Mulilo Newcastle Wind Power 2 (Pty) Ltd Newcastle Wind Energy Facility in the Newcastle Local Municipality, KwaZulu-Natal

AQUATIC & WETLAND ECOSYSTEM IMPACT ASSESSMENT REPORT

31 January 2023

VERDANT ENVIRONMENTAL (PTY) LTD | Reg. No.: 2020/047106/07

A: 12 Umkuhla Lane, Glen Anil, 4051, KwaZulu-Natal, South Africa

T: +27 73 121 3392 | **E**: ryan@verdantenv.co.za | **W**: www.verdantenv.co.za

Project Details

Project Name	Mulilo Newcastle Wind Power 2 (Pty) Ltd Newcastle Wind Energy Facility in the Newcastle Local Municipality, KwaZulu-Natal
Client Name	CES – Environmental and Social Advisory Services
Client Contact Person	Alan Carter
Client Email	a.carter@cesnet.co.za
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Authors	Ryan Edwards and Russell Tate

Expertise of Specialists

Ecologist	Ryan Edwards
Highest Qualification	Master of Science in Environmental Science
SACNASP Registration Number	400089/13
SACNASP Field of Practice	Environmental Science
Experience (no. of years)	14
Ecologist	**Russell Tate**
Highest Qualification	Master of Science in Aquatic Ecotoxicology
SACNASP Registration Number	400089/15
SACNASP Field of Practice	Aquatic Science
Experience (no. of years)	10

Declaration of Independence

This is to certify that the following report has been prepared as per the requirements of:

- Section 32 (3) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2017 as per Government Notice No. 40772 Government Gazette, 4 December 2014 (as amended); and
- The Department of Human Settlements, Water & Sanitation for Water Use Licensing and wetland assessment, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017.

I, **Ryan Edwards**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Water and Sanitation (DWS), Department of Forestry, Fisheries and the Environment (DFFE) and/or the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA).

Signed:	**Date:**
	31 January 2023

I, **Russell Tate**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Water and Sanitation (DWS), Department of Forestry, Fisheries and the Environment (DFFE) and/or the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA).

Signed:	**Date:**
	31 January 2023

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1. Introduction & Background

1.1. Location and Description of the Proposed Development Activities

Mulilo Renewable Project Developments (Pty) Ltd (Mulilo) is developing the Newcastle Wind Energy Facility (WEF) Complex near Newcastle in the Newcastle Local Municipality, in KwaZulu-Natal Province, comprising:

- Mulilo Newcastle Wind Power WEF (up to 200 MW and up to 45 turbines) (Scoping and Environmental Impact Assessment process);
- Mulilo Newcastle Wind Power 2 WEF (up to 200 MW and up to 35 turbines) (Scoping and Environmental Impact Assessment process);
- Mulilo Newcastle Wind Power grid connection infrastructure and associated powerlines (Basic Assessment process); and
- Mulilo Newcastle Wind Power 2 grid connection infrastructure and associated powerlines (Basic Assessment process).

A total of four (4) applications will be submitted to the Department of Forestry, Fisheries and the Environment (DFFE) for Environmental Authorization (EA) for the Mulilo Newcastle WEF Complex.

This specialist report will inform the draft Environmental Impact Assessment report for the Mulilo Newcastle Wind Power 2 (Pty) Ltd (up to 200 MW and up to 35 turbines WEF) (hereafter referred to as MNWP 2).

The MNWP 2 WEF will be located near Newcastle, KwaZulu-Natal. The applicant, Mulilo Newcastle Wind Power 2 (Pty) Ltd, intends to develop, construct and operate an up to 200 MW WEF, approximately 15 kilometres northwest of the town of Newcastle in the Kwazulu-Natal Province. The study area is situated in the Newcastle Local Municipality, which forms part of the Amajuba District Municipality (ADM) and will have an anticipated lifespan of 20 – 25 years.

The MNWP2 WEF will consist of up to thirty-five (35) wind turbine generators, with a maximum generating output of up to two hundred (200) megawatts (MW). The proposed turbine footprints and associated facility infrastructure will cover an area of up to 87 ha after rehabilitation, depending on final layout design.

The MNWP 2 WEF infrastructure will be located on up to ten (10) land parcels with a total extent of 3530 ha (Figure 2). Wind turbines are planned to be placed on five (5) of these land parcels, while infrastructure as well as the site access road may traverse up to an additional 5 properties. Therefore, a total of ten (10) properties are listed in the EA application for approval.

Table 1. Specific Information Requirements from the Competent Authority (DFFE).

DESCRIPTION OF REQUIRED INFORMATION	DESCRIPTION OR RELEVANT SECTION IN THE REPORT			
General site information				
Description of all affected farm portions	**Farm ID**	**Farm Name**	**Farm Number**	**Area (ha)**
21-digit Surveyor General codes of all affected farm portions	N0HS00000001742100000	Embosweni	17421	156
	N0HS00000000883100000	Paardeplaat A Dene Heights	8831	232
	N0HS00000000938900000	Paardeplaat A	9389	270
	N0HS00000000880000000	Franzhoek	8800	208
	N0HS00000000939000000	Paardeplaat B	9390	244
	N0HS00000000290100000	Glendower	0/2901	223
	N0HS00000000943900000	Cliffdale	9439	587
	N0HS00000000944800000	Byron	9448	392
	N0HS00000000335000002	Geelhoudtboom	1/3350	647
	N0HS00000000335000000	Geelhoudtboom	RE/3350	567
Copies of deeds of all affected farm portions	Note that property title deeds are no longer available on Windeed.			
Photos of areas that give a visual perspective of all parts of the site	Photographs have been attached as Appendix E.			
Photographs from sensitive visual receptors (tourism routes, tourism facilities, etc.)	Photographs have been attached as Appendix E.			

The following Tables 2 to 4 summarise the key technical details for the Mulilo Newcastle Wind Power WEF project:

Table 2. Turbine specifications.

Component	Specification
WEF Capacity	Up to 200 MW
Number of Turbines	Up to 35
Hub Height	Up to 140 m
Rotor Diameter	Up to 200 m
Blade length	Up to 100 m

Table 3. Facility component descriptions.

Facility Component	Description
Crane platform and hardstand area	Crane platform and hardstand laydown for each turbine position.
Turbine Foundations	Reinforced Concrete Foundation. Depth: up to 3.5 m Diameter: up to 25 m per turbine Volume of concrete: up to 800 m³ per turbine.
IPP Substation	33 kV to 132 kV collector substation to receive, convert and step-up electricity from the WEF to the 132 kV grid suitable supply. The substations maximum height will be Lightning Mast up to 25 m high. The facility will house control rooms and grid control yards for both Eskom and the IPP. Additional infrastructure includes parking, up to 2.8 m high fencing, storm water channels and culverts, ablutions, water storage tanks, septic tank, and borehole.
Construction/office yard	This includes bunded fuel areas, oil storage areas, general stores (containers) and skips.
WTG component laydown area	Temporary laydown area.
On-site concrete batching plant	Temporary on-site concrete batching plant.
Primary Site Access Roads	Site access will, where possible, make use of existing farm roads that will be upgraded and maintained for the life of the WEF. The existing roads to be upgraded will be expanded to a width of up to 9 m. New roads will be constructed (in areas where there are no existing roads) with a width of up to 9 m to the IPP substation and laydown areas. V-drains will run on both sides of the road.

Facility Component	Description
Internal roads	Roads connecting the turbine positions will where possible make use of existing farm roads that will be upgraded and maintained for the life of the plant. The existing roads to be upgraded will be expanded to a width of up to 6 m. New roads will be constructed (in areas where there are no existing roads) with a width of up to 6 m and will connect all turbines. V-drains will run on both sides of the road.
33 kV reticulation	A combination of 33 kV overhead lines and 33 kV underground cable (where technically feasible) will be used, aligned along the road network as far as possible, connecting each WTG position to the IPP substation.
Operations and maintenance (O&M) buildings	Includes other infrastructure such as parking, up to 2.8 m high fencing, storm water channels and culverts, ablutions, water storage tanks, septic tank and borehole.
Met masts	Two met masts (Up to 140 m height).

Table 4. Facility component footprints.

Facility Component	Construction footprint	Final footprint after rehabilitation
Crane platform and hardstand area	Up to 0.8 ha per turbine which equates to 28 ha.	Up to 0.8 ha per turbine which equates to 28 ha.
Turbine foundations	Up to 0.06 ha per turbine which equates to 2.1 ha (included in hardstand area).	Up to 0.06 ha per turbine which equates to 2.1 ha (Included in hardstand area).
IPP substation	Up to 1 ha	Up to 1 ha
Construction/office yard	Up to 2 ha	0 ha
WTG component laydown area	Up to 4 ha	0 ha
On-site concrete batching plant	Up to 1 ha	0 ha
Temporary stockpiles	Up to 2 ha	0 ha

Facility Component	Construction footprint	Final footprint after rehabilitation
Primary site access road and reticulation	Total width of up to 15 m consisting of: • Up to 12 m wide area prepared for road and v-drain. • Up to 3 m width for underground 33 kV reticulation. Overhead lines to be used where underground cables are not technically feasible. Total length up to 10 km which equates to 15 ha.	Total width of up to 12 m consisting of: • Up to 9 m wide road. • Up to 1.5 m wide v-drain on either side of road. Total length up to 10 km, which equates to 12 ha. 33 kV underground / overhead line reticulation and stockpile areas to be rehabilitated. Final footprint up to 0.25 ha to account for cable markers and/or overhead line foundations and stays along primary site access roads.
Internal roads and reticulation	Total width of up to 12 m consisting of: • Up to 9 m wide area prepared for road and v-drain. • Up to 3 m wide area for underground 33 kV reticulation. Overhead lines to be used where underground cables are not technically feasible. Total length up to 25 km which equates to 30 ha.	Total width of up to 9 m consisting of: • Up to 6 m wide road. • Up to 1.5 m wide v-drain on either side of road. Total length up to 28 km, which equates to 25.2 ha. 33 kV underground / overhead line reticulation and stockpile areas to be rehabilitated. Final footprint up to 1 ha to account for cable markers and/or overhead line foundations and stays along internal roads.
Operations and maintenance (O&M) buildings	Up to 0.5 ha	Up to 0.5 ha
Met masts	Up to 0.002 ha per met mast which equates to 0.004 ha.	Up to 0.002 ha per met mast which equates to 0.004 ha.
Total	**Up to approximately 104 ha**	**Up to approximately 87 ha**

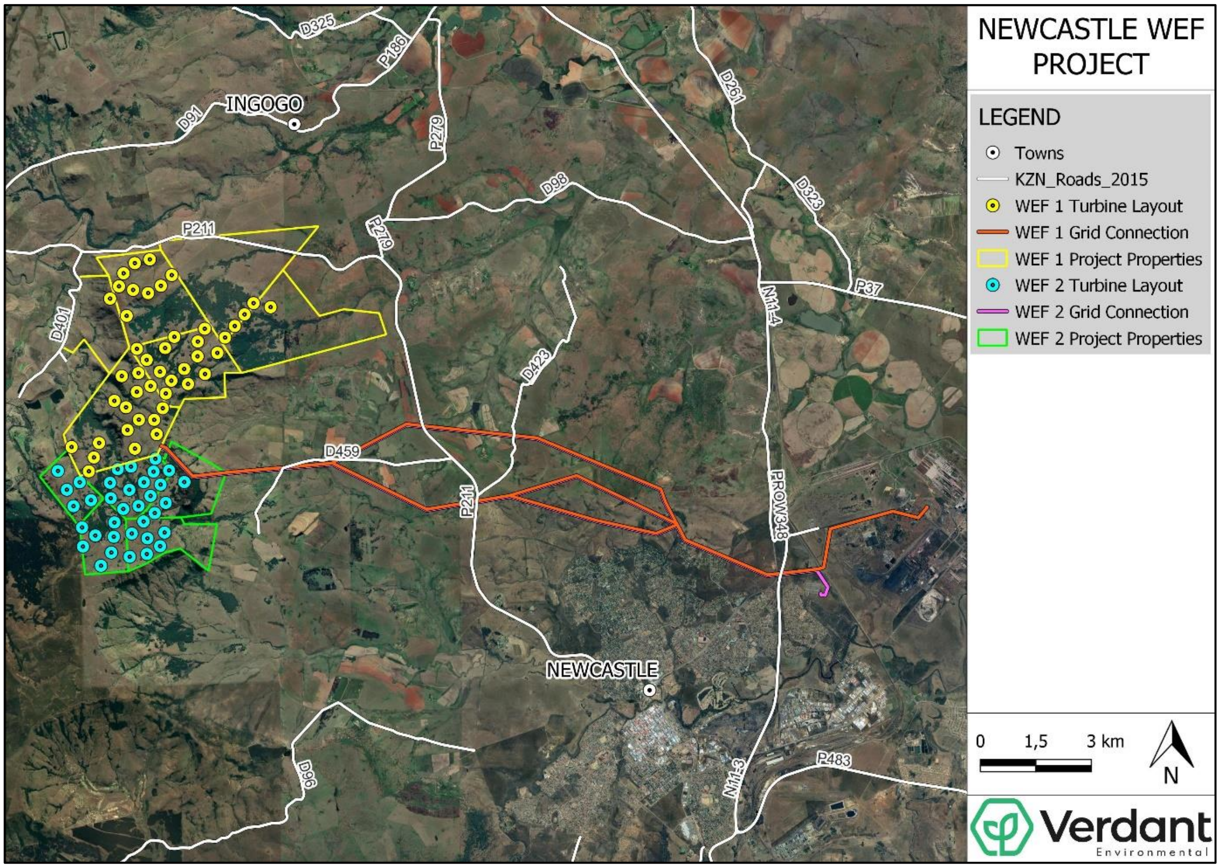

Figure 1. Locality of MNWP 1 and MNWP 2 project areas in relation to towns and roads.

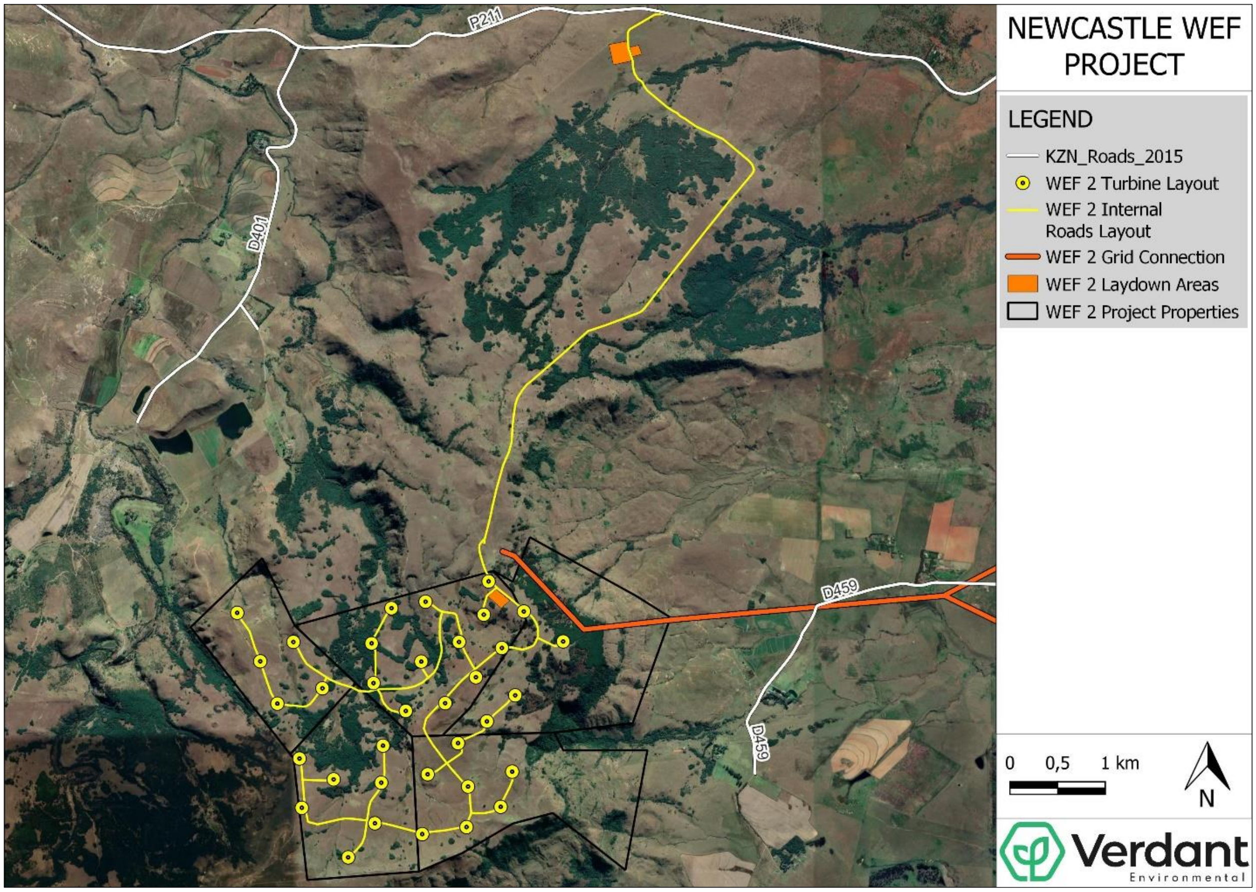

Figure 2. Development plan for turbines, internal roads and laydown areas.

1.2. Purpose of the Assessment

The proposed development activities require a Water Use Licence (WUL) in terms of the National Water Act (Act 36 of 1998) (NWA) and Environmental Authorisation (EA) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA). In this regard, Verdant Environmental were appointed by the Environmental Assessment Practitioner, CES – Environmental and Social Advisory Services (CES), to undertake a combined aquatic and wetland impact assessment to inform the WUL and EA applications.

1.3. Scope of Work

The scope of work completed as part of this assessment was as follows:

- Undertake a desktop review of the biophysical setting and freshwater ecosystem conservation planning context of the project site.
- Undertake the desktop mapping of all watercourses (i.e. stream / river channels, riparian areas, wetlands, dams etc.) within a 500m radius of the project activities.
- Undertake a watercourse 'likelihood of impact' assessment to identify the wetlands to be measurably negatively affected by the proposed project activities.
- Infield delineation of all wetlands that stand to be measurably negatively affected by the proposed project activities occurring within 500m of the development activities.
- Subdivision of the desktop and infield delineated wetlands into definable resource / hydrogeomorphic (HGM) units and the classification of these units according to the national wetland ecosystem classification system (Ollis *et al*., 2013).
- Provision of a description of the key biophysical characteristics of the infield delineated wetlands (i.e. soils, vegetation and hydrology) based on the infield sampling and data collection.
- Assessment of the Present Ecological State (PES) of the infield delineated rivers, streams and wetlands.
- SASS5 macroinvertebrate assessment of perennial rivers only.
- Water chemistry sampling and analysis of perennial rivers only.
- Assessment of the supply, demand and importance of the direct and indirect ecosystem services provided by the infield delineated wetlands.
- Assessment of the Ecological Importance and Sensitivity (EIS) of the infield delineated rivers and wetlands.
- Determination of the recommended ecological category (REC) recommended management objectives for each of the river and wetland units assessed.
- Identification, description and assessment of the direct and indirect impacts of the proposed project on local rivers and wetlands.
- Assessment of the risk of potential impact to freshwater ecosystems (rivers, wetlands).
- Provision of project design, construction phase and operational phase mitigation measures to avoid, minimize and/or rehabilitate the potential impacts.

1.4. Key definitions and concepts

An ecosystem is a group of plants, animals and other organisms interacting with each other and with non-living (abiotic) components of their environment. Ecosystems can be classified broadly into terrestrial and aquatic ecosystems. Terrestrial ecosystems occur on land where water is a limiting factor, whereas aquatic ecosystems occur within landforms that are permanently or periodically inundated with flowing or standing water (Ollis *et al*., 2013). Freshwater ecosystems are a subset of the Earth's aquatic ecosystems and include all inland freshwater rivers, streams, wetlands, lakes, ponds and springs. This broad range of freshwater ecosystem types contains a multitude of habitats of varying ecological complexity and diversity (Wrona *et al*., 2016). Wetlands, streams and rivers fall under the umbrella term of "freshwater ecosystems".

Wetlands, streams and rivers fall under the umbrella term of 'watercourse' in the National Water Act (Act No. 36 of 1998) (NWA) of South Africa. Section 1(1)(xxiv) of the NWA defines a 'watercourse' as:

- a river or spring;
- a natural channel 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, and a reference to a watercourse includes, where relevant, its bed and banks.

This assessment focusses on the assessment of natural watercourses and their associated habitats / ecosystems likely to be measurably affected by the proposed development, focussing specifically on wetlands. For the purposes of this assessment, wetlands, streams and rivers are defined as follows:

- **Wetlands** are areas that have water on the surface or within the root zone for extended periods throughout the year such that anaerobic soil conditions develop which favour the growth and regeneration of hydrophytic vegetation (plants which are adapted to saturated and anaerobic soil conditions). In terms of Section 1 of the NWA, wetlands are legally defined as: (1) "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

- **Rivers and streams** are natural channels that are permanent, seasonal or temporary conduits of freshwater. In terms of ecological habitats, rivers and streams comprise in-stream aquatic habitat and riparian habitat. Generally, riparian zones mark the outer edge of stream and river systems. Streams and rivers are differentiated in terms of channel dimensions and generally fall within the broad category of rivers / riverine ecosystems in this report.
- **Instream habitat** is the aquatic habitat (or alluvial in the case of intermittent / ephemeral watercourses) within the active channel that includes the water column, river bed and the inundated active channel margins, and associated vegetation. In terms of Section 1 of the NWA, instream habitat is legally defined as habitat that includes "…the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse."
- **A riparian zone** is a habitat, comprising bare soil, rock and/or vegetation that is: (i) associated with a watercourse; (ii) commonly characterised by alluvial soils; and (iii) inundated or flooded to an extent and with a frequency sufficient to support vegetation species with a composition and physical structure distinct from those of adjacent land areas (DWAF, 2005). In terms of Section 1 of the NWA, riparian habitat is legally defined as: 'habitat that "…includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."

1.5. Legislative Context Relevant to Freshwater Ecosystems

Rivers and wetlands are not formally protected by law but their alteration is regulated by three different pieces of legislation in South Africa, namely:

- National Water Act (No. 36 of 1998) ('NWA');
- National Environmental Management Act (No. 107 of 1998) ('NEMA'); and
- Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA').

