid impoundment upslope.

11.2. Construction Mitigation Measures

Table 30: Construction Phase Mitigation Measures

MITIGATIVE MEASURES	PHASE OF PROPOSED DEVELOPMENT - PRE-CONSTRUCTION
Generic/Broad	- A construction method statement is required to be compiled by the applicant/contractor for all activities associated with the proposed development. This method statement must include the phases of the project, activities associated with the construction and all mitigation measures stipulated within this report and the site-specific EMPr. The applicant, engineer, contractor and ECO must agree and approve the statement as this will become a binding document which must be implemented onsite. The independent ECO must ensure this document is continuously implemented onsite to ensure no unnecessary disturbance. - A serial plan of construction must be developed: • Construction must be immediately followed by rehabilitation; • Excavation of any soils must be done to allow the storage of soil in sequence; • Soil replacement must be conducted in same sequence as excavated; • Soil surfaces must not be left open for lengthy periods to prevent erosion. • Affected surface vegetation must be removed, appropriately stored then reinstated, immediately post-construction, as close to their original position as possible, to reduce the possibility of longer-term change to the vegetation community. The vegetation must be removed keeping the root systems intact as far as possible. • If required vegetation plugs can be sorted from areas adjacent to the construction site, under the supervision of the Environmental Control Officer. - Environmental inductions and training must include the contents of the above method statement. - During the necessary removal of the natural vegetation for the development of the associated infrastructure (e.g. site camp, access roads) any protected species which are recorded must be safely relocated to an adequate habitat within the same catchment area. An independent botanist must be consulted during this process. - Excess dust observed in the vicinity of the proposed development must be noted and the appropriate dust suppression techniques implemented to ensure no excess sediment input into the surrounding wetlands. - Cut and fill must be avoided where possible during the set-up of the construction camp. The utilization of the already heavily disturbed areas should be encouraged. - The relocation of services, i.e. water, stormwater and especially sewerage infrastructure, must not result in the contamination of the surrounding environment.

	- Removal of vegetation must only be done when essential for the proposed development. Do not allow any disturbance to the adjoining natural vegetation cover or soils. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO. - Where feasible, construction activities should be conducted during the drier months of the year (April – August) to minimize the possibility of erosion, sedimentation and transport of suspended solids associated with disturbed areas and rainfall events. - All potential stormwater contaminants must be bunded in the site camp to prevent run-off into the surrounding environment. A drainage system must be established for the construction camp. The drainage system must be regularly checked to ensure an unobstructed water flow. - Establish cut off drains and berms to reduce stormwater flow through the construction site. - The contractor must prepare a Stormwater Control Plan (which may form part of the construction method statement) to ensure that all construction activities do not cause, or precipitate, soil erosion sediment which may result in sediment input into the surrounding environment. - The designated responsible person on site, as indicated in the stormwater control plan (usually the contractor/ECO) must ensure that no construction work takes place before the stormwater control measures are in place and must include post-construction/operational phase stormwater requirements. - No contaminated runoff or grey water is allowed to be discharged from the construction camp. - The demarcated wetlands systems must be protected from erosion and direct or indirect spills of pollutants, e.g. sediment, refuse, sewage, cement, oils, fuels, chemicals and wastewater. - All exposed surfaces within the construction site must be checked for AIPs monthly and any identified alien species must be removed by hand pulling/uprooting and appropriately disposed of. Herbicides should **only** be utilised where manually removing is not possible. Herbicides utilised are restricted to products which have been certified safe for use by an independent testing authority. The ECO must be consulted before the purchase of any herbicide. - Stockpiles and topsoil storage areas must not be located within the wetland constructional buffer, wetlands and/or riverine channels or within the 1:100-year flood lines. The furthest threshold must be adhered to. They should not be placed in vegetated areas that will not be cleared. - Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles. - Water used on site must be from an approved source. Should the water be extracted from a natural source, a water use licence must be acquired from DWS before abstraction. Water use on the site must be recorded and monitored. - The digging of pit latrines is not allowed under any circumstances. - None of the open areas or the surrounding environment may be used as ablution facilities. - Material Safety Data Sheets (MSDSs) must be readily available on site for all chemicals and hazardous substances to be used on site. Where possible and available, MSDSs should additionally include information on ecological impacts and measures to minimize negative environmental impacts during accidental releases or escapes. - Hazardous material storage areas must not be within 50 m of any watercourse or within the 1:100-year flood line. The furthest threshold must be adhered to. Hazardous storage areas to be hard surfaced and bunded with an impermeable liner to protect groundwater quality and undercover. The bunded a catch pit must have at least 110% the storage capacity of the total stored quantity. - Should any spills of hazardous materials occur on the site or in the storage area, the relevant clean-up specialists must be contacted immediately. Materials that absorb fuel & oil, such as spill kits or earth should be placed over the spill. This contaminated material must be uplifted, placed within impermeable container and disposed of at a recognized disposal site.