1.5.1. National Water Act (Act No. 36 of 1998) ('NWA')

Section 21 of the National Water Act (No 36 of 1998) lists eleven (11) activities that constitute water uses that require a Water Use License (WUL) prior to the activities commencing, unless the use is excluded. The water uses included in Section 21 are:

a) taking water from a water resource;
b) storing water;
c) impeding or diverting the flow of water in a watercourse;
d) engaging in a stream flow reduction activity contemplated in section 36;
e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g) disposing of waste in a manner which may detrimentally impact on a water resource;
h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
i) altering the bed, banks, course or characteristics of a watercourse;
j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k) using water for recreational purposes.

Typically, development activities that directly and indirectly alter the characteristics of watercourses are considered Section 21(c) and 21(i) water uses and are the most common water uses.

1.5.2. National Environmental Management Act (No. 107 of 1998) ('NEMA')

Listed Activities that may negatively affect watercourses are included in three (3) Listing Notices in the EIA Regulations (2017) published under Section 24(5) and 44 of NEMA. Listed activities require Environmental Authorisation (EA) subject to conducting either a basic assessment or full Environmental Impact Assessment (EIA) prior to the project activities commencing.

1.5.3. Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA')

Regulated activities that may negatively affect watercourses are included in the CARA Regulations as amended (2001) published under Section 29 the CARA. Formal approval / permission from an executive officer is required before such regulated activities can take place.

2. Methods

2.1. Desktop Review of Freshwater Ecosystem Context

Freshwater ecosystems are typically linear features that are connected over regional scales in the landscape and embedded in the terrestrial matrix. Furthermore, freshwater ecosystems are typically located at topographical low points in the landscape, thereby collecting and conveying materials (water and dissolved and particulate matter) from within their entire catchment (UN Environment, 2018). It is thus important to first contextualise the onsite freshwater ecosystems in terms of local and regional setting, and conservation planning. An understanding of the biophysical and conservation context of the site will assist in the assessment of the importance and sensitivity of the onsite freshwater ecosystems, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information listed in Table 5 was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information is provided.

Table 5. Data sources and GIS information consulted to inform the freshwater ecosystem assessment.

Data/Coverage Type		Relevance	Source
Biophysical / Ecological	**Latest Google Earth ™ imagery**	*To supplement available aerial photography where needed and to inform catchment level impacts*	Google Earth™ On-line
	National Rivers (GIS Coverage)	*Highlight potential onsite and local rivers and map local drainage network*	DWS

Data/Coverage Type		Relevance	Source
	South African Quaternary catchments	*Locates the project area within the principal water resource management units in South Africa*	DWS
	South African Quinary catchments	*Locates the project area within the principal water resource management units in South Africa*	DWS
	DWA Eco-regions (GIS Coverage)	*Understand the regional biophysical context in which water resources within the study area occur*	DWA (2005)
	South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference vegetation*	SANBI (2006 - 2018)
	South African Inventory of Inland Aquatic Ecosystems (SAIIAE), 2018 – River Ecosystems	*Shows location of river within the relevant inventories*	Van Deventer *et al.* (2018a)
	South African Inventory of Inland Aquatic Ecosystems (SAIIAE), 2018 – Wetland Ecosystems	*Shows location of wetlands within the relevant inventories*	Van Deventer *et al.* (2018a)
Conservation Context	**The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (2011)** – Wetland FEPAs	*Shows location of national wetland ecosystem conservation priorities*	CSIR (2011)
	The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR, 2011) – River FEPAs	*Shows location of national river ecosystem conservation priorities*	CSIR (2011)
	National Biodiversity Assessment – Terrestrial Realm (GIS Coverage)	*Terrestrial ecosystem / vegetation type threat status*	Skowno et al. (2018)
	National Biodiversity Assessment – Inland Aquatic / Freshwater Realm (GIS Coverage)	*Freshwater ecosystem / vegetation type threat status*	Van Deventer *et al.* (2018b)
	KZN Biodiversity Sector Plan: Critical Biodiversity Areas Irreplaceable (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2016)
	KZN Biodiversity Sector Plan: Critical Biodiversity Areas Optimal (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2016)
	KZN Terrestrial KZN Aquatic Systematic Conservation Plan (GIS Coverage	*Provincial conservation planning importance.*	EKZNW (2011)
	KZN Aquatic Systematic Conservation Plan (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2007)

2.2. Desktop Mapping

All watercourses within 500m of the turbine properties and the two grid connection options were mapped at a desktop level in a GIS. The mapping process involved digitization of the wetland and riparian zone boundaries in QGIS by the eyeballing of 2022 Google Earth imagery in conjunction with the use of 10m contour information of the study area.

2.3. Impact Screening / Likelihood of Impact

For the purposes of this assessment, the study area for infield assessment comprised **all rivers within 100m and wetlands within 500m of the development footprint <u>that stand to be measurably negatively impacted</u>**. The wetlands and rivers likely to be impacted were identified using the 'likelihood of impact' guidelines in Table 6.

Table 6. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
Definite	These resources are likely to require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within the footprint** of the proposed development activity and will be impacted by the project; and/or ➢ resources located **within 15m upstream and/or upslope** of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located **within 15m or downslope** of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located downstream within the following parameters: o **within 15m downstream** of a low-risk development; o **within 50m downstream** of a moderate risk development; and/or o **within 100m downstream** of a high-risk development e.g. mining, large industrial land uses.
Likely / Possible	These resources may require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within 32m but greater than 15m upstream, upslope or downslope** of the proposed development; and/or ➢ resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. This is generally resources located downstream within the following parameters: o **within 32m downstream** of a low-risk development;

Likelihood of Impact Rating	Description of Rating Guidelines
	○ **within 100m downstream** of a moderate risk development; and/or ○ **within 500m downstream** of a high-risk development (note that the extent of the affected area downstream could be greater than 500m for high-risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Unlikely	These resources are unlikely to require impact assessment or Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or ➢ resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: ○ **greater than 32m downstream** of a low-risk development; ○ **greater than 100m downstream** of a moderate risk development; and/or ○ **greater than 500m downstream** of a high-risk development (note that the extent of the affected area downstream could be greater than 500m for high-risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
None	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located within another adjacent sub-catchment, and which will not be impacted by the development in any way, shape or form.

2.4. Infield Data Collection

Two site visits were undertaken to sample the rivers and wetlands within the study area. The first visit was undertaken from the 21st to 25th of February 2022, and the second from the 26th to 27th July 2022. All aquatic sampling was undertaken during the first visit and therefore represented a high-flow survey. The location of the sampling sites is shown in Figures 3 and 4 below.

Data collection involved the following:

- Systematic soil sampling across all valley lines, valley bottom areas, valley heads, hillslopes and depressions using a clay auger to confirm the presence and extent of wetland and alluvial (riparian) soils according to the guideline: '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2005). Soil sample points were recorded onsite using a hand-held GPS. Soil sample points were recorded onsite using a hand-held GPS.

- Instream aquatic sampling of perennial rivers was conducted as per the SASS 5 macroinvertebrate assessment protocol (Dickens & Graham, 2002). The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).
- Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms were made to family level (Dickens and Graham, 2002; Gerber and Gabriel, 2002).
- Fish were captured and identified in field using Skelton (2001) and released at the point of captured. Fish were captured using a SAMUS electrofisher. The data obtained from the survey was utilised to compile a standard qualitative dataset.
- In situ water quality was obtained at each site using a calibrated Extech DO-600 Multimeter. The following constituents included conductivity (mS/m), temperature (°C), pH and dissolved oxygen (mg/l). No water samples will be collected and sent for chemical, biological or toxicant laboratory analysis.
- The recording of the dominant plant species and general composition of the wetland and riparian vegetation in the vicinity of the soil sample points based on visual observations. Observations points were recorded onsite using a hand-held GPS.
- The recording of the landscape / terrain position at each sample point based on visual observations. Observations points were recorded onsite using a hand-held GPS.
- The recording of existing river and wetland impacts (such as extent of existing infilling) using a hand-held GPS.

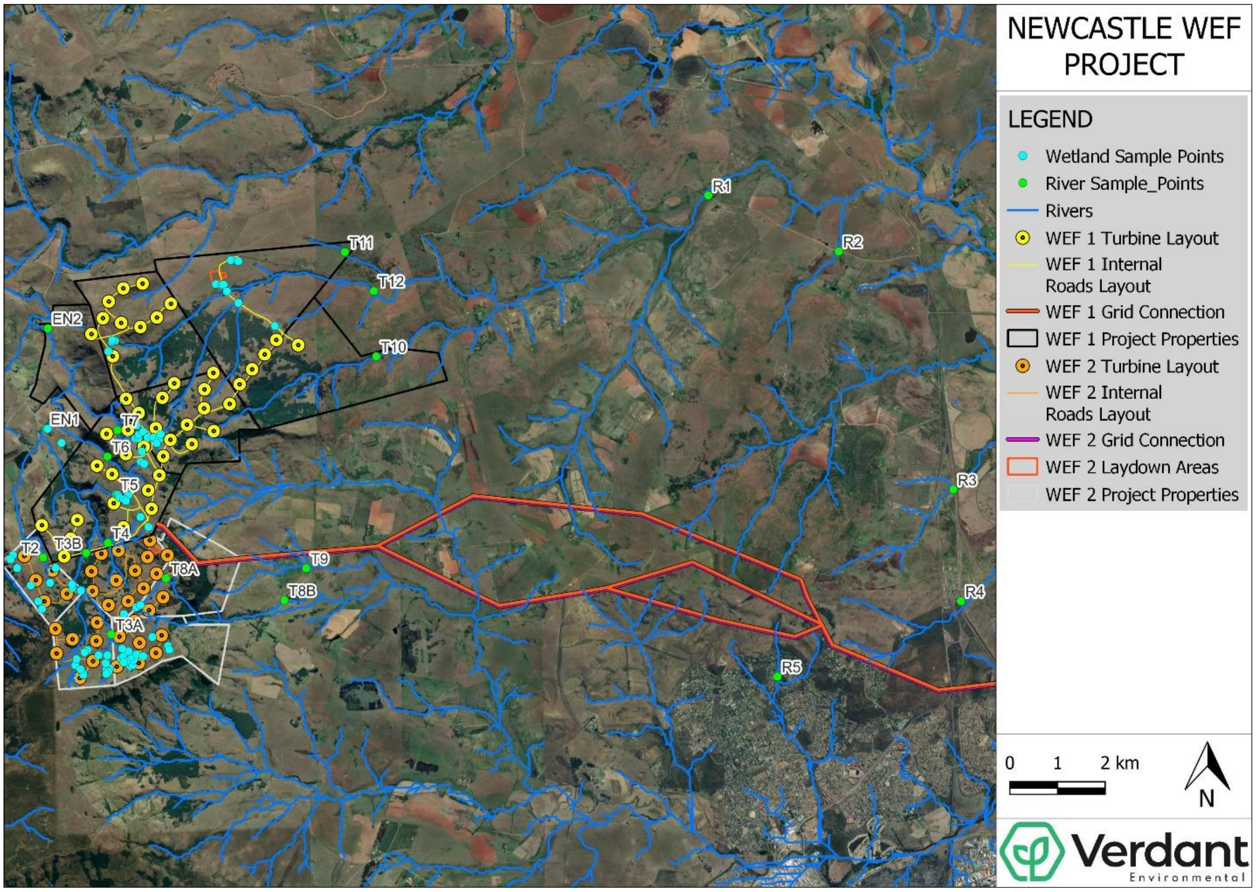

Figure 3. Aquatic, riparian zone and wetland sample sites for all project phases.

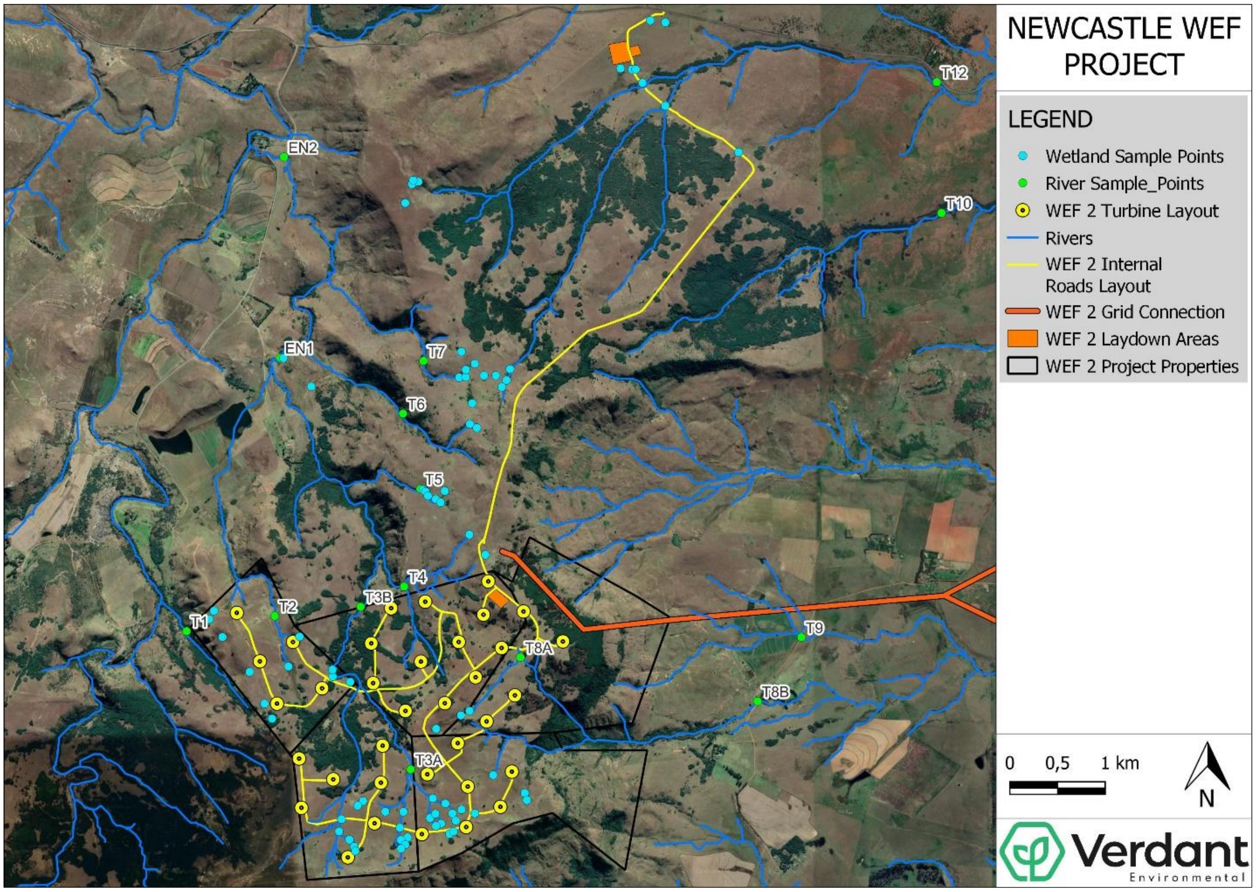

Figure 4. Aquatic, riparian zone and wetland sample sites for MNWP 2.

2.5. Data Analysis

The methods and tools that were used as part of the baseline wetland ecosystem assessment are summarised as follows:

2.5.1. Wetland and Riparian Zone Delineation

Based primarily on the soil wetness indicators, and where relevant the other supplementary indicators (terrain and vegetation), sample points within wetlands were confirmed using DWAF (2005) wetland delineation guideline and the outer boundary of all wetland and riparian areas within the study area was delineated and mapped by importing the sample points into a Geographical Information System (GIS).

2.5.2. Wetland and River Classification

A. Wetland classification

Wetland classification was achieved by observing the topographical and geomorphic setting, and the general hydrology of the wetland units during the site visit. The wetland ecosystems assessed were classified in terms hydro-geomorphic types as per the National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al., 2013). The HGM types considered are defined as follows: (Ollis et al., 2013):

1. **Seep** (S) – A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor. The only exception are valley head seeps. A valley head seep is concave wetland area located within a defined valley head (side slopes and valley bottom) but which is still characterised by the colluvial processes.
2. **Valley bottom wetland** - A mostly flat wetland area located along a valley floor, often connected to an upstream or adjoining river channel. Valley bottom wetlands are either channelled or un-channelled.
    a. **Channelled valley bottom wetland** (CVB) - a valley bottom wetland with a river channel running through it. The valley bottom wetland is divided by and typically elevated above a stream channel, which makes that this wetland generally drains faster than an un-channelled valley bottom wetland. Water inputs to these areas are from adjacent valley side slopes and from the overtopping of the channel during floods.
    b. **Un-channelled valley bottom wetland** (UCVB) - A valley bottom wetland without a river channel running through it. The valley bottom wetland is connected to a drainage network, but without a major channel running through it. It is characterized by the prevalence of diffuse flow, which is at or near the surface especially after rainfall events. Water mainly enters the wetland through an upstream channel, but sometimes also from adjacent slopes.
3. **Floodplain wetland** (F) - A wetland area on the mostly flat or gently-sloping land adjacent to and formed by an alluvial river channel under its present climate and sediment load, which is subject to periodic inundation by overtopping of the channel bank. Floodplain wetlands are characterised by typical floodplain features like levees, oxbow lakes and depressions where fine sediment is deposited.

4. **Flat** (FL) – A level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat. Their main input of water is from rainfall and/or the regional groundwater table as in the case of low lying coastal plain settings.
5. **Depression** (D) - A wetland or aquatic ecosystem with closed (or near-closed) elevation contours (within a closed basin), which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates.

B. River classification

Riverine units were classified locally according to the duration of low flows (Table 7). Regionally, the riverine units were classified according to slope and geomorphic setting (longitudinal zones) (Rowtree & Wadeson, 2000) included in the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al., 2013).

Table 7. Classification of flow type according to flow duration.

Flow Classification	Flow Description (Kleynhans et al., 2008)
Perennial	Flows throughout the year or most of the year (e.g. >95% of the time. The water table is located above the streambed for most of the year.
Seasonal	Flows during certain times of the year (>50% of the time), usually during the wet season.
Ephemeral	Flows only occur during, and for a short duration after precipitation events in a typical year. Stream bed is located above the water table year-round.

The regional river types considered for classification were based on the geomorphological longitudinal river zones for South African rivers (after Rowtree & Wadeson 2000), namely:

- **Source zone** - Low-gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
- **Mountain headwater stream** - A very steep-gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
- **Mountain stream** - Steep-gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, plane bed. Approximate equal distribution of 'vertical' and 'horizontal' flow components.

- **Transitional** - Moderately steep stream dominated by bedrock or boulders. Reach types include plane bed, pool-rapid or pool-riffle. Confined or semi-confined valley floor with limited floodplain development.
- **Upper foothills** - Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/ rapids similar. Narrow floodplain of sand, gravel or cobble often present.
- **Lower foothills** - Lower gradient, mixed-bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock-controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Floodplain often present.
- **Lowland river** - Low-gradient, alluvial sand-bed channel, typically regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increase in silt content in bed or banks.
- **Rejuvenated bedrock fall** - Moderate to steep gradient, often confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
- **Rejuvenated foothills** - Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge; characteristics similar to foothills (gravel/ cobble-bed rivers with pool-riffle/pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro-channel activated only during infrequent flood events. A floodplain may be present between the active and macro-channel.
- **Upland floodplain** - An upland low-gradient channel, often associated with uplifted plateau areas as occur beneath the eastern escarpment.

Classification was achieved by observing the topographical and geomorphic setting, and the general flow conditions during the site visit, human impacts (direct and indirect), as well as the review of relevant literature and desktop information.

2.5.3. Present Ecological State (PES) Assessment

Present Ecological State (PES) is a measure of the deviation of the ecological integrity / health / condition of a definable ecosystem unit from its reference state.

A. Wetland PES

For the purposes of the wetland PES assessment, all the wetland HGM units were grouped into 'process units' based on key selected biophysical characteristics and the intensity of human impacts. The PES of the wetland process units within the study area were assessed using the Level 1B WET-Health assessment (Macfarlane et al., 2020). The Level 1B is a desktop-based assessment with infield verification that involves the following components:

- The assessment of selected wetland attributes that informs the relative weighting of the four wetland health drivers in the calculation of PES (i.e. hydrology, geomorphology, water quality and vegetation);
- The assessment of the extent and nature of wetland and catchment landcover types that informs the magnitude of impacts; and
- The assessment of the extent and nature of point source discharges within the wetland and/or its catchment that informs the magnitude of impacts to the water quality driver.

The impact scores were interpreted using the PES categories and descriptions provided in Table 8 below.

Table 8. WET-Health impact and PES categories and descriptions.

Impact Category	Impact Score	Description
None	0-0.9	No discernible modification or the modification is such that it has no impact on wetland integrity.
Small	1-1.9	Although identifiable, the impact of this modification on wetland integrity is small.
Moderate	2-3.9	The impact of this modification on wetland integrity is clearly identifiable, but limited.
Large	4-5.9	The modification has a clearly detrimental impact on wetland integrity. Approximately 50% of wetland integrity has been lost.
Serious	6-7.9	The modification has a clearly adverse effect on this component of habitat integrity. Well in excess of 50% of the wetland integrity has been lost.
Critical	8-10	The modification is present in such a way that the ecosystem processes of this component of wetland health are totally / almost totally destroyed.

B. River PES

The overall PES of the associated riverine ecosystems was determined using the River Eco-status Monitoring Programme (REMP) Ecological Classification manual (Kleynhans and Louw, 2007). The PES will be calculated based on the results of the various biological indexes, namely:

- SASS 5 macroinvertebrate assessment method (Dickens & Graham, 2002).
- Macroinvertebrate Response Assessment Index (MIRAI) (Thirion, 2007).
- Fish Response Assessment Index (FRAI) (Kleynhans, 2007).
- Intermediate Habitat Assessment Index (IHIA) (Kleynhans, 1996).

SASS 5 macroinvertebrate assessment:

Macroinvertebrate assemblages are indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour et al., 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour et al., 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the “Aquatic Invertebrates of South African Rivers” Illustrations book, by Gerber and Gabriel (2002). Identification of organisms were made to family level (Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores were then compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Uplands and Eastern Escarpment Mountain ecoregions (Figures 5 and 6).

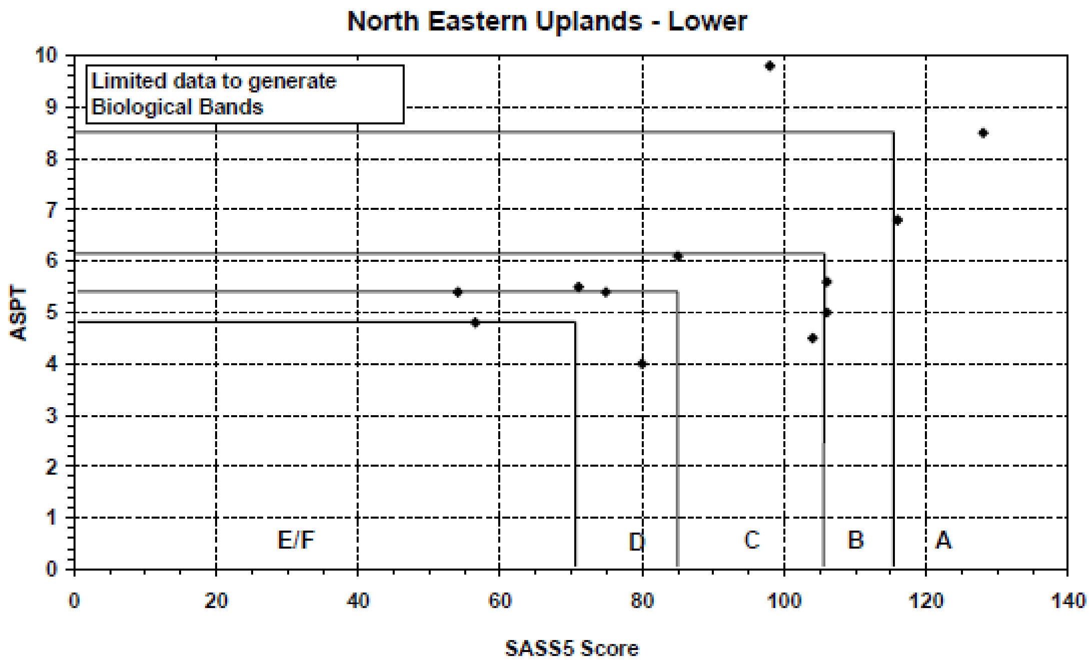

Figure 5. North Eastern Uplands Ecoregion (Dallas, 2007).

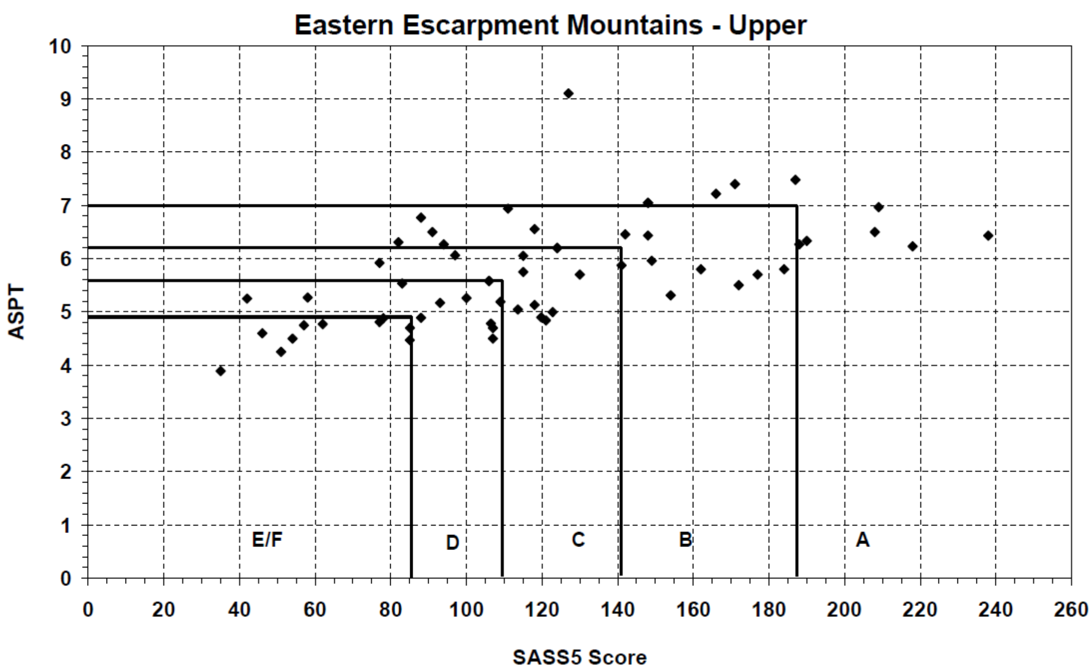

Figure 6. Eastern Escarpment Mountains Ecoregion (Dallas, 2007).

Macroinvertebrate Assessment Index (MIRAI):

To complete the PES assessment, the Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat and water quality-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the relevant ecoregion (Thirion, 2007; Thirion et al., 1995). The four major components of a watercourse that determine productivity for aquatic macroinvertebrates are:

- Flow regime;
- Physical habitat structure;
- Water quality; and
- Energy inputs from the watershed riparian and terrestrial vegetation.

The results of the MIRAI will provide an indication of the current ecological category and therefore are required for the determination of the PES.

Fish Response Assessment Index (FRAI):

The fish and aquatic habitat data and information sampled and recorded during the infield fish sampling will be interpreted and analyzed in terms of the Fish Response Assessment Index (FRAI) tool (Kleynhans, 2007).

Intermediate Habitat Assessment Index (IHIA):

The Intermediate Habitat Assessment Index (IHIA) as described by Kleynhans (1996) was used to define the ecological condition of the riparian habitat of the considered river reach. The IHIA was informed by the results of the land cover assessments and direct observations of changes to the river system. The method relies on the study of reference condition or natural watercourses within a similar setting. The spatial framework for the IHIA included sample points within a river reach from its source to the most downstream.

2.5.4. Ecosystem Services Assessment

Ecosystem services are broadly defined as the benefits people obtain from ecosystems (Kotze et al., 2020). A broader definition is that they are all the aspects of ecosystems utilized (actively or passively) to produce human well-being (Kotze et al., 2020).

For the purposes of the wetland ecosystem services assessment, all the wetland HGM units were grouped into ‘process units’ based on key selected biophysical characteristics and the intensity of human impacts. The supply of ecosystem goods and services of the wetlands within the study area was assessed using the Version 2 of Level 2 WET-EcoServices assessment tool (Kotze et al., 2020). This approach relies on a combination of desktop and on-site indicators to assess the importance of a range of common wetland ecosystem services. A level 2 (detailed) assessment was conducted that assessed a suite of services/benefits by assigning a score to each service based on a rating system that rates a range of pre-defined variables affecting the importance of services provided by the wetland system. The results are captured in tabular form as a list of services/goods with the level of supply and demand rated on a scale of 0 - 4. The ecosystem services scores were interpreted using the categories and descriptions provided in Table 9 below.

Table 9. Ecosystem services importance categories and descriptions.

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

2.5.5. Ecological Importance and Sensitivity (EIS) Assessment

The ecological importance (EI) of a river or wetland is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) (ES) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007).

A. Wetland EIS

For the purposes of the wetland EIS assessment, all the wetland HGM units were grouped into 'process units' based on key selected biophysical characteristics and the intensity of human impacts. Wetland EIS was assessed using a combination of wetland EIS framework included as part of Version 2 of the WET-EcoServices tool (Kotze et al., 2020) and the wetland EIS tool developed by Kotze & Rountree (2013). In the Kotze et al. (2020) framework, EI is assessed as the maximum score of the three main components as assessed in the WET-EcoServices, namely:

- Biodiversity maintenance;
- Regulating services; and
- Provisioning and cultural services.

ES was assessed using the Kotze & Rountree (2013) tool.

The EIS scores were interpreted using the categories and descriptions provided in Table 10 below.

Table 10. Wetland EIS rating categories.

EIS Score	EIS Rating	General Description
0-0.79	Very Low	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers.
0.8 – 1.29	Low	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers.
1.3 – 1.69	Moderately-Low	-
1.7 – 2.29	Moderate	Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers.
2.3 – 2.69	Moderately-High	-
2.7 – 3.19	High	Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers
3.2 - 4.0	Very High	Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers

B. River EIS

River EIS was assessed using the River EIS tool (Kleynhans, 1999). This method evaluates the following ecosystem components:

- Riparian & in-stream biota: referring to the presence and status of biota (including fauna & flora). This includes aspects of species richness/diversity, the presence of rare/endangered species, unique species/endemics, species that are sensitive to changes in flows/water quality.
- Riparian & in-stream habitat: including the diversity of habitat types within the in-stream and riparian zones, the sensitivity of habitats to changes in flow/water quality and the importance of riparian areas as migration routes/ecological corridors as well as the conservation importance of areas.

The EIS scores generated by the tool were interpreted according to Table 11 below.

Table 11. River EIS categories used to inform the assessment (after Kleynhans & Louw, 2007).

EIS Score	EIS Rating	General Description
0-1	Very Low	Features are not ecologically important and sensitive at any scale. The biodiversity of these areas is typically ubiquitous with low sensitivity to anthropogenic disturbances and play an insignificant role in providing ecological services.
1-2	Low	Features regarded as somewhat ecologically important and sensitive at a local scale. The functioning and/or biodiversity features have a low-medium sensitivity to anthropogenic disturbances. They typically play a very small role in providing ecological services at the local scale.
2-3	Medium	Features that are considered to be ecologically important and sensitive at a local scale. The functioning and/or biodiversity of these features is not usually sensitive to anthropogenic disturbances. They typically play a small role in providing ecological services at the local scale.
3-4	High	Features that are considered to be ecologically important and sensitive at a regional scale. The functioning and/or biodiversity of these features are typically moderately sensitive to anthropogenic disturbances. They typically play an important role in providing ecological services at the local scale.
4	Very High	Features that are considered ecologically important and sensitive on a national or even international level. The functioning and/or biodiversity of these features are usually very sensitive to anthropogenic disturbances. This includes areas that play a major role in providing goods and services at a regional level.

2.6. Impact Assessment

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). A significant impact is defined in the NEMA EIA Regulations 2017 as follows:

> "*…an impact that may have a notable effect on one or more aspects of the environment or may result in non-compliance with accepted environmental quality standards, thresholds or targets and is determined through rating the positive and negative effects of an impact on the environment based on criteria such as duration, magnitude, intensity and probability of occurrence*."

Wetland and river ecosystem impacts can be grouped into the following broad impact types:

1. **Direct ecosystem modification or destruction / loss impacts** – This impact refers to the direct physical destruction and/or modification of wetland communities, habitat and associated biota. Such impacts may be attributed to a range of activities including vegetation / habitat clearing (stripping / grubbing), earthworks (i.e. excavation and infilling) and deep flooding by impoundments.
2. **Alteration of hydrological and geomorphological processes** – This impact refers to all the indirect impacts resulting from human activities within the watercourse or catchment that alter hydrological and geomorphological processes i.e. rates of erosion and sedimentation. This includes activities that: (i) modify landcover characteristics that alter the quantity and pattern of catchment runoff and sediment inputs e.g. earthworks, surface hardening, plantations, etc.; (ii) activities that regulate, reduce or increase flows e.g. impoundment / dams, abstraction, return flows and decant flows; and activities that alter wetland flow hydraulics e.g. establishment of drains, flow canalisation, flow constrictions and flow diversions.
3. **Water pollution impacts** – This impact refers to the alteration of the chemical and biological characteristics of soil and water within watercourses and the associated ecological impacts. In the context of this impact assessment, water quality is assessed in relation to changes to its fitness for use (e.g. for domestic, recreational or agricultural purposes) and ability to maintain the health of aquatic ecosystems. This impact includes a full spectrum of activities ranging from direct inputs (e.g. spillages / point source discharges) through to diffuse source inputs from land use activities that affects the

quality of water entering watercourses (e.g. hazardous substances handling, storage & transport; urban stormwater management; irrigation return flows and acid mine drainage).

4. **Ecological connectivity and edge disturbance impacts** – This impact refers to the alteration of local and regional ecological processes resulting from the transformation of land and disturbance within and/or surrounding a watercourse. Key ecological processes of relevance in this regard include ecological connectivity and edge effects that are impacted by habitat fragmentation, patch size reduction, increased alien invasive plant invasion, noise pollution, vibrations, light pollution, and the occurrence of barriers to propagule and animal movement.

The significance of the potential construction and operational impacts was assessed using an impact assessment method developed by Eco-Pulse (2020) included in **Annexure A**. In this method, the significance of the potential wetland ecosystems impacts are interpreted in terms of the degree of change to the following aspects that drive wetland and river importance:

1. Provision of regulating ecosystem services and their contribution to water resource management, disaster risk management, climate resilience / adaptation, human safety and biodiversity / conservation.
2. Biodiversity maintenance and conservation importance (ecosystem, habitat and species conservation).
3. Provision of provisioning and cultural ecosystem services and their contribution to human livelihoods and wellbeing.

The impact assessment was undertaken for the following mitigation scenarios only:

1. **Realistic Poor Mitigation Scenario**: This scenario involves the implementation of the proposed development plan and designs that are currently proposed with the associated implementation of standard construction and operational phase mitigation measures. In terms of implementation success, this scenario assumes a realistic / likely poor implementation scenario based on the author’s experience with such activities.
2. **Realistic Good Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that incorporate all the project planning and design, construction, operational and decommissioning phase mitigation measures recommended by the author. In terms of implementation success, this scenario

assumes a realistic best-case scenario for implementation based on the author's experience with such activities.

2.7. Section 21(c) and 21(i) Water Use Risk Assessment Matrix

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorisation (GA) of Section 21(c) and 21(i) water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does not apply to the following activities:

- Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area' of a watercourse where the Risk Class is Medium or High.
- Where any other water use as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.
- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 c and I water use Risk Assessment Protocol') was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD
whereby:
CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION
and
LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risk stressors associated with each of the four (4) impact groups / types considered were:

1. Direct transformation and modification of habitat – Physical disturbance

2. Indirect impacts resulting from alteration of hydrological and geomorphic processes as a result of activities within and outside of the watercourse – Erosive surface runoff, sediment and increased and/or reduced water inputs
3. Water pollution impacts – Chemical, organic and biological pollutants
4. Ecological process and disturbance impacts – Alien invasive plants, noise pollution, dust pollution

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool.

It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty-five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses was used to inform WUL requirements for the proposed development.

3. Desktop Assessment

3.1. Review of Ecosystem Context and Setting

3.1.1. Climate Setting

The project area was located within the Cwb Köppen-Geiger classification which is a subtropical highland climate. Using data extracted from the WaPOR database (WaPOR, 2022) the precipitation patterns of the study area was investigated between 2009 and 2022. The hydrological regime indicates a unimodal flood pattern, with rainfall peaking in summer months, between November and February where peak rainfall of 128mm is recorded in January (Figure 7). The Mean Annual Precipitation was indicated to range from 475 mm in 2015 to 878 mm in 2010 where a mean value was indicated at 726 mm (WaPOR, 2022).

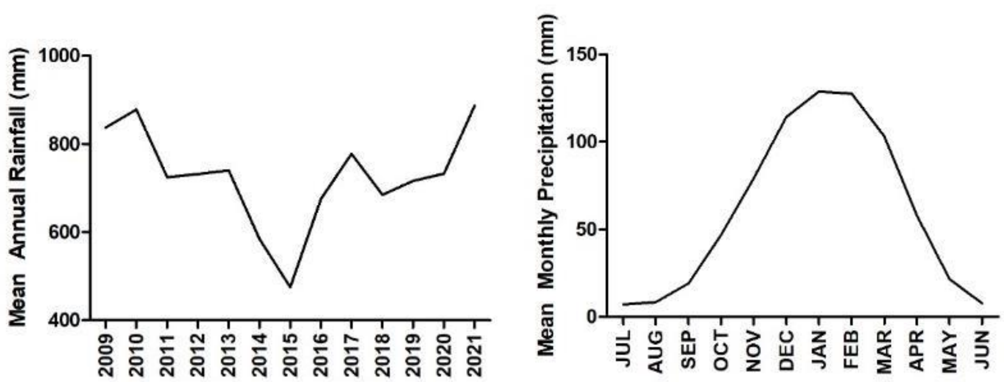

Figure 7. Annual (left) and mean monthly (right) precipitation in the watersheds between 2009 and 2020 (WaPOR, 2022).

3.1.2. Topography and Geology

The turbine sites are located on a gently to moderately undulating plateau of the escarpment west of Newcastle. The grid connection options will traverse steep and highly undulating topography of the escarpment and foothills.

The plateau area within the study area is predominantly underlain by dolerite with the southern areas of the study area underlain by mudstone and sandstone of the Adelaide and Tarkastad Sub-groups of the Beaufort Group. Areas underlain by mudstone include subordinate sandstone.

Both the northern and southern powerline alignments are underlain exclusively by dolerite and sandstone, shale and coal seams of the Vryheid Formation of the Ecca Group.

3.1.3. Freshwater Ecoregion

According to FOEW (2022), the project area is located within the Southern Temperate Highveld Freshwater Ecoregion where the dominant limnological features include wetlands, rivers and pans. The region is characterised by open, undulating, hygrophilous *Cymbopogon-Themeda* grasslands. Frost, fire and grazing maintains the grassland dominance of the terrestrial habitats where trees are predominantly restricted to rivers valleys (FOEW, 2022). In relation to the South African Freshwater Ecoregions the project site was located across two including the North Eastern Uplands and the Eastern Escarpment Mountains.

3.1.4. Drainage and River Setting

The study area extends across two (2) quaternary catchments, namely V31D and V31J as illustrated in Figure 8 below. Most of the study site is drained by a series of non-perennial and perennial drainage lines, streams and rivers that drain in northerly and easterly directions into the Ngogo, Mbizana and Ngudumeni Rivers. The Ngogo and Mbizana rivers are both right-bank tributaries of the Buffers River. The Ngudumeni River is left-bank tributary of the Nguduma River, which in turn is a left-bank tributary of the Ncandu River. The Ncandu River is a left-bank tributary of the Ngagane River, which is a right-bank tributary of the Buffels River. The Buffels River is a left-bank tributary of the Thukela River.

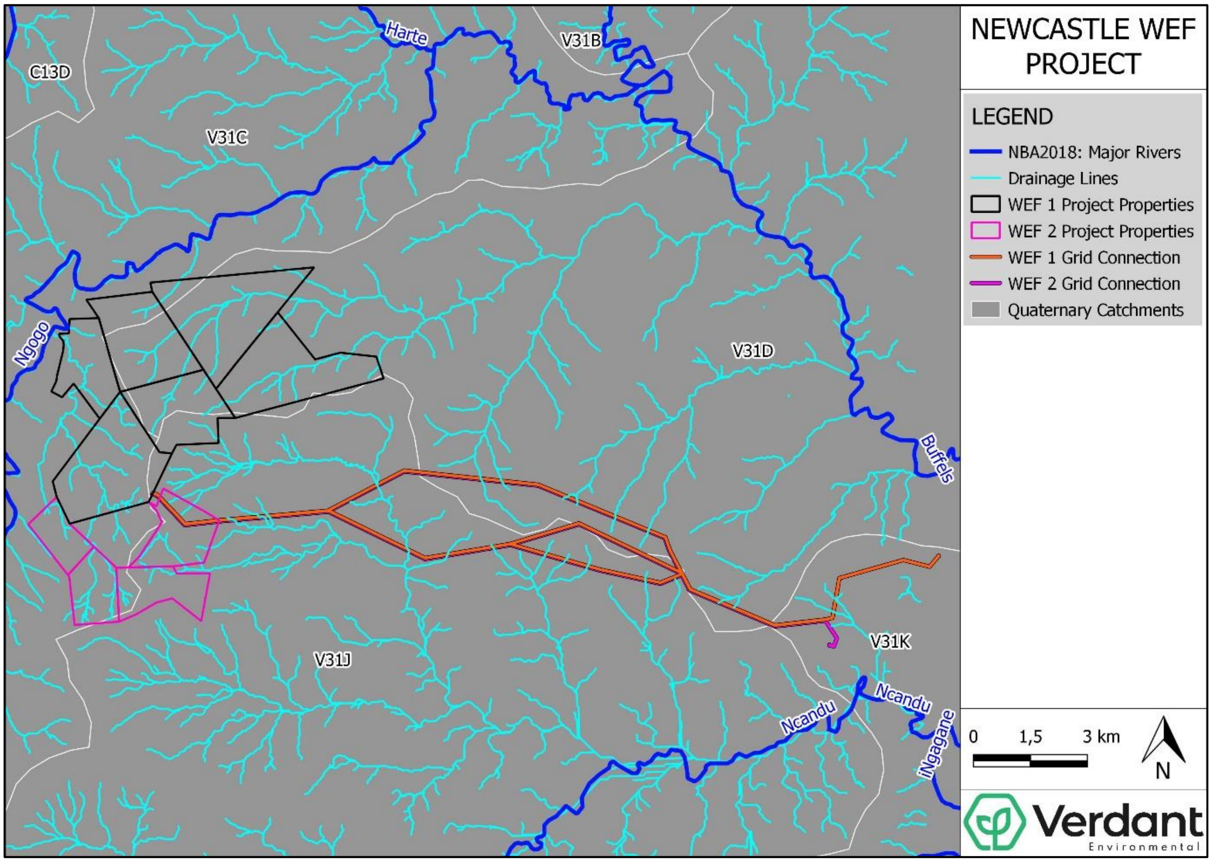

Figure 8. Drainage and river ecosystem setting of the greater study area, within catchment U31C, U31D and U31J.

3.1.5. Terrestrial Vegetation Type

The study area extends across four (4) terrestrial vegetation types as listed and described in Table 12.

Table 12: Description of vegetation types across the study area (Mucina and Rutherford, 2006).

Vegetation Type	Biome	Bioregion	General Description (Mucina and Rutherford, 2006)
KwaZulu-Natal Highland Thornveld	Grassland	Sub-Escarpment Grassland	*'Hilly, undulating landscapes and broad valleys supporting tall tussock grassland usually dominated by Hyparrhenia hirta, with occasional savannoid woodlands with scattered Acacia sieberiana var. woodii and in small pockets also with A. karroo and A. nilotica'.*

Vegetation Type	Biome	Bioregion	General Description (Mucina and Rutherford, 2006)
Low Escarpment Moist Grassland	Grassland	Sub-Escarpment Grassland	*'Supporting tall, closed grassland with Hyparrhenia hirta and Themeda trindra dominant. Protea caffra communities and patches of Leucosidea scrub feature at higher altitudes'.*
Northern Afrotemperate Forest	Forest	Zonal and Intrazonal Forests	*'Low, relatively species-poor forests of Afromontane origin and some of them still showing clear Afromontane character. Canopy dominated usually by Podocarpus latifolius, Olinia emarginata, Halleria lucida, Scolopia mundii and rarely also by Widdringtonia nodiflora, in drier faces also by Pittosporum viridiflorum, Celtis Africana, Mimusops zeyheri, Nuxia congesta and Combretum erythrophyllum'.*
Northern KwaZulu-Natal Moist Grassland	Grassland	Sub-Escarpment Grassland	*'Hilly and rolling landscapes supporting tall tussock grassland usually dominated by Themeda triandra and Hyparrhenia hirta. Open Acacia sieberiana var. woodii savannoid woodlands encroach up the valleys, usually on disturbed (strongly eroded) sites'.*

3.1.6. Wetland Setting

In terms of the National Wetland Map (Van Deventer *et al*., 2018), three (3) wetlands have been modelled to occur on the plateau where the turbines are located (Figure 9). However, field work has confirmed that the study area is wetland rich comprising an extensive network of small and moderately sized wetlands, mostly seep wetlands.