	- In the event of a spillage that cannot be contained and which poses a serious threat to the local environment, the following Departments must be informed of the incident in accordance with Section 30 of the National Environmental Management Act, Act 107 of 1998, within forty-eight (48) hours: • The Local Authority; • DWS; • The Department of Economic Development, Tourism and Environmental Affairs • The Local Fire Department when relevant; and • Any other affected departments. - An incident record must be completed for all spills that do occur onsite. Minor incidents will include small spills of less than 5 litres that do not enter a watercourse, stormwater drains, housekeeping issues and general small non-compliances with the requirements of this report, method statements, EA and/or EMPr. The record of incidents is to be included in the reporting to the authorities. Major incidents must be reported to the authorities, which include spills larger than 5L and all incidents involving contamination of water resources, stormwater or other reportable incidents. **Minor incidents**: small spills less than 5l that do not enter stormwater, minor non-compliance with EMPr that does not cause major environmental impact i.e. Housekeeping issues etc. **Action**: Supervisor and staff on site to record and address and notify ECO. ECO to advise on remediation measures and to follow up on actions taken to address incident. **Records**: On site incident register. **Major incidents**: Large spills or any spills that enter watercourses, stormwater, contamination of soil, fires, explosions. **Action**: Report immediately to ECO, action to be taken to prevent further damage and incident to be reported to authorities. ECO to advise on remediation measures and to follow up on actions taken to address incident. **Records**: On site incident register and report to authorities as listed above. - The harvesting of firewood, medicinal plants, tree bark, flowers or other natural materials is forbidden on the site and surrounding environment. - The Contractor must, as an initial and on-going exercise, implement erosion and sedimentation control measures (e.g. gabion structures, geotextiles) to the satisfaction of the ECO. Stabilisation of cleared areas to prevent and control erosion and/or sedimentation must be actively managed. - Sediment control: construct silt fences/traps in areas prone to erosion, to retain sediment-laden runoff. (i.e. place silt traps strategically on the periphery of freshwater resources, remove sediment on a regular basis and transport to designated dumping site, ensure silt fences/traps are adequately maintained). - A designated waste area, which must be located outside of the wetland constructional buffer and the 1:100 year floodline, must be utilised at all times. Bins must be provided and emptied at no less than monthly intervals. - All solid waste generated during the construction process (including packets, plastic, rubble, cut plant material, waste metals etc.) must be placed in the waste collection area in the construction camp and must not be allowed to blow around the site, be accessible by animals, or be placed in piles adjacent the skips / bins. - Burying of waste, rubble on site, or dumping in drainage lines/rivers is strictly prohibited.
Site/Project Specific	- Silt traps must be erected around all excavation, dumping and/or infill activity which may take place at the proposed development which are given authorization to be utilised to reduce the siltation to the downslope wetlands. - Silt traps must be erected at the base of the slopes leading into the downslope wetlands and around all site camps, spill sites, access roads and temporary structures. Removal of sediment from the erected silt traps must take place on a weekly basis.