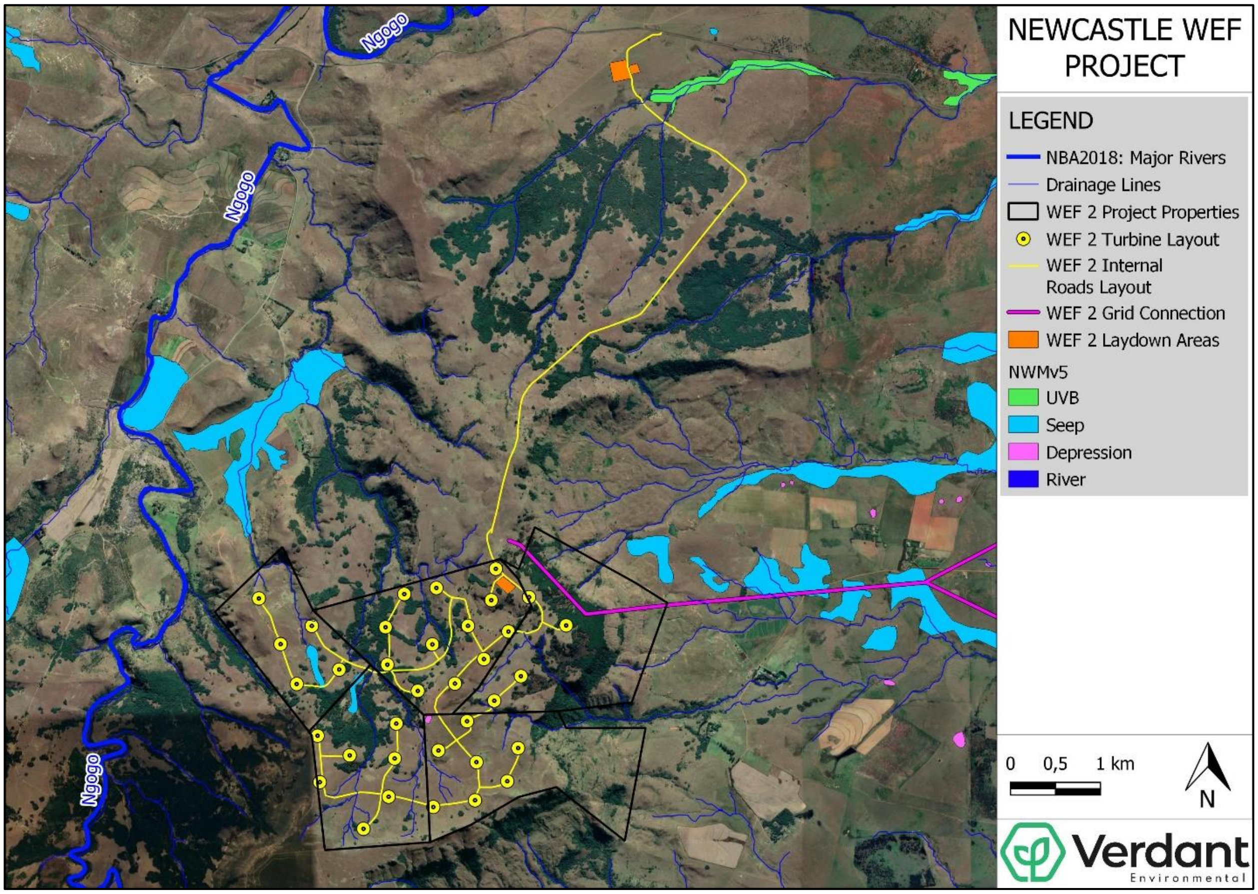

Figure 9. The MNWP 2 study area in relation to the wetland mapping from the National Wetland Map Version 5 (NBA, 2018).

3.1.7. Water Resource Management Context

The majority of the MNWP 2 project area is located within the Northern Drakensberg Strategic Water Source Area (SWSA). This SWSA provides important water resource linkages between Gauteng, KwaZulu-Natal and the Free State. Major rivers within this SWSA are the Senqu, Caledon, Thukela, Orange and Vaal.

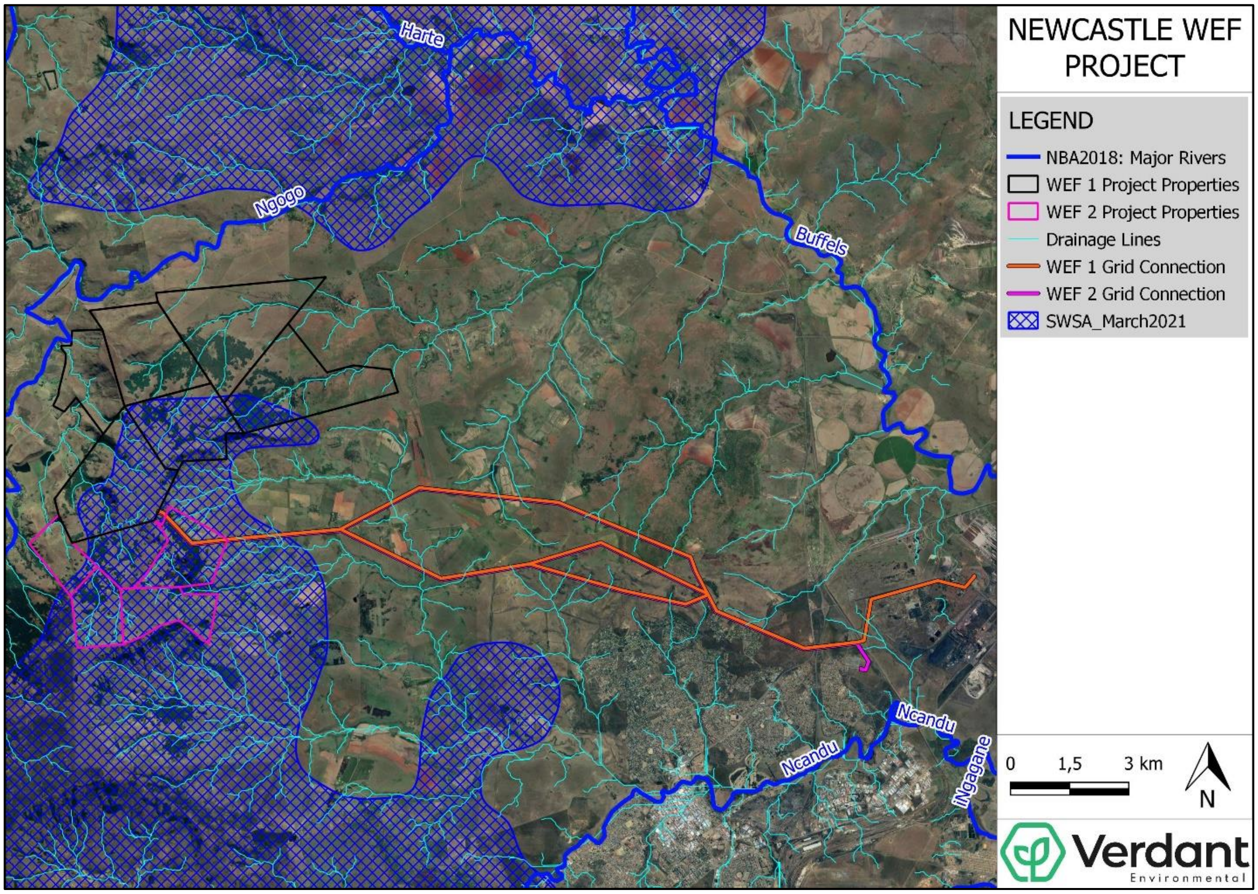

Figure 10. Study area in relation to national Strategic Water Source Areas (SWSAs).

3.1.8. Conservation Context

A summary of the conservation planning and threat status of the ecological features in the study area is provided in Table 13. Noteworthy features include:

- The terrestrial vegetation types of the study area are all listed as **Least Concern (LC)** in the NBA (SANBI, 2018) at the national level. At a provincial level, the Northern KwaZulu-Natal Moist Grassland has been listed as **Vulnerable (VU).**
- The entire MNWP 2 study area falls within the Ngogo sub-quaternary catchment that is listed as 'River FEPA' (Freshwater Ecosystem Priority Areas) in terms of the NFEPA project.
- The three wetlands modelled to occur within the study area are all Wetland FEPAs in terms of the NFEPA project. This is because the entire study area is a River FEPA sub-quaternary catchment.

- The three wetlands modelled to occur within the study area fall within a wetland cluster in terms of the NFEPA project.
- The wetland vegetation group for the study area is the 'Sub-Escarpment Grassland' group, which is regarded as being '**Least Threatened**' in terms of ecosystem threat status and 'well-protected' (CSIR, 2011). Based on the National Wetland Map V5, depression wetlands, seep wetlands and unchanneled valley bottom wetlands of the type identified in the study are considered '**endangered**', '**critically endangered**' and '**critically endangered**', respectively (Van Deventer *et al*¸ 2018).
- The relevant reach of the Ngogo River is currently listed as **'least threatened'** in the NBA (SANBI, 2018).
- The relevant reach of the Ncandu River is currently listed as **'critically endangered'** in the NBA (SANBI, 2018).
- A large proportion of the study area has been categorised as '**CBA: irreplaceable**' in the KZN Terrestrial Systematic Conservation Plan (EKZNW, 2016). The southern and eastern portions of the study area also fall within an ESA (Ecological Support Area) corridor.
- The study area is in an Important Bird Area (IBA) for grasslands in the region.

Table 13. Key conservation context details for the study area.

Conservation Planning Dataset		Relevant Conservation Feature	Conservation Planning / Threat Status	Location in Relation to Project Site
NATIONAL LEVEL CONSERVATION PLANNING CONTEXT				
National Freshwater Ecosystem Priority Areas (NFEPA)	River	Seepwaterspruit River	Non-FEPA River	North of site
		Mbizana River		East of site
		Ngudumeni River		Within site fottprint
		Ngogo River	FEPA River	Within site fottprint
	Wetland	Depression, seep and unchanneled valley bottom wetlands	FEPA wetland	On site
2018 National Biodiversity Assessment	Terrestrial	Low Escarpment Moist Grassland	Least Concern	On site
		KwaZulu-Natal Highland Thornveld	Least Concern	On site

Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning / Threat Status**	**Location in Relation to Project Site**
		Northern Afrotemperate Forest	Least Concern	On site
		Northern KwaZulu-Natal Grassland	Least Concern	On site
	River	Ngogo River	Least Threatened	Adjacent to and within site footprint
	Wetland	Depression, seep and unchanneled valley bottom wetlands	Critically Endangered	On site
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT				
KZN Biodiversity Conservation Plan Freshwater		Catchment Planning Unit	Available[1] Earmarked[2]	Entire project site
KZN Vegetation Type Threat Assessment		KwaZulu-Natal Highland Thornveld	Least Concern	On site
		Northern Afrotemperate Forest	Least Concern	On site
		Northern KwaZulu-Natal Grassland	Vulnerable	On site

[1] "Available" suggests that the catchment has not specifically been identified as a provincial priority area aquatic conservation priority.
[2] "Earmarked' suggests that the catchment has been identified as an optimal biodiversity area required to meet biodiversity targets.

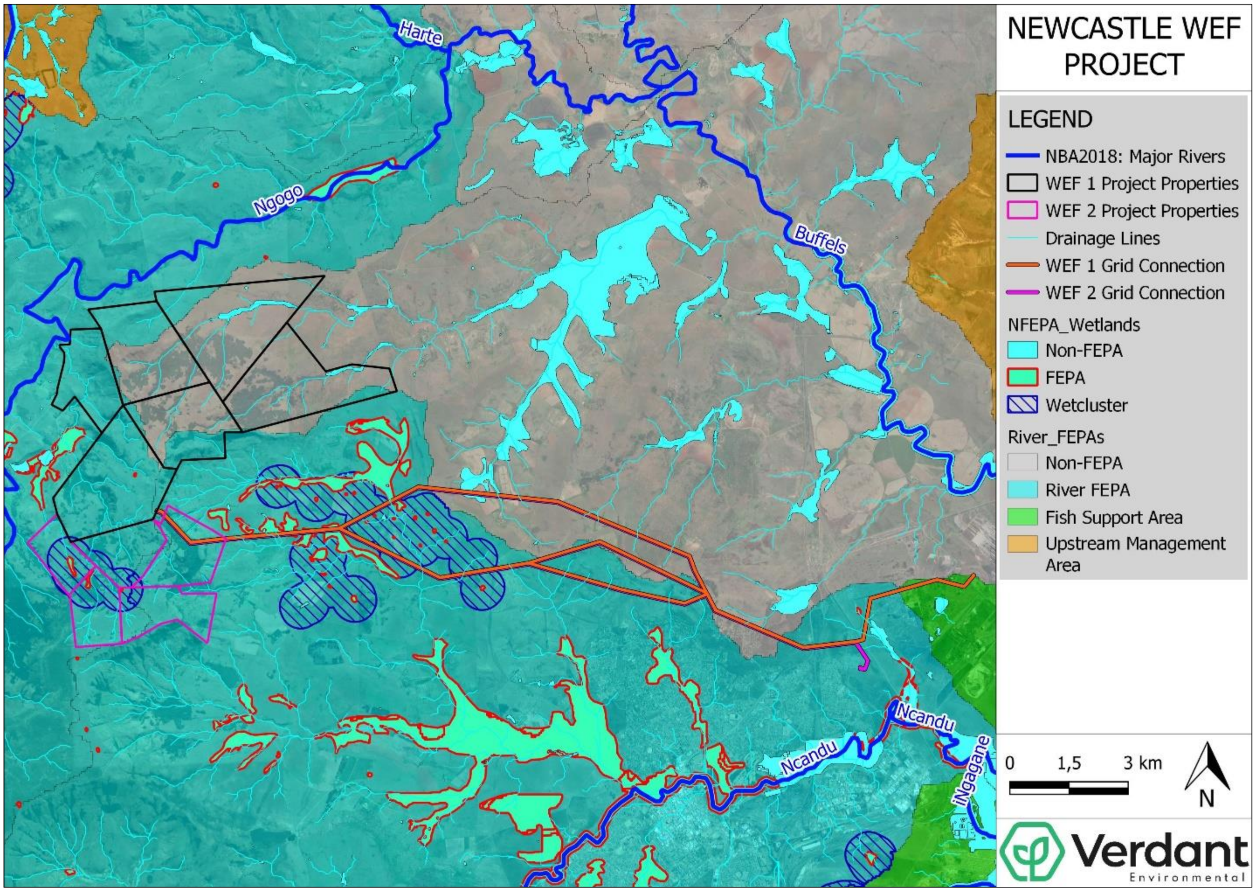

Figure 11. River and Wetland FEPAs in relation to the greater project area.

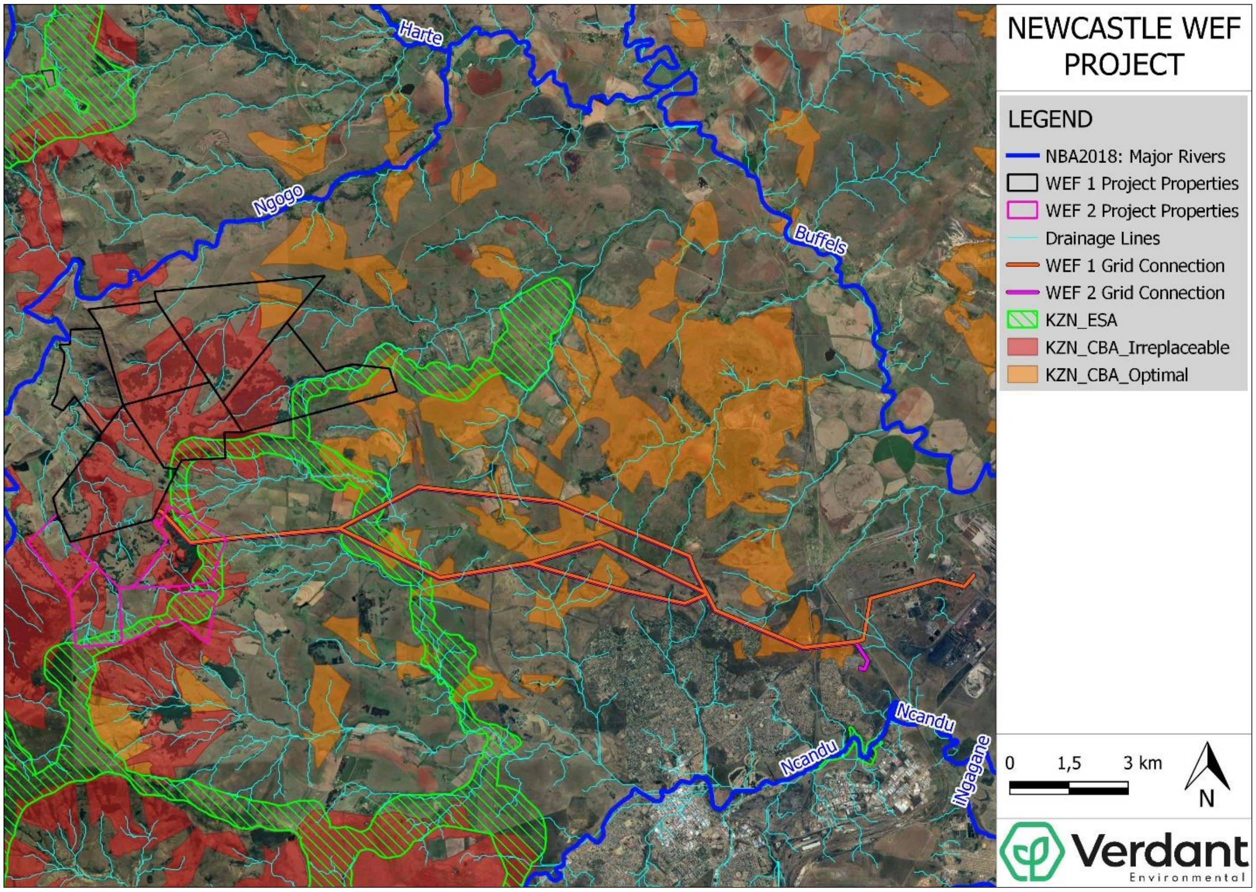

Figure 12. Provincial CBAs and ESAs in relation to the project site.

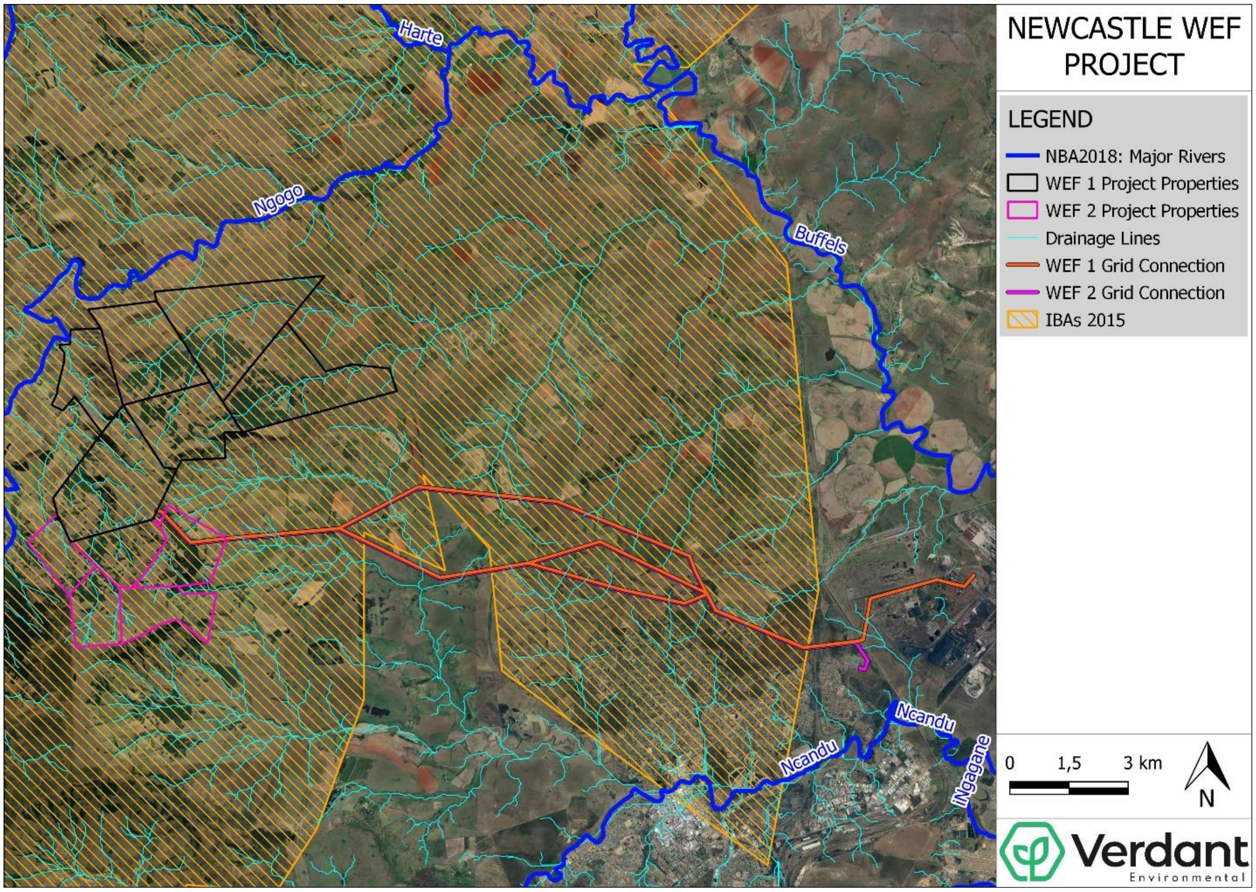

Figure 13. International Bird Areas (IBAs) in relation to the greater project area.

3.2. Desktop Mapping within 500m and Confirmation of the Study Area

All the potential rivers and wetlands occurring within 500m of the proposed development activities were mapped as shown in Figure 14. The mapped watercourses were also assessed in terms of 'likelihood of impact' as shown in Figure 15. Please note that only the watercourses within the 500m regulated area are relevant to this project. Watercourse mapped and rated outside of this area are part of the greater consolidated study consisting of all four projects.

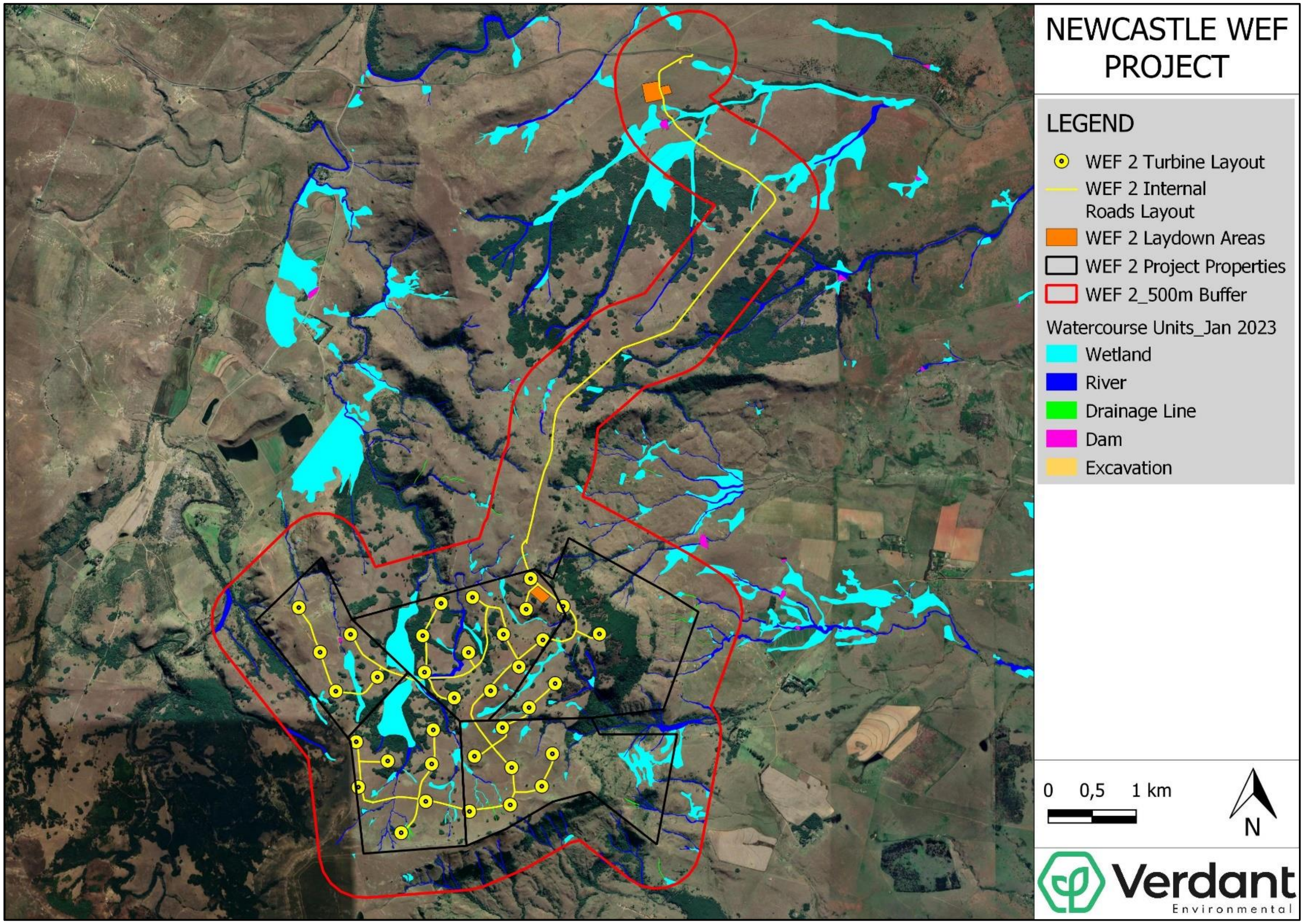

Figure 14. Rivers and wetlands within 500m of the project activities of MNWP 2.

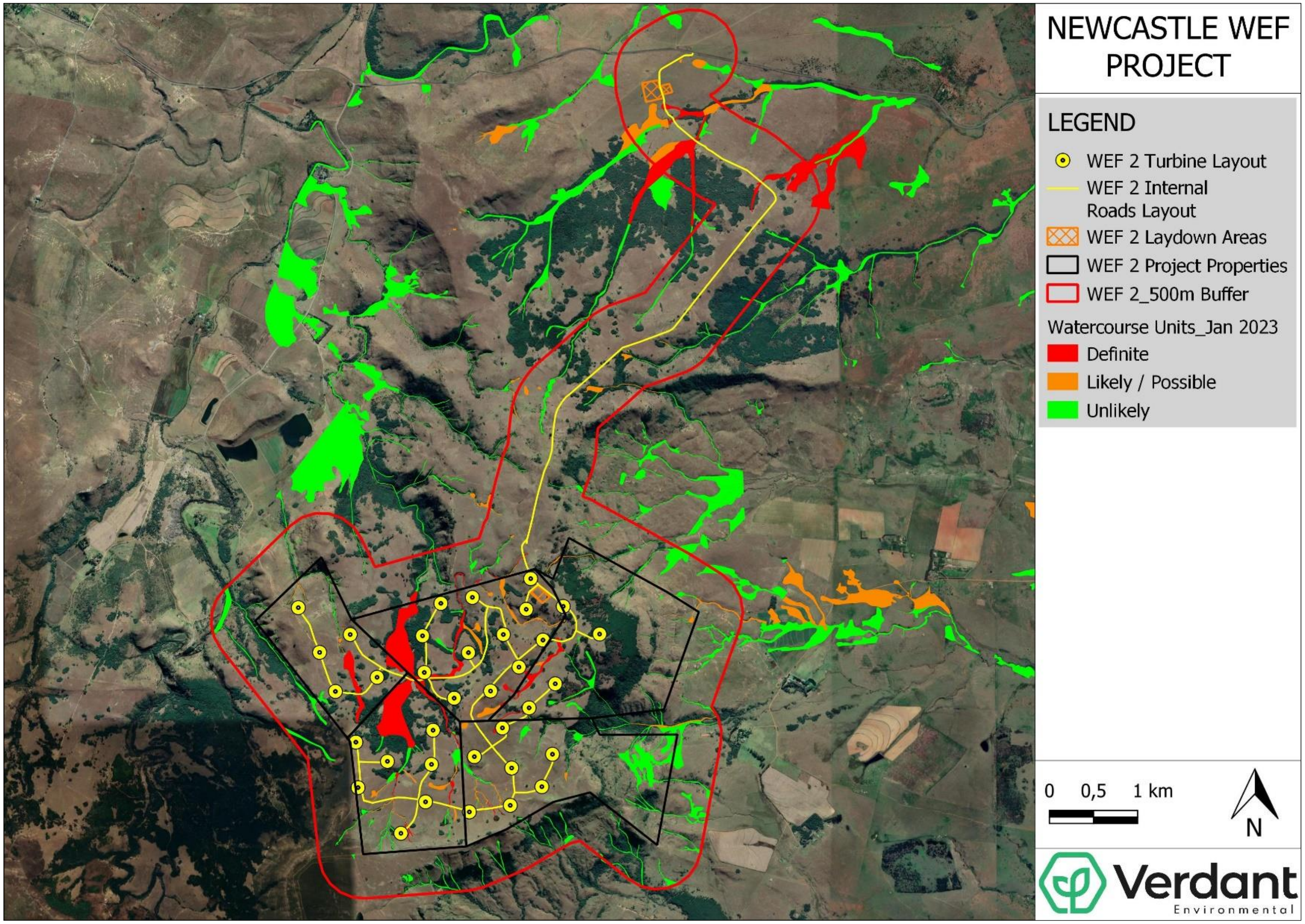

Figure 15. Indication of the 'likelihood of impact' to watercourses within 500m of the project activities of MNWP 2.

4. Delineation, Classification and Biophysical Characterises

The infield baseline assessment focused on the wetland ecosystems likely to be measurably negatively impacted by the project development activities only. The extent (infield delineation), classification and habitat characteristics are discussed in this section of the report.

4.1. River Units

The proposed turbines occur at elevations approximate to 1846 metres above mean sea level (mamsl) whilst the grid connection span elevations from 1846 mamsl to 1243 mamsl in the east of the project area. A typical elevation profile of a river system in the study area is provided in Figure 16 below. The watercourse source is located at 1846 mamsl where the watercourse exits the study area at elevations proximate to 1521 mamsl showing mean gradients of 0.03 across the profile. The landform setting of the watercourses were typically either associated with headwater source zone wetlands and within valley bottom topography where the lateral movement of the watercourses was confined by valley slopes. Knickpoints were present within the watercourses where waterfalls and cascades were observed across the turbine study in the higher elevations.

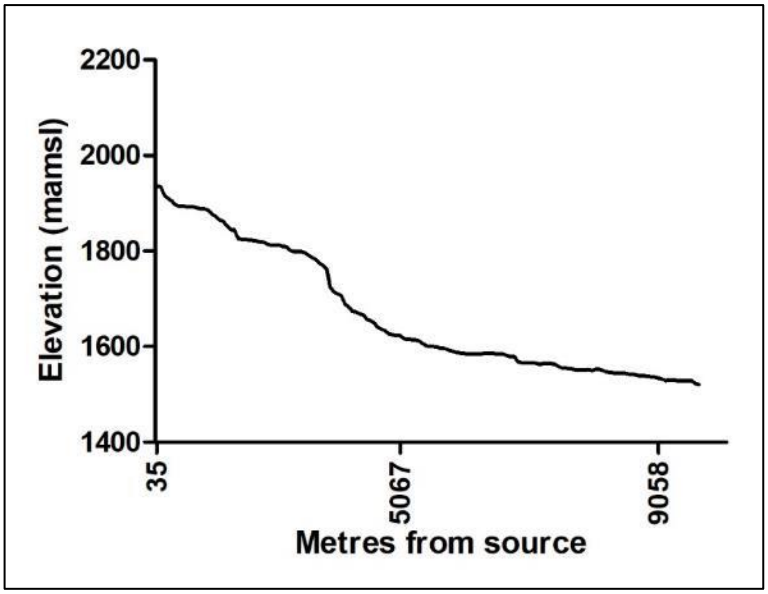

Figure 16. The typical elevation profile of streams / rivers within the study area.

The river systems were observed to be bedrock controlled in the upper reaches, whilst headwater rivers associated wetlands were alluvially controlled. Similarly, the foothill rivers were largely alluvially controlled. Riverine substrates were noted to vary according to gradient, elevation and Strahler order whereby bedrock, boulders, cobbles and sandy substrates were present. Floodplains were generally limited to the immediate margins of the watercourses, with the rivers set within deep incised channels.

Figure 17. Typical steep sided valleys with mountain streams draining from the plateau to the foothills of the mountains (February 2022).

Figure 18. Waterfalls, a common feature along the mountain streams (February 2022).

Figure 19. Bedrock sheet substrates common in the mountain streams in the study area (February 2022).

Figure 20. Boulder and gravel substrates along mountain streams (February 2022).

Figure 21. Cobbled substrates in Upper Foothills River (February 2022).

The watercourse types observed and considered in this assessment consisted of four primary drainage characters:

1. Drainage Lines

Drainage lines are defined by areas where concentrated discharge occurs during and immediately after precipitation events. These watercourse types are typically low Strahler order with steep gradients. The hydrological drivers of these watercourse types are limited to direct overland flow. These watercourse types are typically devoid of alluvial substrates, defined channels and banks. These systems are however considered important due to their capacity to direct and control discharge velocity and volume. It is also important to note that ephemeral discontinuous channels are present in some of the plateau areas that are strongly associated with soil piping and sinkholes. These features have also been included as drainage lines rather than streams.

2. Mountain Streams

These watercourse types conformed to the classification by Ollis et al. (2013) whereby unidirectional flows within a concentrated active channel were present (Figure 22). It is noted that these watercourse types include the open channels closely associated with the CVB/Seep habitats. The hydrological driving characteristics of these watercourse types was attributed to two sources including:

- Direct overland flow during rainfall.

- Seepage and interflow from springs and surrounding wetland areas/valley slopes.

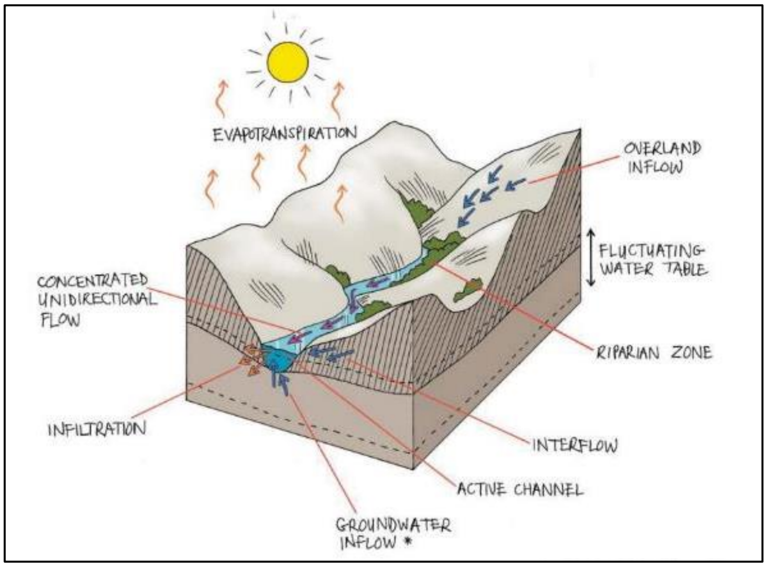

Figure 22. River HGM unit indicated in the study area (Ollis et al., 2013).

Figure 23. A typical headwater river/stream with associated wetland areas in the project area.

Figure 24. A typical mountain stream in the project area.

Figure 25. Typical mountain stream marginal vegetation.

Figure 26. Typical mountain stream plant species (February 2022) (*Monopsis decipiens*, *Hesperantha coccinea*, *Cyperus congestus*).

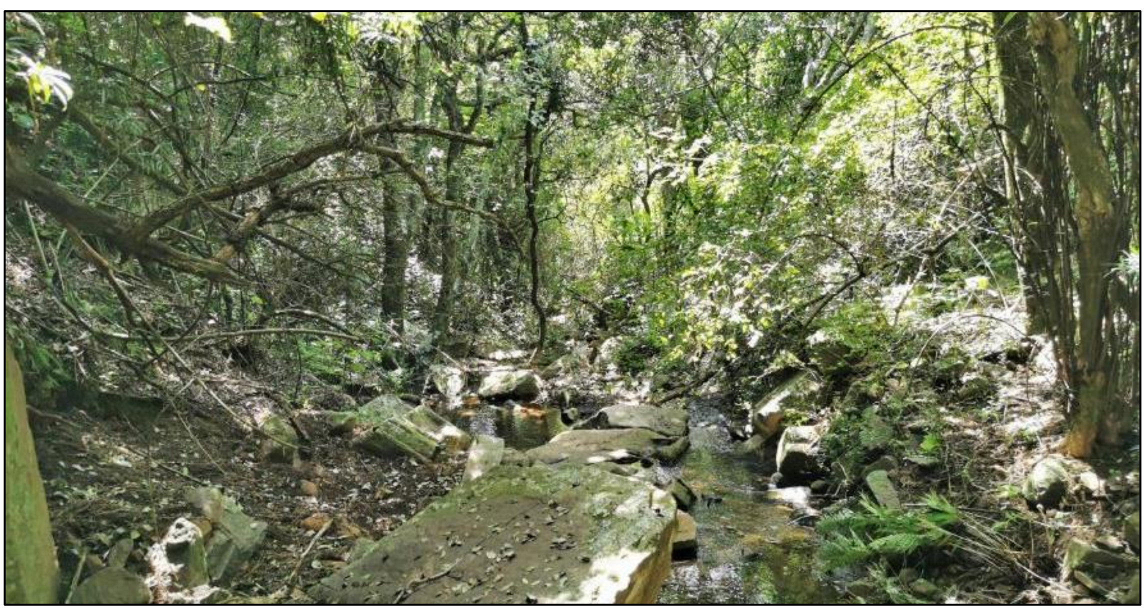

Figure 27. Densely forested mountain stream (February 2022).

Figure 28. Densely forested valley hosting a mountain stream (February 2022)

3. Upper Foothill Rivers

Upper foothill rivers in the study area also conformed to the definitions provided by Ollis et al. (2013) but were generally wider, located at a lower elevation and a higher Strahler order in comparison to mountain streams. In addition, these systems had lower gradients in comparison to mountain streams. The hydrological drivers of these systems were typically driven by upslope watercourses such as the mountain headwater and headwater rivers, springs and wetlands.

Figure 29. A typical upper foothill river system in the project area.

Figure 30. Typical upper foothills river marginal vegetation.

Figure 31. Typical upper foothills river species (February 2022) (*Miscanthus* sp. *Persicaria* sp, *Buddleja salviifolia* and *Searsia pyroides*).

4. Lower Foothill Rivers

Similarly, to the upper foothill rivers, these watercourse types conformed to the definition provided in Ollis et al. (2013). These systems were typically higher Strahler order, lower elevation, wider, reduced gradients and the presence of substrates dominated by gravels and cobbles.

Figure 32. A typical lower foothills river.

4.2. Wetland Units

Most of the wetlands encountered within the study area were spring-fed seeps. Several un-channelled and channelled valley bottom wetlands, and depression wetlands were also encountered but at a measurably lesser abundance.

A. Seep wetlands (SWs)

The seep wetlands encountered ranged from spring-fed permanent hygrophilous grassland and sedgeland to non-spring fed seeps with seasonal and temporary sedgeland and hygrophilous grassland. The permanent seeps are either located on uniform and concave slopes below springs and/or seepage daylighting at bedrock outcrops, or are located in linear and un-channelled valley lines fed by springs. In terms of vegetation, prominent species recorded in the permanently wet sedgelands of the seeps included: *Eleocharis dregeana*, *Juncus oxycarpus*, *Hesperantha coccinea*, *Pycnostachys reticulata*, *Gunnera perpensa*, *Eriocaulon dregei*, *Schoenoplectus paludicola*, *Xyris capensis*, *Pycreus nitidus*, *Leersia hexandra*, *Fuirena pachyrrhiza* and *Isolepis capensis*. The seasonally and temporary wet areas were dominated by *Kyllinga erecta*, *Eragrostis plana*, *Themeda triandra*, *Lobelia* sp. and *Monopsis decipiens*.

For the purposes of this assessment, seep wetlands were subdivided into the following process units:

- SW1a - Permanently wet seep – gently sloping, limited impacts.
- SW1b - Permanently wet seep – gently sloping, moderate impacts.
- SW2a - Permanently wet seep – steeply sloping, limited impacts.
- SW2b - Permanently wet seep – steeply sloping, moderate impacts.
- SW2c - Permanently wet seep – steeply sloping, large impacts.
- SW3a - Seasonally wet seep – gently sloping, limited impacts.
- SW3b - Seasonally wet seep – gently sloping, moderate impacts.
- SW3c - Seasonally wet seep – gently sloping, large impacts.
- SW4a - Seasonally wet seep - steeply sloping, limited impacts.
- SW4b - Seasonally wet seep - steeply sloping, moderate impacts.
- SW4c - Seasonally wet seep - steeply sloping, large impacts.
- SW5a - Temporarily wet seep – gently sloping, limited impacts.
- SW5b - Temporarily wet seep – gently sloping, large impacts.
- SW6 - Temporarily wet seep - steeply sloping, limited impacts.

Figure 33. A broader spring-fed seep wetland with sedgeland vegetation with the conspicuous Scarlet River Lilly (*Hesperantha coccinea*).

Figure 34. A typical narrow, linear, spring-fed seep wetland with sedgeland vegetation.

Figure 35. A narrow, linear, spring-fed seep dominated by the striking herbaceous shrub, *Pycnostachys reticulata* (Blue Soldier Sage) punctuated with the broad-leaved wetland herb, *Gunnera perpensa* (River Pumpkin).

B. Un-channelled and channelled valley bottom wetlands (UCVBs and CVBs)

The un-channelled valley bottom wetlands encountered were permanent wetlands with hygrophilous grassland and sedgeland. Prominent species within the communities include: *Eleocharis dregeana*, *Juncus oxycarpus*, *Schoenoplectus paludicola* and *Leersia hexandra*, with margins of hygrophilous grassland dominated by *Kyllinga erecta* and *Eragrostis plana*.

The channelled valley bottom wetlands encountered ranged from permanent hygrophilous grassland and sedgeland fed by lateral inputs and springs, and drier valley bottom wetlands with seasonal and temporary hygrophilous grassland on floodplains and terraces elevated above the channel and that are inundated periodically by channel overtopping. The vegetation communities within the wetter areas resembled those of the seep communities whereas the drier seasonal and temporary zones comprise hygrophilous grassland dominated by *Kyllinga erecta* and *Eragrostis plana*.

For the purposes of this assessment, valley bottom wetlands were subdivided into the following nine (9) process units:

- CVB1 - Permanently wet CVB – gently sloping, limited impacts.
- CVB2a - Permanently wet CVB – steeply sloping, limited impacts.
- CVB2b - Permanently wet CVB – steeply sloping, large impacts.
- CVB3a - Seasonally wet CVB – gently sloping, moderate impacts.
- CVB3b - Seasonally wet CVB – gently sloping, large impacts.
- CVB3c - Seasonally wet CVB - steeply sloping, critical impacts.
- UCVB1 - Permanently wet UCVB – gently sloping, limited impacts.
- UCVB2 - Permanently wet UCVB – gently sloping, large impacts.
- UCVB3 - Permanently wet UCVB – steeply sloping, large impacts.

Figure 36. One of the few broad un-channelled valley bottom wetlands encountered on the plateau with sedgeland and informal vehicle crossing.

C. Depression wetlands (DWs)

The depression wetlands encountered included some small and localised sheet bedrock depressions with open water and short sedgeland, and more typical depressions with sedgeland and hygrophilous grassland.

For the purposes of this assessment, depression wetlands were subdivided into the following process units:

- DW1 - Permanently wet depression – limited moderate impacts.
- DW2a - Seasonally wet depression – limited impacts.
- DW2b - Seasonally wet depression – large impacts.
- DW3 - Seasonally wet depression – bedrock sheet.
- DW4 - Temporarily wet depression – limited impacts.

Figure 37. A bedrock sheet depression wetland with open water bordered by *Persicaria* sp.

Figure 38. A depression wetland with short sedgeland and heavily grazed surrounds.