	- Erosion and sedimentation must be monitored closely. After every heavy rainfall event, the contractor must check the site for erosional damage and rehabilitation must occur immediately if damage is found. - Topsoil and subsoil which is excavated from the terrestrial areas must be stockpiled with the topsoil separate from the subsoil and preserved for future rehabilitation. Cleared vegetation and soils which will not be utilised for rehabilitation purposes must be disposed of at a registered waste disposal facility. Stockpiles must be seeded with indigenous grasses or stabilised with geotextiles to reduce erosion potential. - All stormwater and sheet runoff management infrastructure must divert flow away from areas susceptible to erosion, specifically steep slopes and wetlands (e.g. stormwater flowing into the wetlands). Unstable areas associated with the proposed development must be stabilised utilising geotextiles or other appropriate stabilisation techniques. - All areas of loose sand, which are prone to wind erosion must be sprayed with water or other dust suppression techniques.

11.3. Post Construction/Rehabilitation Phase

Table 31: Post-construction/rehabilitation phase measures

MITIGATIVE MEASURES	PHASE OF PROPOSED DEVELOPMENT - PRE-CONSTRUCTION
Generic/Broad	- Rehabilitation is not the static endpoint of a recipe-like process (Kusler & Kentula, 1990). Rather, it is a process in its own right, whereby the wetland/riverine system is given an opportunity for a new beginning (Grenfell, *et. al*., 2007). - Rehabilitation requires that there is an attempt to imitate natural processes and reinstate natural ecological driving forces in such a way that it aids the recovery (or maintenance) of dynamic systems so that, although they are unlikely to be identical to their natural counterparts, they will be comparable in critical ways so as to function similarly (Jordan, et. al., 1987). - It must be recognised that rehabilitation interventions may have different ecological starting points (ranging from totally degraded to slightly degraded) and different goal endpoints (ranging from a state that is close to the pristine to one which is still far from pristine, but nonetheless an improvement on the state of the system without any rehabilitation intervention). The chosen goal endpoint depends on what is achievable, given the site conditions, and those ecosystem attributes and services that are considered most important. Any rehabilitation project should therefore be based on an understanding of both the ecological starting point and on a defined goal endpoint, and should accept that it is not possible to predict exactly how the wetland/riparian system is likely to respond to the rehabilitation interventions. - The most typical rehabilitation interventions designed to assist in the recovery of degraded wetland ecosystems are 'plugs' constructed within artificial drainage channels. The 'plugs' are placed with the intention of reinstating a more natural hydrology. Typical interventions for maintaining the health wetland ecosystems that are in the process of degrading are the placement of erosion control structures which assist in halting the advance through a wetland of an erosion headcut. However, rehabilitation is not confined to physical structures, and rehabilitation may include interventions such as reducing livestock grazing-pressure or reducing the frequency of burning. - All post-construction building material and waste must be cleared in accordance with the EMPr, before any re-vegetation may take place.