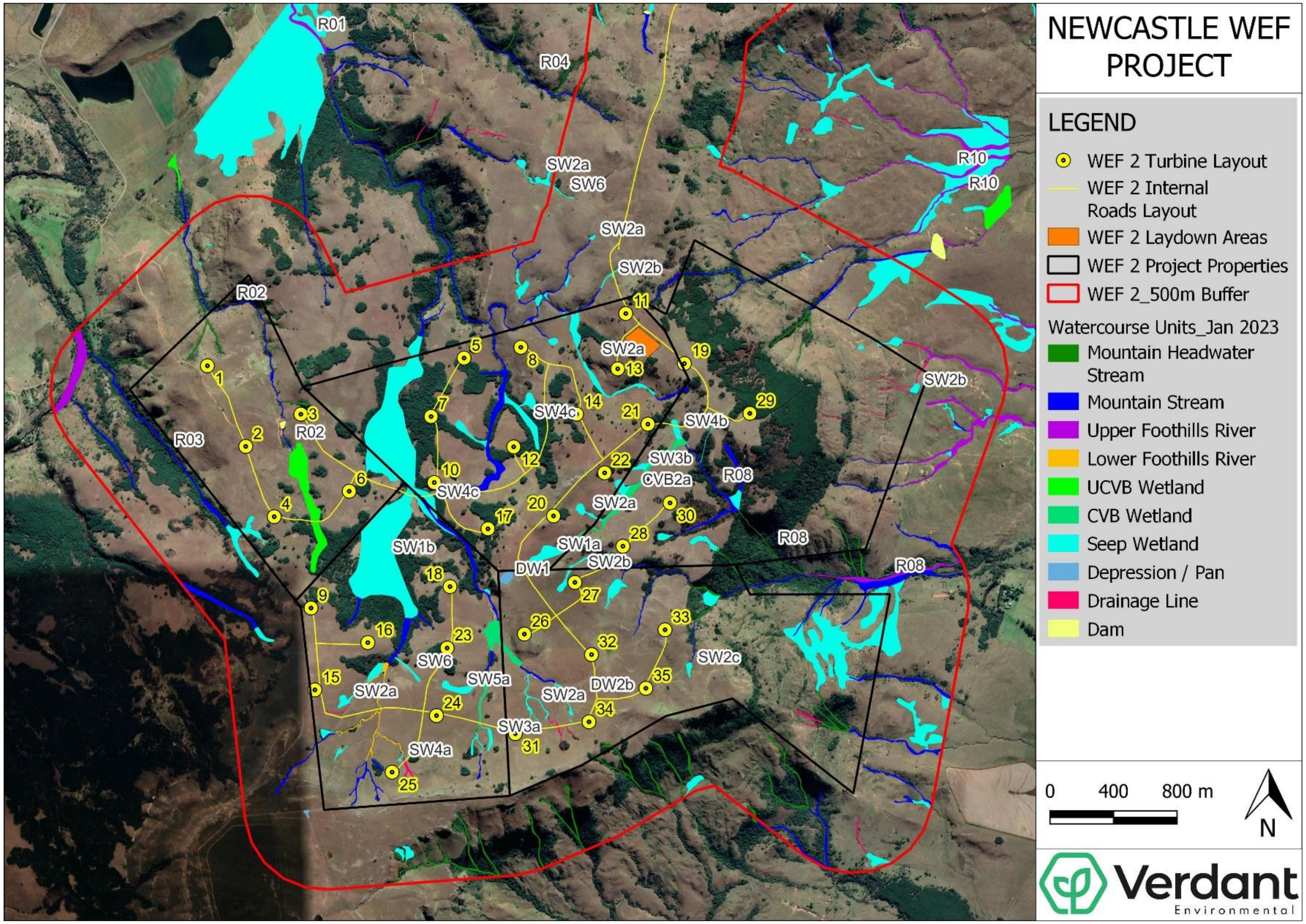

Figure 39. Delineation map showing the location and extent of river and wetland units assessed within the study area - north.

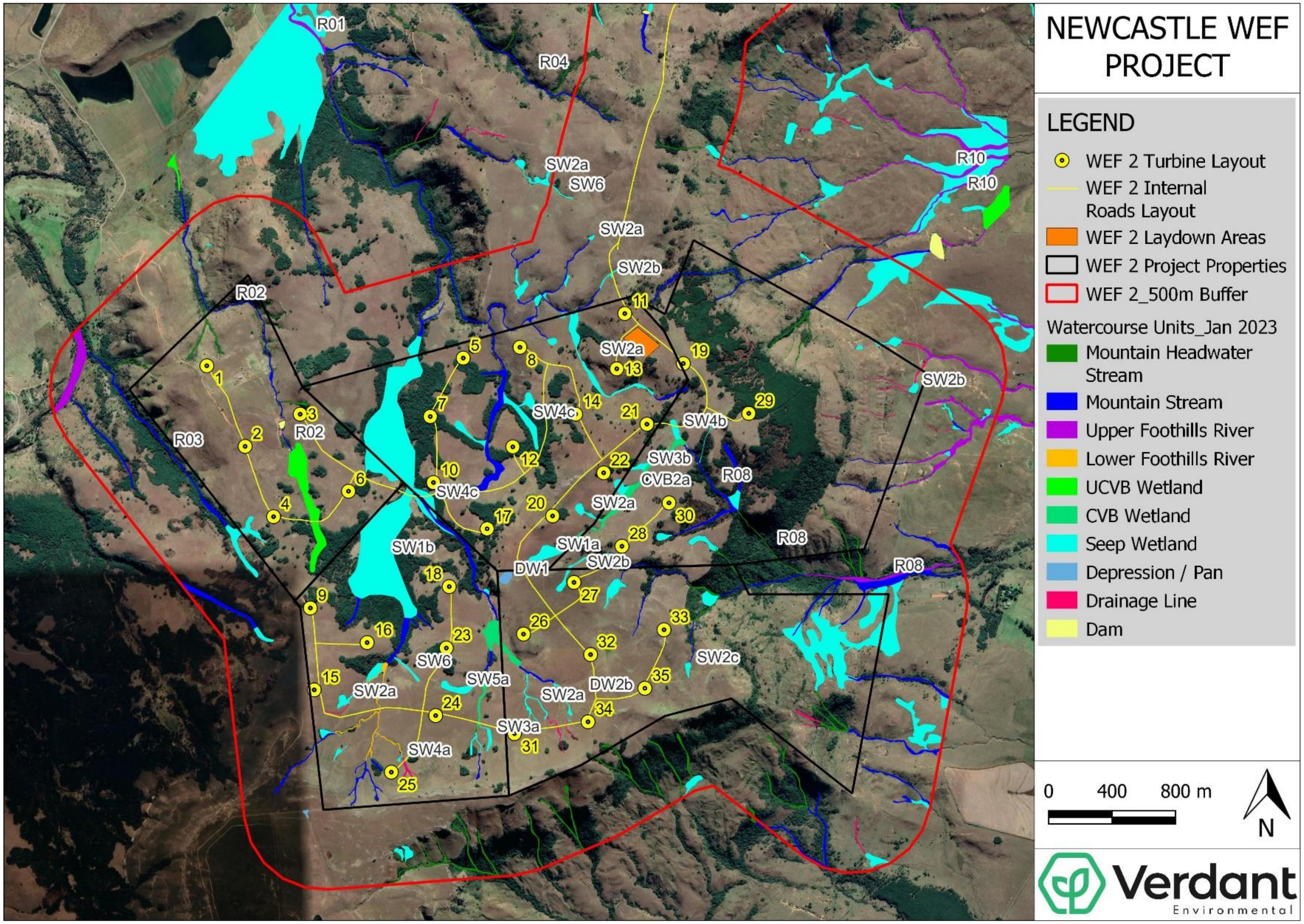

Figure 40. Delineation map showing the location and extent of river and wetland units assessed within the study area - south.

5. Present Ecological State (PES) Assessment

5.1. River PES

5.1.1. Water Quality

The term 'water quality' is used to describe the microbiological, physical and chemical properties of water resources as defined by the National Water Act (Act No. 36 of 1998) that determine its fitness for a specific use and is determined by substances which are either dissolved or suspended in the water (DWAF, 2001). In this context, water quality therefore refers to its fitness for maintaining the health of aquatic ecosystems and ensuring no impact to downstream water quality or water users (if any).

The results of the water quality analysis are presented in Table 14, with the location of the sampling points shown in Figure 3 earlier. The water quality results observed in the February survey showed natural temperatures, neutral pH, adequate levels of dissolved oxygen, and low concentrations of dissolved solids. The lowest levels of dissolved solid concentration were observed at T3A where 1.9 mS/m were measured, the highest levels were observed at T10 at 152 mS/m. The results of the in-situ water quality analysis indicate excellent water quality conditions in the project area. It is noted that additional chemical analysis, which includes the analysis of nutrients of selected watercourses is recommended.

Table 14. In situ water quality results (February 2022).

Sample Point	Temperature	pH	DO (mg/l)	Conductivity (mS/m)
Guideline (RQO)	**-**	**6.5-9.0**	**>5.0**	**<50**
T1	17	7.8	8.1	12.5
T2	22	6.7	7.1	5.8
T3A	24	6.7	7.3	1.9
T3B	20	6.45	6.8	4.1

Sample Point	Temperature	pH	DO (mg/l)	Conductivity (mS/m)
T4	21	6.3	6.3	9.2
T5	27	6.9	6.2	3.5
T6	18	6.8	7.2	5.1
T7	22	6.8	7.1	4.0
T8A	21	6.7	5.8	9.2
T8B	26	6.8	7.2	11
T9	29	7.35	6.1	12
T10	20	7.4	6.4	152
T11	31	7.8	5.2	31
T12	28	7.5	5.2	15
EN1	22	7.56	8.1	76
EN2	24	7.3	7.4	10
R1	26	7.5	6.8	25
R2	26	7.4	6.1	12
R3	26	7.6	5.8	25
R4	25	8.2	5.8	38
R5	23	6.9	5.1	42
Mean Values	23±0.7	7.1±0.1	12±3.8	24±7.4
RQO = Resource Quality Objective (DWS, 2022)				

5.1.2. Hydrological and Habitat Condition

To further characterise the condition of the riverine habitat, the land cover of the watersheds was investigated as presented in Figure 39 (Thompson, 2019). As observed in the figure, the watersheds were dominated by natural grasslands, whilst watercourses associated with Newcastle had both urban and industrial landcover types. The results of the IHIA for the watercourse is presented in Tables 15 and 16.

The most significant impacts in the study area were impacts to riparian condition, whereby stands of *Acacia mearnsii* (Black Wattle) were noted to occupy significant proportions of the headwater systems. The presence of the wattle directly impacted marginal and instream habitat conditions by reducing basal cover and increasing sedimentation.

The primary impacts identified in the watersheds was associated with general land cover alteration. Land cover change alters initial abstraction and roughness factors in the hydrological process. The resultant impact is flow alteration, bed modification (sedimentation) and channel morphology change. Direct impacts from impoundments were further noted to occur in the study area, where habitats were directly inundated, and downstream habitats modified.

Livestock watering also occurred in the headwater systems where cattle utilised the systems for watering. Direct impacts to banks and substrates are typically associated with livestock watering. Urban encroachment in the town of Newcastle, as well as linear infrastructure in the study area further impacted on the condition of the watercourses.

Table 15. Instream IHIA for subset of the river reaches (February 2022).

Criterion	Water loss	Flow mod	Bed mod	Channel mod	Water quality	Inundation	Exotic veg	Exotic fauna	Solid waste disposal	Condition
R01	10	7	7	10	3	5	0	5	2	76.16
R02	11	12	15	15	2	12	0	5	2	64
R03	10	11	12	10	5	0	0	5	2	72.36
R04	8	8	8	6.5	5	5	0	0	2	78.54
R05	10	15	15	12	5	2	0	0	3	68.24
R06	8	12	13	13	5	8	0	5	5	66.96
R07	10	13	8	10	5	2	0	0	2	74.2
R08	8	7.5	5	5	5	3	0	0	3	81.7
R09	5	12	13	13	7.5	3	0	0	5	70.84
R10	No Access									
R11	7	9	10	5	3	6	0	0	3	78.8
R12	7	10	14	9	5.5	7	0	5	3	70.72
R13	5	11	12	10	5	6	0	5	2	72.76
R14	No Access									
R15	12	17	18	18	10	12	0	10	5	50.92
R16	8	18	20	18	10	8	0	0	10	55.2
R17	10	21	18	18	15	5	0	0	15	50.76
R18	No Access									

Table 16. Riparian IHIA for a subset of the river reaches (February 2022).

Criterion	Indigenous vegetation removal	Exotic vegetation encroachment	Bank erosion	Channel mod	Water loss	Inundation	Flow mod	Water quality	Condition
R01	8	12	6	5	5	5	8	2	74.64
R02	10	10	5	15	8.5	10	10	2	65.34
R03	12	16	10	8	5	5	12	2	65.04
R04	10	10	5	6.5	5	5	8	2	74.4
R05	15	19	8	10	5	5	10	2	63.16
R06	10	5	5	10	5	8	10	5	71.28
R07	10	12	10	8	5	2	8	3	70.72
R08	8	8	5	5	3	3	7	2	79.52
R09	3	5	10	12	5	5	10	5	72.48
R10	No Access								
R11	5	8	7	6	2	7	3	5	78.6
R12	12	8	5	8	5	5	10	5	71.08
R13	10	10	5	5	2	5	11	5	73.68
R14	No Access								
R15	10	9	16	15	10	13	15	7	52.56
R16	12	10	7.5	12	5	7	10	7.5	64.62
R17	16	19	10	19	5	9	21	12	44.96
R18	No Access								

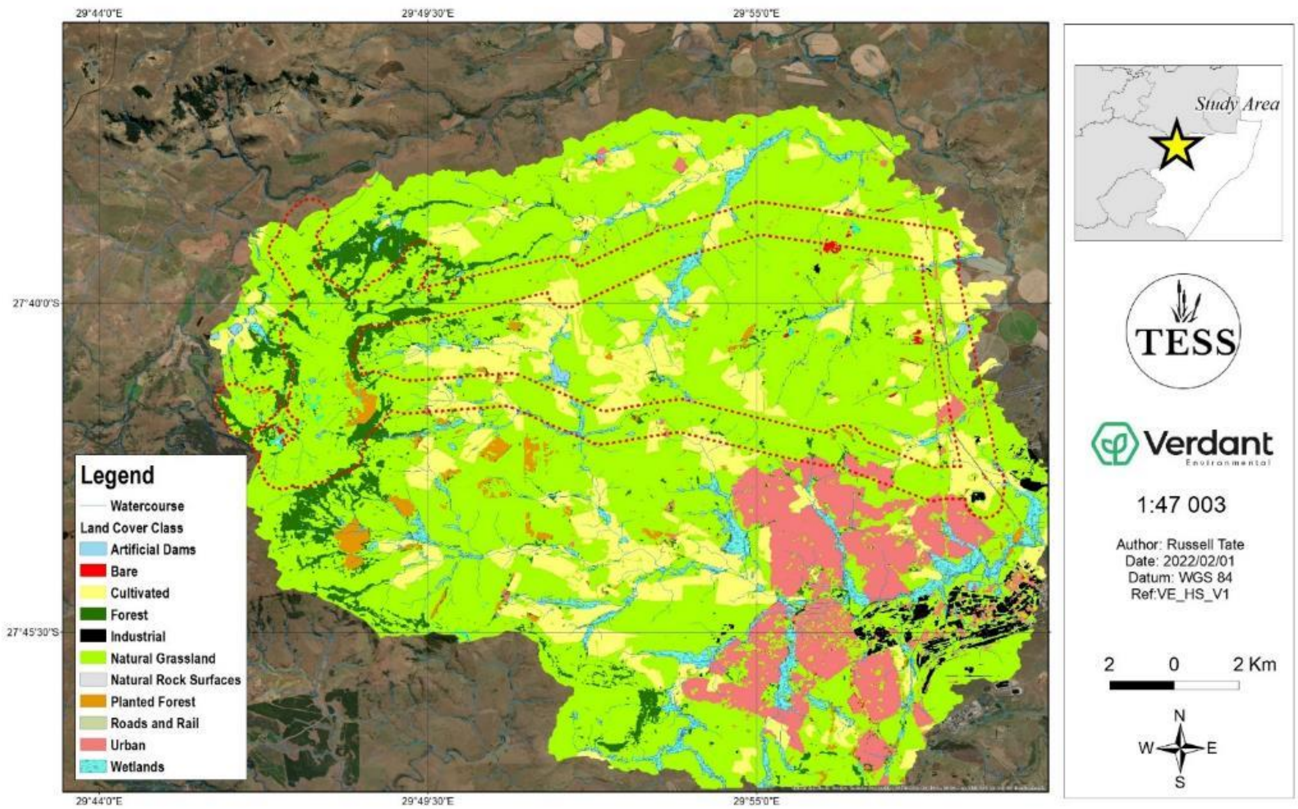

Figure 41. Land cover in the watershed considered in this study area.

Figure 42. *Acacia mearnsii* in the riparian zone of a watercourse (February 2022).

Figure 43. A sedimented reach of a watercourse (February 2022).

Figure 44. A structure within a watercourse in the study area (February 2022).

Figure 45. An eroded bank of a watercourse in the study area (February 2022).

5.1.3. Aquatic Macroinvertebrates

A. Macroinvertebrate Habitat

Aquatic macroinvertebrate habitat diversity results are presented in Table 17 below. The aquatic habitats conformed to the riverine zonation for mountain streams and foothill river systems (Rowntree and Ziervogel, 1999).

Hydraulic biotopes observed included cascades, riffles, runs, and pools and were present at most sampling points. Substrates predominantly consisted of cobbled and bedrock. It is expected that the gravel, sand and mud biotopes, which were noted to be abundant, have been increased through the sedimentation in the watersheds.

The results of the biotope assessment indicate diverse habitats at the sampling points, where the variety and abundance of invertebrate biotopes would not limit diversity at most sampling points.

B. Macroinvertebrate Indices

The results of the SASS5 assessment for the study area is presented in Table 18. The results of the SASS5 indicate the presence of diverse and sensitive aquatic macroinvertebrates. The invertebrate assemblages observed in the headwater systems were typical of the expected conditions where highly sensitive families were observed, particularly with regards to the Ephemeroptera and Plecoptera (Figure 46).

Figure 46. Invertebrates sampled in the project area showing Baetidae, Perlidae, Tricorythidae and Oligoneuridae (February 2022).

Sample points associated with the lower lying reaches were classified as moderately to seriously modified (class C – class E/F). This can be attributed to landcover alteration in the watersheds and anticipated water quality impacts stemming from diffuse source pollutants across cultivated lands and the urban environment.

Sample points at higher elevations were largely classified into class A (natural) and class B (largely natural) categories indicating limited impacts in the watersheds. Sample points at higher altitudes where class C (moderately modified) and class D (largely modified) categories could be attributed to sedimentation or the reduction in available invertebrate biotopes. The baseline SASS5 scores are not established and must be utilised in future monitoring evaluations.

Table 17. Invertebrate Biotope Assessment Results (February 2022).

	T1	T2	T3A	T3B	T4	T5	T6	T7	T8A	T8B	T9	T10	T11	T12	EN1	EN2	1	2	3	4	5
Stones In Current (SIC)	2	2	1.5	2	3	2	2	1	1	3.5	3	2	1	2	4	3	1	0	1	1	0
Stones Out Of Current (SOOC)	2	1	1	1	3	2	1	2	2	2	2	1	0	1	2	1	0	0	0	0	0
Bedrock	3	3	3	3	3	3	2	3	2	1	0	1	2	2	3.5	0	1	0	3	2	2
Aquatic Veg	0	0	0	1	1	1	0	0	1	0	0	0	2	0	0	0	1	1	0	1	0
MargVeg In Current	0	2	3	2	2	2	0	1	1	2	1	2	1	2	1	3	4	0	2	2	1
MargVeg Out Of Current	0	1	3	3	3	3	0	1	2	2	3.5	1	3.5	2	2	2	3	4	2.5	3.5	2
Gravel	2	2	2	2	3	1	1	1	1	2	1	0	0	1	2	2	3	0	0	0	1
Sand	3	3.5	2	2	2	2	1	1	2	2	3	1	2	3	2	3	2	1	2	2	3
Mud	3	1	2	2	2	2	3	2	1	2	4	3	2	1	1	1	2	3	3	2	1
Total Score	**15**	**12**	**17.5**	**18**	**22**	**18**	**10**	**12**	**13**	**13**	**14**	**11**	**13.5**	**14**	**17.5**	**15**	**17**	**9**	**11**	**10**	**10**

Table 18. South African Scoring System Results (February 2022).

Site	SASS Score	No. of Taxa	ASPT*	Category (Dallas, 2007)**
T1	115.0	17.0	6.8	***class B**
T2	149.0	24.0	6.2	***class B**
T3A	105.0	19.0	5.5	***class D**
T3B	166.0	26.0	6.4	***class B**
T4	199.0	29.0	6.9	***class A**
T5	165.0	26.0	6.3	***class B**
T6	109.0	16.0	6.8	***class B**
T7	118.0	19.0	6.2	***class B**
T8A	90.0	16.0	5.6	***class C**
T8B	136.0	23.0	5.9	***class C**
T9	112.0	22.0	5.1	***class C**
T10	89.0	17.0	5.2	***class D**

Site	SASS Score	No. of Taxa	ASPT*	Category (Dallas, 2007)**
T11	84.0	17.0	4.9	***class D**
T12	91.0	16.0	5.7	***class C**
EN1	167.0	25.0	6.7	***class B**
EN2	189.0	28.0	6.8	***class A**
R1	91.0	20.0	4.6	****class C**
R2	102.0	20.0	5.1	****class C**
R3	99.0	21.0	4.7	****class C**
R4	74.0	16.0	4.6	****class E/F**
R5	29.0	8.0	3.6	****class E/F**

*ASPT: Average score per taxon
* Eastern Escarpment Mountains (Dallas, 2007)
**North Eastern Uplands (Dallas, 2007)

The MIRAI was completed based on the river delineations presented which serve as the spatial framework for the PES assessments. The results of the MIRAI are presented in Table 19.

The results of the MIRAI indicated ecological conditions that ranged from class B (largely natural) at HGM1 to class E (seriously modified) in HGM17. The expected invertebrate taxa consisted of highly sensitive families such as Notonemouridae, Blepharoceridae and Prosopistomatidae. Only Notonemouridae were present in headwaters of HGM1. Although with a low Frequency of Occurrence (FROC), Notonemouridae presence effectively illustrated the excellent water quality present.

Lowered FROC for Heptageniidae, Psephenidae and several Trichoptera were noted in the headwater systems illustrating condition modification in the watercourses. The modification was attributed to sedimentation and impacts on cobbled substrates in the headwater systems, whilst severe sedimentation was noted in the lowland sampling points as depicted in the habitat assessment (Section 67).

According to the RQO's for the Upper Tukela River system, MIRAI scores for the Buffels, Ncandu and Ngagane Rivers must be maintained at B/C or 70-89%, whilst SASS5 scores greater than 190 with ASPT values of >6.0 must be obtained (RSA Government, 2021).

Table 19. Reach Based Macroinvertebrate Assessment Index results for rivers (February 2022).

HGM Unit	Sample Points Considered	MIRAI Score	Ecological Category
R01	T3A, T3B, EN1, EN2	83	Class B
R02	T2	68	Class C
R03	T1	55	Class D
R04	T6	64	Class C
R05	T12	53	Class D
R06	T11	57	Class D
R07	T10	53	Class D
R08	T8A, T8B	64	Class C
R09	T9	54	Class D
R10	No access		
R11	T7	73	Class C
R12	R1	56	Class D
R13	R2	55	Class D
R14	No access		
R15	R3	52	Class D
R16	R4	55	Class D

HGM Unit	Sample Points Considered	MIRAI Score	Ecological Category
R17	R5	36	Class E
R18	No access		

C. Observations on Odonata

The expected Odonata in the project area was investigated using the IUCN (2022) distribution shapefiles. The expected species are presented in Table 20. Of the expected 77 taxa, 48 were recorded during the February 2022 survey period across the study area. The absent taxa were rare species where further survey time will be required to observe.

Table 20. Odonata observed in February 2022.

Species	Family	IUCN Status (IUCN, 2022)	Observed 2022	Habitat	
				Upland	Lower Foothills
Anax imperator	AESHNIDAE	LC	Yes	X	X
Pinheyschna subpupillata	AESHNIDAE	LC	Yes	X	X
Anax speratus	AESHNIDAE	LC	Yes	X	X
Anaciaeschna triangulifera	AESHNIDAE	LC	No		
Anax ephippiger	AESHNIDAE	LC	Yes		X
Anax tristis	AESHNIDAE	LC	No		
Platycypha caligata	CHLOROCYPHIDAE	LC	Yes	X	X
Platycypha fitzsimonsi	CHLOROCYPHIDAE	LC	No		
Africallagma sinuatum	COENAGRIONIDAE	LC	No		
Pseudagrion sublacteum	COENAGRIONIDAE	LC	Yes		X
Azuragrion nigridorsum	COENAGRIONIDAE	LC	Yes		X
Ischnura senegalensis	COENAGRIONIDAE	LC	Yes		X
Pseudagrion kersteni	COENAGRIONIDAE	LC	Yes	X	X
Pseudagrion citricola	COENAGRIONIDAE	LC	No		
Africallagma glaucum	COENAGRIONIDAE	LC	Yes	X	X
Pseudagrion salisburyense	COENAGRIONIDAE	LC	Yes	X	X
Agriocnemis falcifera	COENAGRIONIDAE	LC	No		
Africallagma sapphirinum	COENAGRIONIDAE	LC	Yes		X
Proischnura rotundipennis	COENAGRIONIDAE	LC	Yes	X	
Pseudagrion caffrum	COENAGRIONIDAE	LC	Yes	X	
Agriocnemis exilis	COENAGRIONIDAE	LC	No		
Pseudagrion massaicum	COENAGRIONIDAE	LC	Yes		X

Species	Family	IUCN Status (IUCN, 2022)	Observed 2022	Habitat	
				Upland	Lower Foothills
Pseudagrion spernatum	COENAGRIONIDAE	LC	Yes	X	X
Ceriagrion glabrum	COENAGRIONIDAE	LC	Yes		X
Onychogomphus supinus	GOMPHIDAE	LC	No		
Ceratogomphus pictus	GOMPHIDAE	LC	Yes		X
Notogomphus praetorius	GOMPHIDAE	LC	Yes		X
Crenigomphus hartmanni	GOMPHIDAE	LC	No		
Paragomphus elpidius	GOMPHIDAE	LC	No		
Paragomphus cognatus	GOMPHIDAE	LC	Yes		X
Paragomphus genei	GOMPHIDAE	LC	Yes		X
Lestes pallidus	LESTIDAE	LC	Yes		X
Lestes plagiatus	LESTIDAE	LC	Yes		X
Lestes virgatus	LESTIDAE	LC	Yes		X
Lestes uncifer	LESTIDAE	LC	No		
Acisoma inflatum	LIBELLULIDAE	LC	Yes		X
Acisoma variegatum	LIBELLULIDAE	LC	No		
Brachythemis leucosticta	LIBELLULIDAE	LC	Yes		X
Bradinopyga cornuta	LIBELLULIDAE	LC	No		
Crocothemis erythraea	LIBELLULIDAE	LC	Yes		X
Crocothemis sanguinolenta	LIBELLULIDAE	LC	Yes		X
Diplacodes lefebvrii	LIBELLULIDAE	LC	Yes		X
Diplacodes luminans	LIBELLULIDAE	LC	No		
Nesciothemis farinosa	LIBELLULIDAE	LC	Yes		X
Orthetrum abbotti	LIBELLULIDAE	LC	No		
Orthetrum caffrum	LIBELLULIDAE	LC	Yes	X	
Orthetrum chrysostigma	LIBELLULIDAE	LC	Yes	X	X
Orthetrum hintzi	LIBELLULIDAE	LC	No		
Orthetrum icteromelas	LIBELLULIDAE	LC	No		
Orthetrum julia	LIBELLULIDAE	LC	No		
Orthetrum machadoi	LIBELLULIDAE	LC	No		
Orthetrum stemmale	LIBELLULIDAE	LC	No		
Orthetrum trinacria	LIBELLULIDAE	LC	Yes		X
Palpopleura jucunda	LIBELLULIDAE	LC	Yes	X	
Palpopleura lucia	LIBELLULIDAE	LC	No		
Palpopleura portia	LIBELLULIDAE	LC	Yes		X
Pantala flavescens	LIBELLULIDAE	LC	Yes	X	X

Species	**Family**	**IUCN Status (IUCN, 2022)**	**Observed 2022**	**Habitat**	
				Upland	**Lower Foothills**
Rhyothemis semihyalina	LIBELLULIDAE	LC	No		
Tramea basilaris	LIBELLULIDAE	LC	No		
Tramea limbata	LIBELLULIDAE	LC	No		
Trithemis annulata	LIBELLULIDAE	LC	Yes		X
Trithemis arteriosa	LIBELLULIDAE	LC	Yes		X
Trithemis donaldsoni	LIBELLULIDAE	LC	No		
Trithemis dorsalis	LIBELLULIDAE	LC	Yes		X
Trithemis furva	LIBELLULIDAE	LC	Yes	X	
Trithemis kirbyi	LIBELLULIDAE	LC	Yes		X
Trithemis pluvialis	LIBELLULIDAE	LC	No		
Trithemis stictica	LIBELLULIDAE	LC	Yes	X	X
Zygonyx natalensis	LIBELLULIDAE	LC	No		
Zygonyx torridus	LIBELLULIDAE	LC	Yes		X
Phyllomacromia picta	MACROMIIDAE	LC	Yes		X
Phyllomacromia contumax	MACROMIIDAE	LC	No		
Allocnemis leucosticta	PLATYCNEMIDIDAE	LC	Yes	X	
Elattoneura glauca	PLATYCNEMIDIDAE	LC	Yes	X	X
Mesocnemis singularis	PLATYCNEMIDIDAE	LC	No		
Chlorolestes tessellatus	SYNLESTIDAE	LC	Yes	X	
Chlorolestes fasciatus	SYNLESTIDAE	LC	Yes	X	

Figure 47. Key Odonata species in the upland habitats (February 2022) - *Pseudagrion caffrum, Allocnemis leucosticta, Pseudagrion spernatum* and *Notogomphus praetorius.*

5.1.4. Fish Community

Fish were sampled using dip netting and electrofishing which took place for approximately 15 minutes per selected sites. The results of the assessment as well as the expected fish community is presented Tables 21 and 22 respectively.

A single data deficient species was expected in the project area. This species represents *Amphilius natalensis* species complex (Mazungula and Chakona, 2021). *A. natalensis* is endemic to the uMngeni and Tukela river systems in KwaZulu Natal Province of South Africa. Based on its limited distribution, this species is regarded as being of conservation concern. Similarly, *A. uranoscopus* has also been indicated to be a species complex and therefore is regarded as being of conservation concern. Two other vulnerable species are expected in the reaches included *Oreochromis mossambicus* and *Labeo rubromaculatus*.

The species observed in the study corroborated the results of the habitat and invertebrate assessments where sensitive species were observed in the upland sample points. The sensitive species included *Amphilius uranoscopus* a rheophilic species, with benthopelagic fish such as *Enteromius* cf. *anoplus* present in the upland systems. It is noted that the *E.* cf *anolplus* is also expected to be within a species complex and therefore is regarded as of conservation concern.

Table 21. Fish species observed in February 2022.

Species	Photo	Sample Point
Amphilius uranoscopus		EN1, EN2
Clarias gariepinus		T9, R3, R4
Enteromius cf. anoplus		EN2, T8B. T12. T11
Enteromius paludinosus		T9, R4

Species	Photo	Sample Point
Pseudocrenilabrus philander		T9, R4, T11
Tilapia sparrmanii		T9, EN2, T11

Table 22. Expected native fish species in the Upper Tugela River system (DWS, 2014 and Skelton, 2001).

Species	IUCN Status (IUCN, 2022)	Observed in Survey
Anguilla mossambica	Least Concern	No
Amphilius uranoscopus	-	Yes
Amphilius natalensis	Data Deficient (LC (SANBI, 2022))	No
Labeobarbus natalensis	Least Concern	No
Enteromius viviparus	Least Concern	No
Enteromius cf. anoplus	-	Yes
Enteromius palidus	Least Concern	No
Enteromius paludinosus	Least Concern	Yes
Labeo rubromaculatus	Vulnerable	No
Oreochromis mossambicus	Vulnerable	No
Pseudocrenilabrus philander	Least Concern	Yes

Species	IUCN Status (IUCN, 2022)	Observed in Survey
Coptodon rendalli	Least Concern	No
Clarias gariepinus	Least Concern	Yes
Tilapia sparrmanii	Least Concern	Yes

5.1.5. Overall PES

The results of the ecostatus classification for the various river system HGM units are presented in Table 23.

Table 23. Present Ecological Status for the considered river reaches (February 2022).

Unit	MIRAI Score	Riparian Condition	PES Score	PES Category
R01	83	74	71	C/B
R02	68	65	66	C
R03	55	65	60	C/D
R04	64	74	69	C
R05	53	63	58	C/D
R06	57	71	64	C
R07	53	70	62	C
R08	64	79	72	C
R09	54	72	63	C
R10	No Access	No Access	No Access	
R11	73	78	75	C
R12	56	71	64	C
R13	55	73	64	C
R14	No Access	No Access	No Access	
R15	52	52	52	D
R16	55	64	59	C/D
R17	36	44	40	D/E
R18	No Access	No Access	No Access	

5.2. Wetland PES

The results of the wetland PES assessment are summarised in Table 24. The PES of the wetlands ranged from Class A/B indicating near natural condition with limited impacts to PES Class D/E and F indicating large/serious/ critical modification and poor condition. The good condition wetlands were typically confined to the higher lying areas on the mountain plateau with the more impacted wetlands occurring at lower elevations in the foothills where agricultural and residential land uses are more abundant and extensive. Where human impacts to wetlands were apparent in the higher lying areas, these were because of overgrazing and the resultant direct disturbance impacts and/or indirect localised erosion and sedimentation impacts, or invasion by Black Wattle. In the lower lying areas, the prominent impacts were overgrazing and associated erosion impacts, as well as agricultural dams and road crossings. There was also evidence of historical cultivation and associated agricultural drains in some of the wetlands.

Table 24. Wetland PES Summary.

Wetland Unit	Overall PES Class	Description
SW1a	A/B	Near-natural condition, low impact
SW1b	C	Fair condition, moderately modified
SW2a	A/B	Near-natural condition, low impact
SW2b	C	Fair condition, moderately modified
SW2c	D/E	Poor condition, largely to seriously modified
SW3a	A/B	Near-natural condition, low impact
SW3b	C	Fair condition, moderately modified
SW3c	D/E	Poor condition, largely to seriously modified
SW4a	A/B	Near-natural condition, low impact
SW4b	C	Fair condition, moderately modified
SW4c	D/E	Poor condition, largely to seriously modified
SW5a	A/B	Near-natural condition, low impact
SW5b	D/E	Poor condition, largely to seriously modified
SW6	A/B	Near-natural condition, low impact
CVB1	A/B	Near-natural condition, low impact
CVB2a	A/B	Near-natural condition, low impact
CVB2b	D/E	Poor condition, largely to seriously modified

Wetland Unit	Overall PES Class	Description
CVB3a	C	Fair condition, moderately modified
CVB3b	D/E	Poor condition, largely to seriously modified
CVB3c	F	Very poor condition, critically modified
UCVB1	A/B	Near-natural condition, low impact
UCVB2	D/E	Poor condition, largely to seriously modified
UCVB3	D/E	Poor condition, largely to seriously modified
DW1	A/B	Near-natural condition, low impact
DW2a	A/B	Near-natural condition, low impact
DW2b	D/E	Poor condition, largely to seriously modified
DW3	A/B	Near-natural condition, low impact
DW4	A/B	Near-natural condition, low impact

6. Ecological Importance & Sensitivity (EIS) Assessment

6.1. River EIS

The results of the EIS for the river systems are provided in Table 25 for upland systems and Table 26 for the lower foothill rivers. The watercourses considered in this study were noted to be within a National Freshwater Ecosystem Priority Area for the listed fish species. The river and wetland EIS maps are shown in Figures 48 and 49 below.

Table 25. River EIS results for the Mountain Headwater Streams, Mountain Streams and Upper Foothills Rivers.

Biological determinants	
Determinant	**Rating**
Rare and endangered biota	4

Biological determinants	
Determinant	**Rating**
Unique biota	3
Intolerant biota	4
Species richness	2
Habitat determinants	
Diversity of aquatic habitat	3
Refuge value of habitat types	2
Sensitivity of habitat to flow modification	3
Sensitivity to flow related water quality changes	3
Migration route corridor for instream and riparian biota	1
National parks and wilderness areas	1
Mean	2.6
EIS class	**High**

Table 26. River EIS results for Lower Foothills.

Biological determinants	
Determinant	**Rating**
Rare and endangered biota	4
Unique biota	3
Intolerant biota	3
Species richness	3
Habitat determinants	
Diversity of aquatic habitat	3
Refuge value of habitat types	3
Sensitivity of habitat to flow modification	2
Sensitivity to flow related water quality changes	2
Migration route corridor for instream and riparian biota	3
National parks and wilderness areas	1
Mean	2.7
EIS class	**High**

6.2. Wetland EIS

6.2.1. Ecosystem Services Assessment

The results of the WET-Ecoservices assessment are summarised in Table 27. Most of the wetlands assessed were of high to very high importance owing to being important in terms of biodiversity maintenance and the provision of regulating services. Most of the wetlands on mountainous plateau are in a good condition with only moderate grazing impacts and thus are good examples of critically endangered and endangered wetland types. Most of the permanent wetlands in a good condition are also important in terms of streamflow regulation, carbon storage and water supply for use. Only the seriously to critically degraded wetlands at the lower elevations along the powerline routes were assessed as being less important i.e. providing services of low to moderately-low importance, although many impacted wetlands are still assessed as being of moderate importance for regulating services.

Table 27. Summary of the outputs of the WET-EcoServices assessment for wetland units.

Wetland Unit	Importance Rating	Key Service
SW1a	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (H), Carbon Storage (MH), Water for Human Use (MH)
SW1b	High	Biodiversity Maintenance (H), Streamflow Regulation (H), Carbon Storage (MH), Water for Human Use (MH)
SW2a	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (H), Carbon Storage (MH), Water for Human Use (MH)
SW2b	High	Biodiversity Maintenance (H), Streamflow Regulation (H), Carbon Storage (MH), Water for Human Use (MH)
SW2c	Moderately High	Streamflow Regulation (MH), Biodiversity Maintenance (M), Water for Human Use (M)
SW3a	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (MH), Carbon Storage (M)
SW3b	High	Biodiversity Maintenance (H), Streamflow Regulation (MH), Carbon Storage (M)
SW3c	Moderate	Biodiversity Maintenance (M), Streamflow Regulation (M)
SW4a	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (MH), Carbon Storage (M)
SW4b	High	Biodiversity Maintenance (H), Streamflow Regulation (MH), Carbon Storage (M)
SW4c	Moderate	Biodiversity Maintenance (M)
SW5a	High	Biodiversity Maintenance (H)
SW5b	Moderately Low	Sediment Trapping (ML), Phosphate Removal (ML), Toxicant Removal (ML)
SW6	High	Biodiversity Maintenance (H)

Wetland Unit	Importance Rating	Key Service
CVB1	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (MH), Carbon Storage (M), Water for Human Use (M)
CVB2a	High	Biodiversity Maintenance (H), Streamflow Regulation (MH)
CVB2b	Moderate	Sediment Trapping (M), Phosphate Removal (M)
CVB3a	Moderately High	Streamflow Regulation (MH), Sediment Trapping (MH), Phosphate Removal (MH), Biodiversity Maintenance (MH), Nitrate Removal (M), Toxicant Removal (M), Carbon Storage (M)
CVB3b	Moderate	Sediment Trapping (M), Phosphate Removal (M), Toxicant Removal (M)
CVB3c	Moderately Low	Streamflow Regulation (ML), Sediment Trapping (ML), Phosphate Removal (ML)
UCVB1	Very High	Biodiversity Maintenance (VH), Streamflow Regulation (H), Carbon Storage (MH), Water for Human Use (MH)
UCVB2	Moderately High	Streamflow Regulation (MH), Sediment Trapping (M), Phosphate Removal (M) Nitrate Removal (M), Toxicant Removal (M), Carbon Storage (M)
UCVB3	Very High	Sediment Trapping (VH), Streamflow Regulation (MH), Phosphate Removal (M)
DW1	Very High	Biodiversity Maintenance (VH), Carbon Storage (MH), Water for Human Use (MH)
DW2a	High	Biodiversity Maintenance (H), Carbon Storage (M)
DW2b	Moderately Low	Biodiversity Maintenance (ML)
DW3	High	Biodiversity Maintenance (H)
DW4	High	Biodiversity Maintenance (H)

6.2.2. Overall Wetland EIS

A summary of the wetland EIS scores and ratings is provided in Table 28. The river and wetland EIS maps are shown in Figures 48 and 49 below.

Table 28. Summary of EIS scores and overall EIS rating for the wetland units.

Units	BI*	FI*	SCI*	EIS
SW1a	Very High	High	Moderately High	**Very High**
SW1b	High	High	Moderately High	**High**
SW2a	Very High	High	Moderately Low	**Very High**
SW2b	High	High	Moderately High	**High**
SW2c	Moderate	Moderately High	Moderate	**Moderately High**
SW3a	Very High	Moderately High	Moderately Low	**Very High**

Units	BI*	FI*	SCI*	EIS
SW3b	High	Moderately High	Moderately Low	**High**
SW3c	Moderate	Moderate	Moderately Low	**Moderate**
SW4a	Very High	Moderately High	Moderately Low	**Very High**
SW4b	High	Moderately High	Moderately Low	**High**
SW4c	Moderate	Moderate	Moderately Low	**Moderate**
SW5a	High	Moderately Low	Moderately Low	**High**
SW5b	Low	Moderately Low	Low	**Moderately Low**
SW6	High	Moderately Low	Moderately Low	**High**
CVB1	Very High	Moderately High	Moderate	**Very High**
CVB2a	High	Moderately High	Moderately Low	**High**
CVB2b	Moderately Low	Moderate	Low	**Moderate**
CVB3a	Moderately High	Moderately High	Low	**Moderately High**
CVB3b	Low	Moderate	Low	**Moderate**
CVB3c	Low	Moderately Low	Moderately Low	**Moderately Low**
UCVB1	Very High	High	Moderately High	**Very High**
UCVB2	Moderately Low	Moderately High	Low	**Moderately High**
UCVB3	Moderately Low	Very High	Low	**Very High**
DW1	Very High	Moderately High	Low	**Very High**
DW2a	High	Moderate	Moderately Low	**High**
DW2b	Moderately Low	Low	Moderately Low	**Moderately Low**
DW3	High	Low	Moderately Low	**High**
DW4	High	Low	Moderately Low	**High**

*BI - biodiversity importance, FI – functional importance, SCI – socio-cultural importance

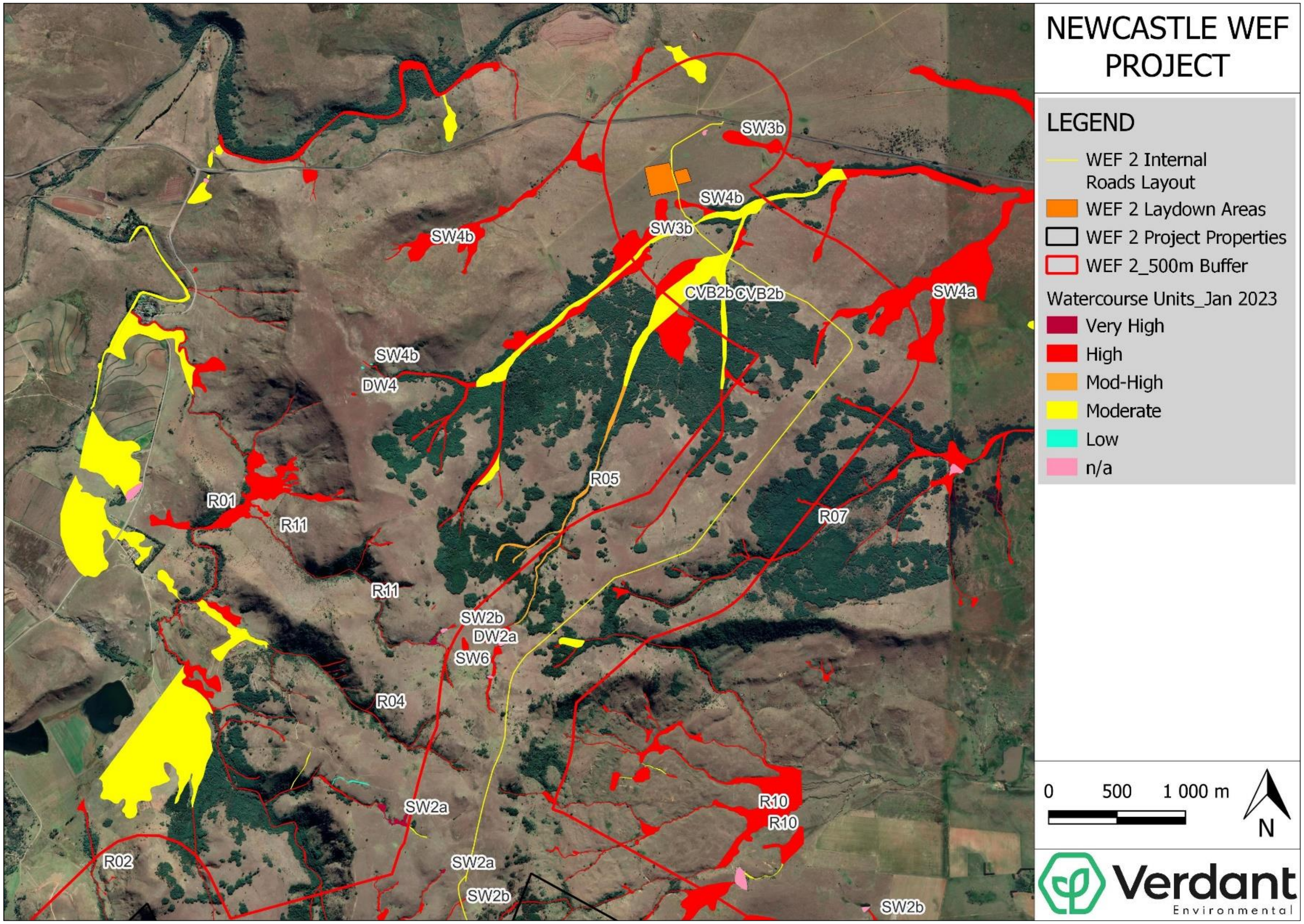

Figure 48. EIS Map – north.