	- Erosion features that have developed as a result of construction related disturbance are required to be stabilised. This may also include the need to deactivate any erosion head cuts/rills/gullies that may have developed by either compacted soil infill, rock plugs, gabions or any other suitable measures. - Slopes that have been altered due to construction must be reshaped to replicate the original condition and contours. - If the gradient of the banks is greater than 1:1.75, the banks must be stabilised with a biodegradable cover such as Geojute which must be secured to the steep slope with wooden (biodegradable) pegs. This will reduce soil erosion potential. - Any areas, which fall outside the direct construction footprint, that have been compacted are required to be ripped to allow for the establishment of vegetation. This ripping must not result in the mixing of sub - and topsoil. - No imported soil material may be utilised for rehabilitation, unless it can be ensured that it is free of any AIPs seeds. - Before adding the topsoil all weeds and AIPs must be removed. - Additional stabilisation of cleared areas to prevent and control erosion must be actively managed. The method of stabilisation should be determined in consultation with the ECO and engineer. The following methods (or a combination) may be considered, depending on the specific conditions of the site: • Brush packing • Mulch or chip cover • Terracing • Straw stabilising (at the rate of one bale/m² and rotated into the top 100mm of the completed earthworks) • Watering • Planting / sodding • Hand-seeding / Hydro-seeding • Mechanical cover or packing structures (Geofabric, Hessian cover, Armourflex, Log / pole fencing) - The landscape architect/horticulturist must supervise the handling, maintenance and planting of the plant/trees. - No AIPs may be utilised during the rehabilitation process. - Rapidly germinating indigenous species (e.g. fast growing, deep rooting, rhizomatous, stoloniferous) known to bind soils in terrestrial, riparian and/or wetland areas must be utilised where there is a strong motivation for stabilisation over reinstating similar plant communities to that being disturbed. This should be informed by a qualified specialist. - Exposure of plant root systems to drying winds, high temperatures or water logging must be avoided. - Where possible, revegetation must take place at the start of the spring rains to maximise water availability and minimise the need for irrigation. This will ensure optimal conditions for germination and rapid vegetation establishment. - If this is not possible, irrigation of planted areas may be necessary during dry periods (external sources of water must be utilised e.g. Joe-Joe tanks). - Water utilised for irrigation must be free of any chlorine or contaminants that may negatively affect the plant species. - The use of irrigation may be halted where hydro-seeding shall be utilised, until seeds have germinated and growth has commenced. - It is the contractor's responsibility to continuously monitor the area for AIPs during the contract and establishment period, and any AIPs encountered must be removed. - Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas. - AIPs shall not be stockpiled, they should be removed from site and dumped at an approved site.

	- Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be used, effectiveness and impacts of the product on aquatic biota.
Site/Project Specific	- Rehabilitation must commence within 30 days from the period when the construction phase has ended. - All alternative tracks and footpaths created during the construction phase should be appropriately rehabilitated (e.g. tillage and re-vegetation of the affected areas). This rehabilitation should result in improved surface roughness and increased infiltration along with reduced stormwater flow and consequently reduced rill erosion. - Any unauthorised haulage or access roads which were created must be decommissioned and rehabilitation to reinstate the natural vegetation, increase the surface roughness and resultantly increase infiltration (e.g. tillage and revegetation). - All construction waste materials must be removed, and temporary structures (e.g. offices, workshops, storage containers, ablution facilities) dismantled, from site and the surrounding environment, this will need to be checked by the ECO and the various contractors. - All banks where there is exposed soil, with the potential for rill/gully erosion to take place, must be stabilised. Gabion structures or geotextiles must be implemented upslope of the proposed development where necessary. - The reinstatement of the longitudinal bank profiles, which have been altered, must be rehabilitated if possible. The soil horizons must be reinstated on the correct structural order and the vegetation groundcover over the disturbed area re-vegetated according to the native indigenous species within the area. - AIPs must be removed manually without further disturbance to the surrounding ecosystems. If manual removal is not possible, seek guidance from a local cooperative extension service or Working for Water. Dispose of the removed AIPs at a registered dumping site or burn the material on a bunded surface. - Rehabilitation of the sections where AIPs are removed must take place. The appropriate indigenous grass and woody vegetation species seeds must be attained from a registered nursery with the guidance of a botanist who is familiar to the region.

11.4. Operation Phase

Table 32: Operational phase mitigation measures

MITIGATIVE MEASURES	PHASE OF PROPOSED DEVELOPMENT - OPERATIONAL
Generic (Broad)	- The establishment and infestation of AIPs must be prevented, managed and eradicated in the areas impacted upon by the proposed construction activities. The type of species and location of that species will determine the type of methodology required for its management and eradication. This methodology should target all lifecycle phases and propagules of the specific species, e.g. seedlings/saplings, seeds, roots. - Indigenous vegetation within the site must not be removed or damaged, where possible, during the alien plant control, increasing the probability of indigenous species propagating and preventing the re-establishment of alien species. - As stated above, any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be used, effectiveness and impacts of the product on aquatic biota.
Site/Project Specific	- The monitoring of the proposed development and associated infrastructure (e.g: water pipelines, sewer pipeines) must be conducted on a bi-annual basis to ensure that structural faults do not result in the unnecessary contamination of the downslope wetlands.

	- Additional monitoring is required as per the monitoring requirements (Section 12) below.

12. MONITORING REQUIREMENTS

The monitoring of the proposed development is essential to maintain and/or improve the PES of the surrounding wetlands. The mitigative recommendations stated above must be incorporated into the project-specific EMPr and compliance with the requirements/recommendations must be audited by a suitability qualified independent ECO. The key to a successful EMPr is appropriate monitoring and review to ensure effective functioning of the EMPr and to identify and implement corrective measures in a timely manner. Monitoring for non-compliance must be undertaken on a daily basis during the construction phase by the contractors under the guidance of the Project Manager / ECO / Engineer. An appropriately timed audit report should be compiled by the independent ECO. Paramount to the reporting of non-conformance and incidents is that appropriate corrective and preventative action plans are developed and adhered to. Photographic records of all incidents and non-conformances must be retained. This is to ensure that the key impacts on the wetlands are adequately managed and mitigated against and that the rehabilitation of any disturbed areas within any system is successful.

- A monitoring programme must be in place not only to ensure compliance with the EMPr throughout the construction phase, but also to monitor any post-construction environmental issues and impacts during the vegetation establishment phase. Compliance against the EMPr must be monitored during the construction phase monthly by an independent ECO. The period and frequency of monitoring required post-construction must be determined by the competent authorities and implemented by the ECO. Once the initial transplants / plugs are planted, the landscaper must conduct weekly site visits to remove AIPs (in accordance with the latest revised NEM:BA requirements) and address any re-vegetation concerns until re-vegetation is considered successful (i.e. >80% indigenous cover). An accepted monitoring period of re-vegetated areas after this initial period is monitoring every 3 months for the first 12 months and every 6 months thereafter until the vegetation has successfully been established. If the re-vegetated areas have inadequate surface coverage (less than 30% within 9 months after re-vegetation) the area should be prepared and re-vegetated again.
- The cost-effective qualitative monitoring of the rehabilitation area may be time based through the use of periodic photographs taken from permanent photo points. These points are required to be established during site inception. The timeline created between the pre- and post-rehabilitation photos will provide an invaluable visual representation of the progress that is conveyed in a straightforward manner. The photographer should be an environmental scientist therefore allowing an expert assessment of the site adding to the qualitative information gathered from the photographs.
- The below mentioned criteria must be adhered to, ensuring the quality of the information collected:
    - Establishment of the photo points must be completed during site inception/establishment. This will allow for pre-rehabilitation imagery spanning more than a once off photograph.
    - These points should be permanently marked and assigned a unique identify number to ensure continual relocation and accuracy of the photographs. GPS co-ordinates should be recorded of each site. This is to ensure if any markers are removed or vandalised then they can be replaced.
    - Photo point locations should be easily relocated and accessible and must not be obscured by future vegetation growth.
    - The level of detail captured must be appropriate to the area that has undergone rehabilitation.
    - Photo record forms must be development and utilised for every photo taken. The information required will be project name, location, unique identity number, directional point (e.g. North, South), date, time, photographers name and additional comments.
    - Qualitative ecological information that must be visually interpreted and recorded at the same time as taking the photograph include:
        - Evidence of any channelling.
        - Extent of the site vegetation ground cover.
        - General level of plant growth, substrate levels, and water levels.
        - General observations of water quality such as clarity and presence of litter.

- Evidence of anthropogenic presence and bird species.
- Vegetation condition, extent of AIPs; and
- Evidence of erosion and close monitoring of the post-construction erosion-control measures which must be implemented.

This is to ensure that the key impacts on the wetlands are adequately managed and mitigated against and that rehabilitation of any disturbed areas within the system is successful.

13. CONCLUSION

After the application of the initial risk screening assessment, it was determined that the proposed development consist of a total of three (3) wetlands, in which the classification of these wetlands are one (1) channelled valley bottom wetland (CVB01) and two (2) unchannelled valley bottom wetlands. The aforementioned wetlands will be indirectly impacted upon by the proposed development, thus determined to be **of a moderate risk** as a result of their position in the landscape in relation to the proposed development. It must be noted that the risk rating was provided on the basis that the proposed development will occur out of the wetland extent and associated buffer.

The overall PES scores for CVB01 and UVB02 was C (moderately modified), whereas UVB01 was determined to be D (largely modified). The aforementioned scores for the at risk wetlands were primarily as a result of anthropogenic pressures in the catchment and wetland extent namely; construction of linear infrastructure (dirt and tar roads, overhead powerlines) within the catchment, increase in hardened surfaces in the catchment predominantly by informal development, ad hoc dumping, construction of WWTWs through wetland and proliferation of AIPs due to the aforementioned changes. This indicated that modifications have moderately and largely impacted the wetlands within the study area which has subsequently impacted on the habitat quality, diversity, and size.

Although, the at risk wetlands within the study area have undergone anthropogenic alterations as a result of the broader catchment activities, the at risk wetlands within the study were recorded to have maintained an ecosystem structure and function to have the ability to supply valuable ESS to the surrounding environment. The at risk wetland systems calculated to have the potential to supply the following ESS at a moderate level; nitrate and toxicant removal, sediment and phosphate trapping; and flood attenuation, streamflow regulation, erosion control and carbon storage at a moderate level. Furthermore, socio-cultural ESS were calculated to be supplied at a moderately low to low level as these wetlands were predominantly not utilised by the surrounding community.

CVB01 and UVB01 were determined at a desktop level to have a FEPA River run through it as per the NFEPA data (Nel *et al*., 2011), whereas CVB01, UVB01 and UVB02 were determined at a desktop level to be within a CBA1 (Desmet and Schaller, 2015). Thus, conservation and maintenance of these wetlands are imperative to achieve biodiversity goals for conservation and protection of these unique environments.

It was identified utilising the RAM (DWS, 2016) in Section 10.2 of this report that an aspects of the construction activities associated with the proposed development scored a moderate risk rating, however this aspects did not have the potential to be mitigated from a moderate to low risk rating. Thus, it is the specialist's opinion, in line with GN 509 (DWS, 2016), **that the proposed development be subject to undergo a full WULA process**.

Lastly, as the proposed development falls within CBA1, the applicability and triggers of listed activities in term of the 2014 EIA Regulations (as amended) must also be investigated, to determine if an Environmental Authorisation is required.

Upon the site visit and conducting the assessments, the specialist is in support of the proposed development as long as no development occurs within the wetland and associated buffers. Furthermore, the mitigation measures outlined in this report are to be included in the EMPr, and must be followed.

14. REFERENCES

BROMILOW, C. 2001. Problem Plants of South Africa: A Guide to the Identification and Control of more than 300 invasive plants and other weeds. Briza Publications, Pretoria.

CSIR (Council for Scientific and Industrial Research). 2010. National Freshwater Ecosystem Priority Areas (NFEPA). Council for Scientific and Industrial Research, Pretoria, South Africa.

DEAT (2006) Risk Management, Integrated Environmental Management Information Series 23, Department of Environmental Affairs and Tourism (DEAT), Pretoria

DEPARTMENT OF ENVIRONMENTAL AFFAIRS, DEPARTMENT OF MINERAL RESOURCES, CHAMBER OF MINES, SOUTH AFRICAN MINING AND BIODIVERSITY FORUM, AND SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE. 2013. Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria. 100 pages.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 1999a. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2005. A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2007. Internal Guideline: Generic Water Use Authorisation Application Process.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 2009. DWAF Training Manual: National Water Act Section 21I and (i) Water Uses. Version: November 2009.

DESMET AND SCHALLER. 2015. North West Terrestrial CBA Map categories (2015). Lyr, Department of Rural, Environment and Agricultural Development (READ).

DOMENIC, P.A. and SCHWARTZ, F.W. 1990. Physical and chemical Hydrogeology, John Wiley & Sons: pg. 824. New York.

DRIVER, A., NEL, J.L., SNADDON, K., MURRAY, K., ROUX, D.J., HILL, L., SWARTZ, E.R., MANUEL, J. AND FUNKE, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Report to the Water Research Commission. WRC Report No. XXXX. June 2011

DWAF. 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. 02. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa

ESCOTT, B, LIVINGSTONE, TC, NXELE, B, HARRIS, J, & JEWITT, D. 2012. Draft Document describing the Conservation Planning Terms for the EKZNW Spatial Planning Products for Ezemvelo KZN Wildlife

KELYNHANS, C. J., and LOUW, M. D. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No.TT 329/08.
KLEYNHANS, C. J. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa). Journal of Aquatic Ecosystem Health 5: 41-54.

KLEYNHANS, C. J. 1999b. Appendix R7: Assessment of Ecological Importance and Sensitivity. From DWAF (Department of Water Affairs and Forestry). 1999. Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0. Pretoria

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. and COLLINS, N.B. 2007. WET-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/09, Water Research Commission, Pretoria.

LOW, A. B., & REBELO, A. G. 1996. Vegetation of South Africa, Lesotho and Swaziland. Pretoria: DEAT.

MACFARLANE, D.M., KOTZE, D.C., ELLERY, W.N., WALTERS, D., KOOPMAN, V., GOODMAN, P. & GOGE, C. 2007. WET-Health: A technique for rapidly assessing wetland health, Version 2. WRC Report No TT 340/09, Water Research Commission, Pretoria.

MACFARLANE, D., HOLNESS, S.D., VON HASE, A., BROWNLIE, S. & DINI, J., 2014. *Wetland offsets: a best-practice guideline for South Africa.* South African National Biodiversity Institute and the Department of Water Affairs. Pretoria. 69 pages.
MUCINA, L. AND RUTHERFORD, M. C. (EDS). 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

NAIMAN, R.J., AND H. DECAMPS. 1997. The ecology of interfaces – riparian zones. Annual Review of Ecology and Systematics 28:621-658

NEL, J.L., MURRAY, K.M., MAHERRY, A.M., PETERSEN, C.P., ROUX, D.J., DRIVER, A., HILL, L., VAN DEVENTER, H., FUNKE, N., SWARTZ, E.R., SMITH-ADAO, L.B., MBONA, N., DOWNSBOROUGH, L. AND NIENABER, S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

ROGERS, KH. 1995. Riparian Wetlands. In: Wetlands of South Africa, Cowan GI (ed). Department of Environmental Affairs and Tourism: Pretoria.

ROUNTREE, M. W., MALAN, H. L., WESTON, B. C., (EDS). 2013, Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0). Report to Report to the Water Research Commission and Department of Water Affairs: Chief Directorate: Resource Directed Measures. WRC Report No. 1788/1/12

SANBI, 2011. National Biodiversity Assessment. An Assessment of South Africa's biodiversity and ecosystems.

SCHOEMAN, J.L. and VAN DER WALT, M. 2004. In Overview of the Status of the Agricultural Natural Resources of South Africa. ARC-ISCW Report number GW/A/2004/38. Jointly published by Department of Agriculture and Agricultural Research Council. Pretoria.

SCHULTZE, R.E. 2010. Mapping hydrological soil groups over South Africa for use with the SCS-SA design hydrograph technique: methodology and results. School of Agriculture, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg.

SCHULTZE, R.E., SCHMIDT, E.J. and SMITHERS, J.C., 1992. PC-based SCS flood estimates for small catchments in Southern Africa. Department of Agriculture Engineering, University of Natal, Pietermaritzburg.

VAN GINKEL, C.E., GLEN, R.P., GORDAN-GRAY, K.D., CILLIERS, C.J., MUASYA AND VAN DEVENTER, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.
VON GRUENWALDT, G. 1989.'Gabbro and norite '. Encyclopaedia of Earth Science: Petrology pp 175.