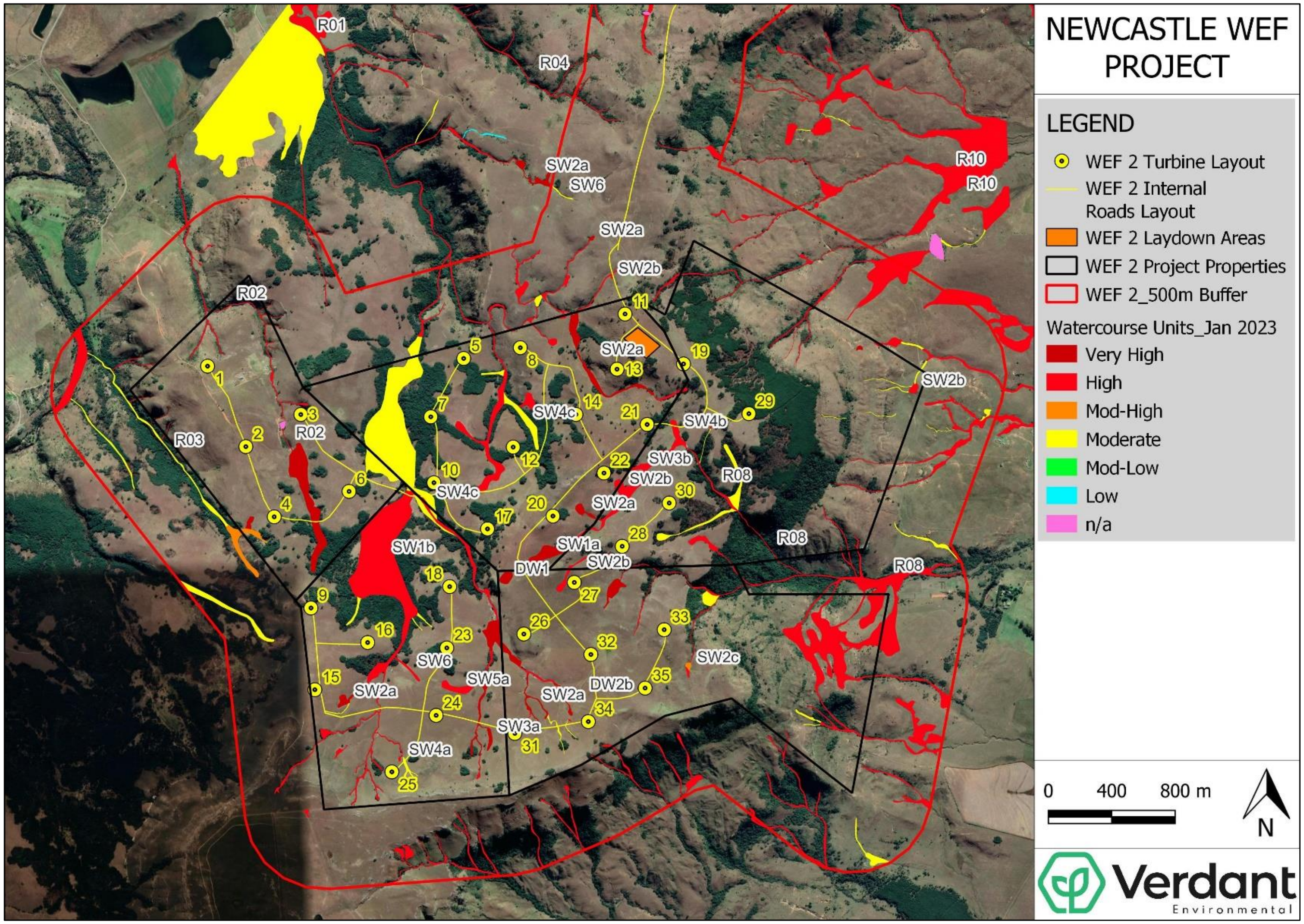

Figure 49. EIS map – south.

7. Recommended Mitigation Measures

This section outlines the mitigation measures recommended to avoid, reduce / minimise, and rehabilitate the freshwater ecosystem impacts discussed in **Section 8** that follows this section.

'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on freshwater ecosystems is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected.

7.1. Project Planning and Design Measures

7.1.1. River and Wetland Buffer Zones

'Buffer zones' (also termed development "set-backs") are essentially strips of vegetated undeveloped land typically designed to act as a protective barrier between human activities and sensitive habitats such as wetlands, rivers and forests. Research shows that buffer zones are useful at performing a wide range of functions such as sediment trapping and nutrient retention, and in doing so, play an important role in protecting water resources from the adverse impacts that are typically associated with various land-uses and developments. Although there are no legislative requirements regarding the establishment of buffers around water resources in the South African legislation, the application of buffers is aligned with the principles of the National Water Act (1998), which is to provide for the sustaining of water quality and preserving natural aquatic habitats and ecosystem functions.

According to the draft Guidelines for Biodiversity Impact Assessment in KZN (EKZNW, 2011), a standard buffer width of 30m from the outer edge of the delineated wetland areas in the Province of KZN, often irrespective of site conditions and development/land use type. The guideline document goes on to recommend that the determination of ecological buffers should rather be based on a number of site-specific factors. A national protocol for buffer determination around rivers, wetlands and estuaries has recently been developed (Macfarlane & Bredin, 2016) and represents emerging best-practice in aquatic buffer zone determination.

The national buffer zone determination tool for wetlands and rivers (Macfarlane & Bredin, 2016) was applied for the different HGM types and used to allocate suitable buffers. Based on the buffer model outputs, **a 50m buffer zone to all watercourses is recommended**.

In addition, many of the permanent and seasonal wetlands are fed directly by springs that have formed as a result of the creation of perched saturated aquifers / water tables above impermeable geology. Any activities that interrupt these subsurface flow paths could have serious impacts on the water inputs to the wetlands. In this regard, all highly sensitive landscapes characterised by soil piping and sink hole formation must be avoided as shown in Figure 50 below.

7.1.2. No-Go Areas for Turbine and Laydown Sites

It is recommended that all turbines and laydown areas be located outside of the following features as shown in Figures 50 and 51:

- All mapped watercourses.
- 50m buffer zone to all watercourses.
- Sensitive area characterised by soil piping and sink hole formation.

According to the current plan, all turbines are located outside of the recommended 50m buffer zone, which is good environmental practice and planning.

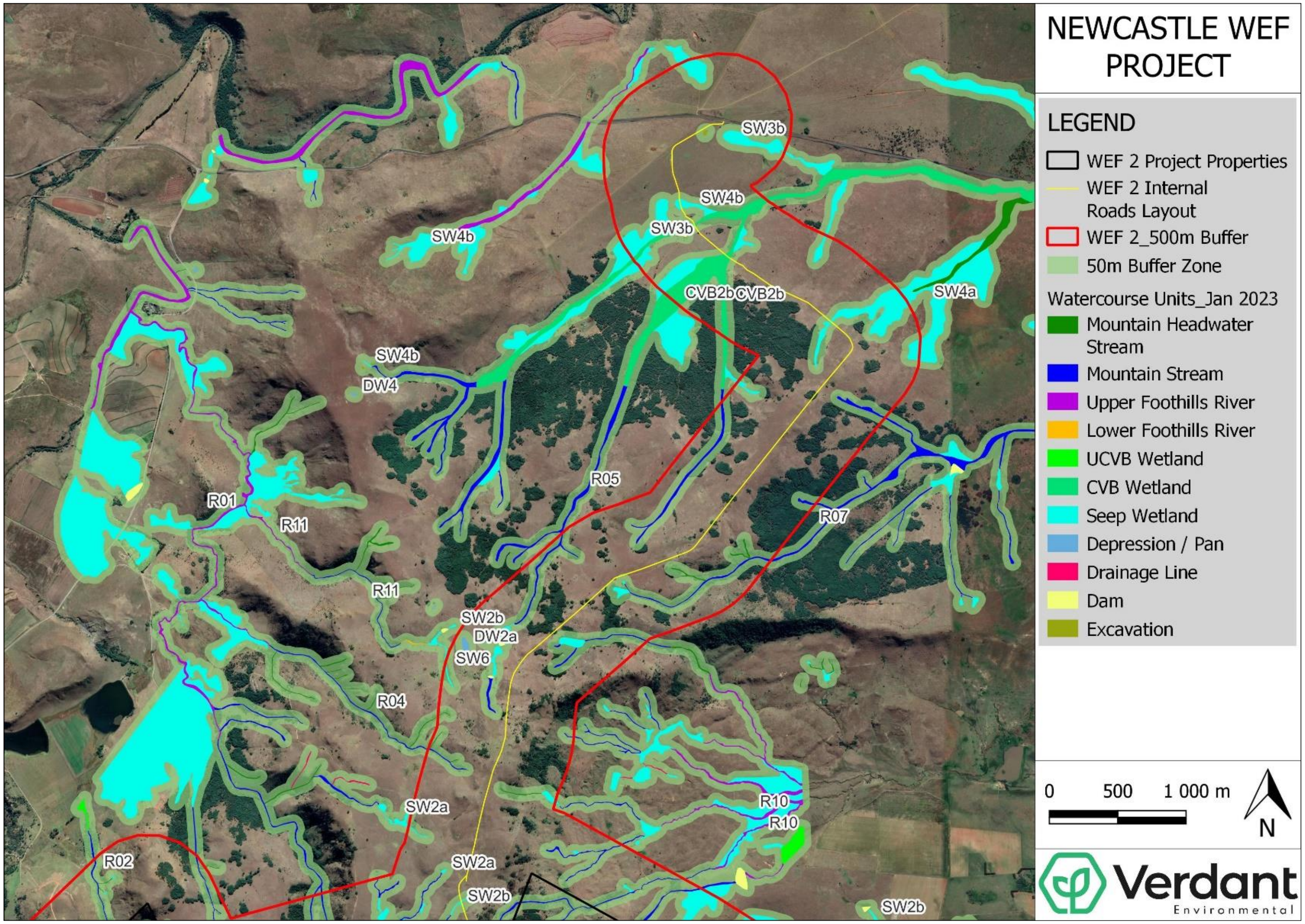

Figure 50. Location and extent of no-go areas i.e. watercourses and 50m buffer zones - north.

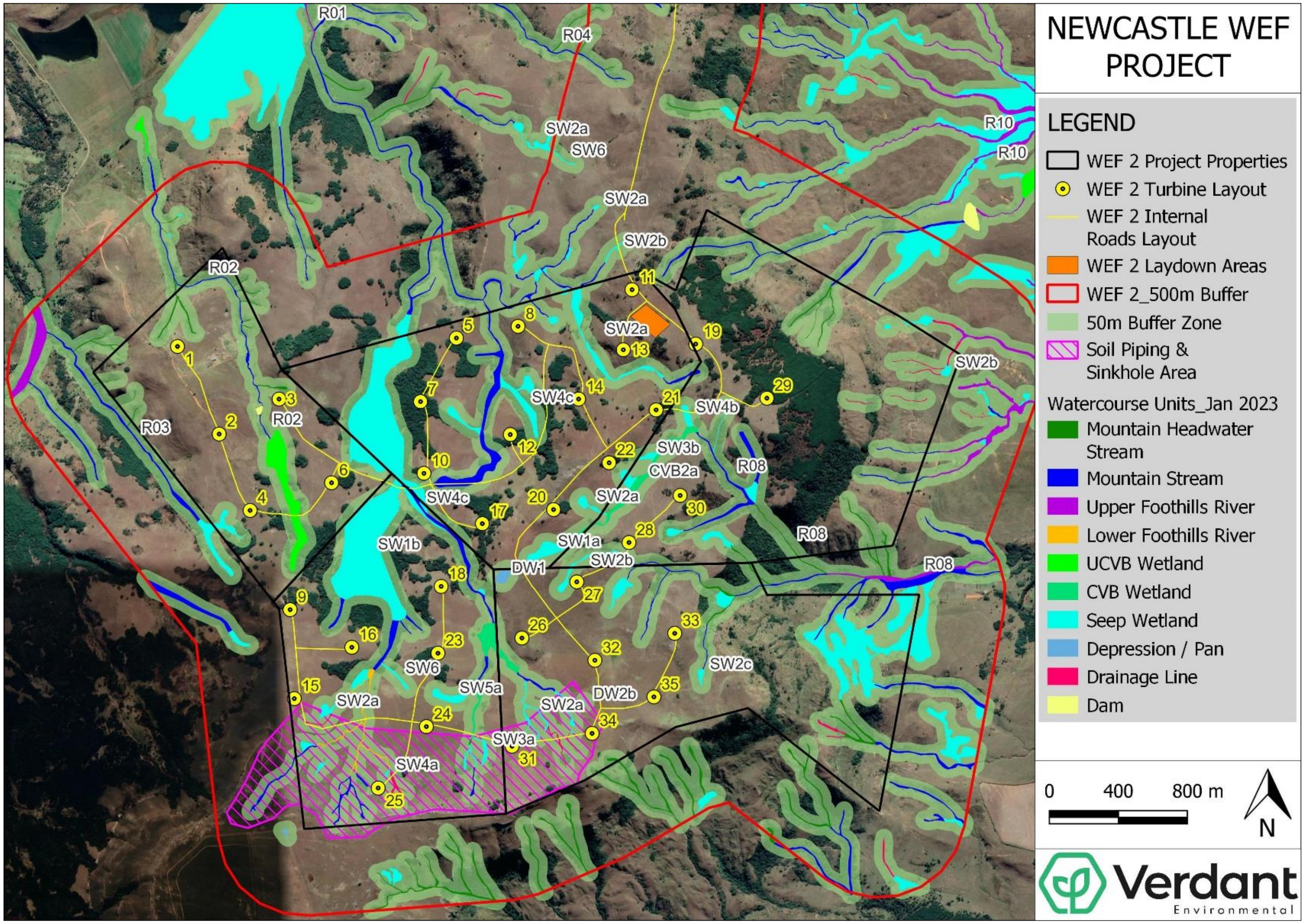

Figure 51. Location and extent of no-go areas i.e. watercourses and 50m buffer zones - south.

7.1.3. Internal Access and Haulage Road Alignment Measures

The following best practice planning and design measures should be investigated for inclusion into the internal road alignment and design:

- All service roads should follow the existing road network as far as practically possible.
- Where new service roads are aligned near wetlands and streams / rivers, a minimum buffer of 50m should be maintained between the wetland / riparian edge and the edge of the road as far as practically possible. This excludes where crossings are required.
- Where new wetland and stream / river crossings are required, every effort should be made to minimize the impacts by considering the following:
    - For all crossing types and designs, flow through road crossings should not be unnecessarily concentrated (or impeded) and flow velocity should not be increased. In this regard, wetland and stream / river crossings should be via box / portal culverts established across the entire width of the wetland or riparian zone to avoid flow narrowing and concentration. Open bottom box culverts should be used and they should be sized to transport not only water, but the other materials that might be mobilized (i.e. debris). Pipe culverts should be avoided.
    - Erosion protection and energy dissipation measures should be established at all road crossing outlets e.g. stilling basins and reno-mattresses.
    - All culvert inlets and outlets and associated outlet erosion protection structures must not be raised above the wetland/riparian surface and/or stream/river bed and must be established to reflect the natural downstream slope of the wetland / riparian surface and/or stream / river bed.
    - Crossing points should be aligned along areas or corridors of existing disturbance e.g. along existing informal road crossings or cattle crossing routes.
    - The length of wetlands and rivers / streams crossed at each crossing must be minimised by adjusting alignments to coincide with narrower sections and ensuring that crossings are straight and do not involve using long curves and are aligned at right angles to flow.
    - If any road fill is utilised at wetland crossings, a porous layer should be established within the road fill at the appropriate elevation to ensure that wetland interflow and overland flow is able to pass through the road fill.
- For existing watercourse crossings, every effort should be made to minimize the impacts by considering the following:

- Undersized or under-designed pipe culverts must be replaced with sufficiently sized box or pipe culverts.
- Erosion protection and energy dissipation measures should be established at all road crossing outlets e.g. stilling basins and reno-mattresses.
- Every effort must be made to minimise the upgraded footprint of the existing roads at watercourse crossings.

According to the current plan, 17 watercourse crossings are proposed as shown in Figures 52 - 55. A summary of the details of the watercourses to be crossed at each crossing point is provided in Table 29 below. It is important to note that Crossings 1 – 5 also form part of MNWP 1.

Table 29. Summary of details of internal road watercourses crossings.

No.	Type	Label	New or Existing
1	Seep Wetland	SW4b	Existing
2	CVB Wetland	CVB2b	Existing
3	CVB Wetland	CVB2b	New
4	Seep Wetland	SW4b	New
5	Seep Wetland	SW2b	New
6	Seep Wetland	SW4b	New
7	Seep Wetland	SW4c	New
8	Mountain Stream	-	New
9	Seep Wetland	SW4c	New
10	Seep Wetland	SW1b	New
11	UCVB Wetland	UCVB1	New
12	Seep Wetland	SW2b	New
13	Drainage Line	-	New
14	Drainage Line	-	New
15	CVB Wetland	CVB1	New
16	Drainage Line	-	New
17	Lower Foothills River	-	New

Several internal road realignments are recommended, with the following reasons provided in Table 30. The re-alignments are illustrated in Figures 56 – 62.

Table 30. Summary of details of recommended road re-alignments.

No.	Crossing No.	Reasons
1	3	Re-align along narrower section of wetland
2	5	Re-align to avoid watercourse crossing 5
3	6	Re-align to avoid watercourse crossing 6
4	12	Re-align to avoid watercourse crossing 12
5	n/a	Re-align to increase width of buffer zone
6	7, 8, 9, 10	Re-align crossing to cross impacted / less sensitive areas and avoid crossing multiple HGM units
7	11	Re-align crossing to cross impacted / less sensitive areas
8	n/a	Re-align to increase width of buffer zone

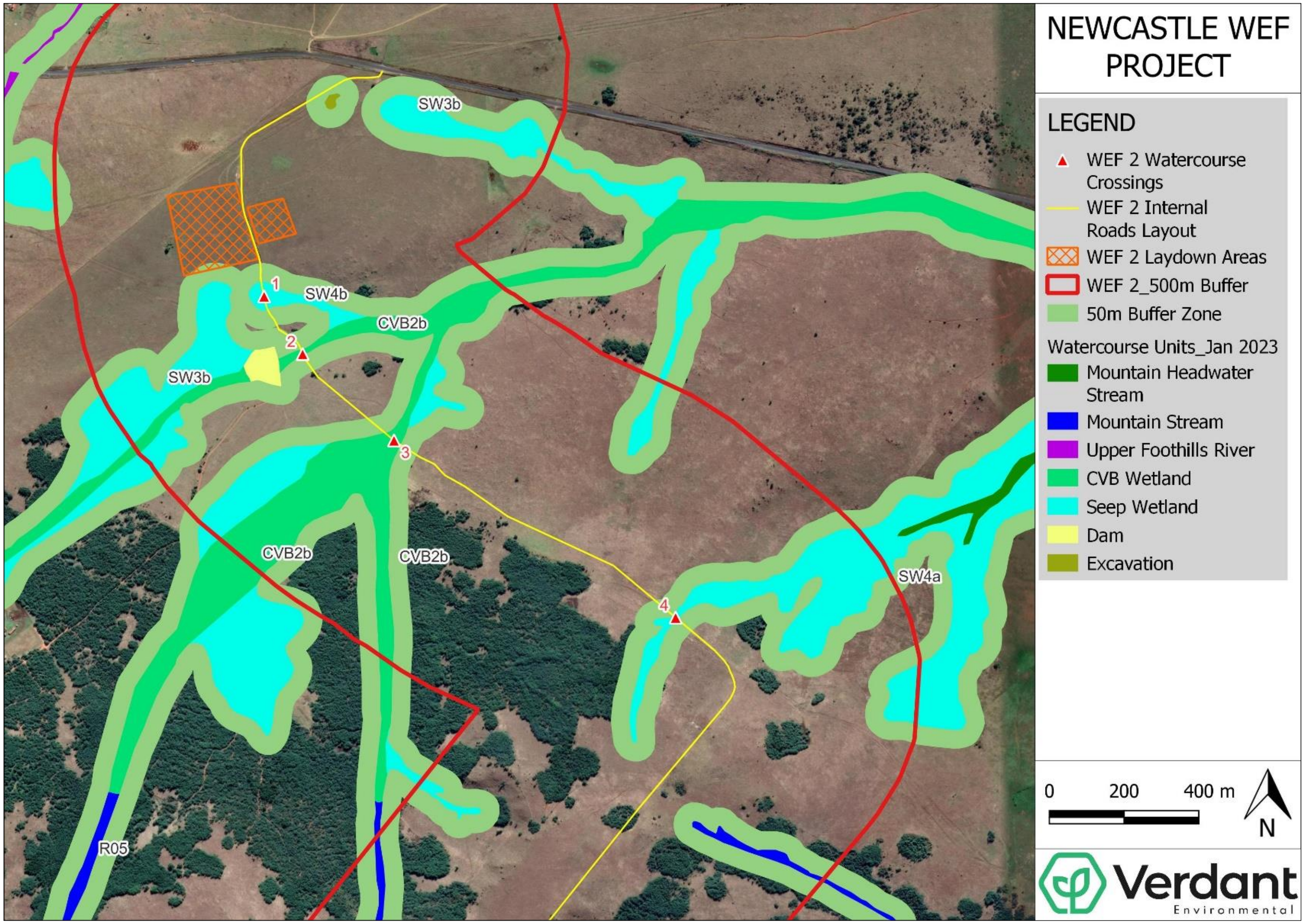

Figure 52. Proposed internal road watercourse crossings (crossing No. 1 – 4).

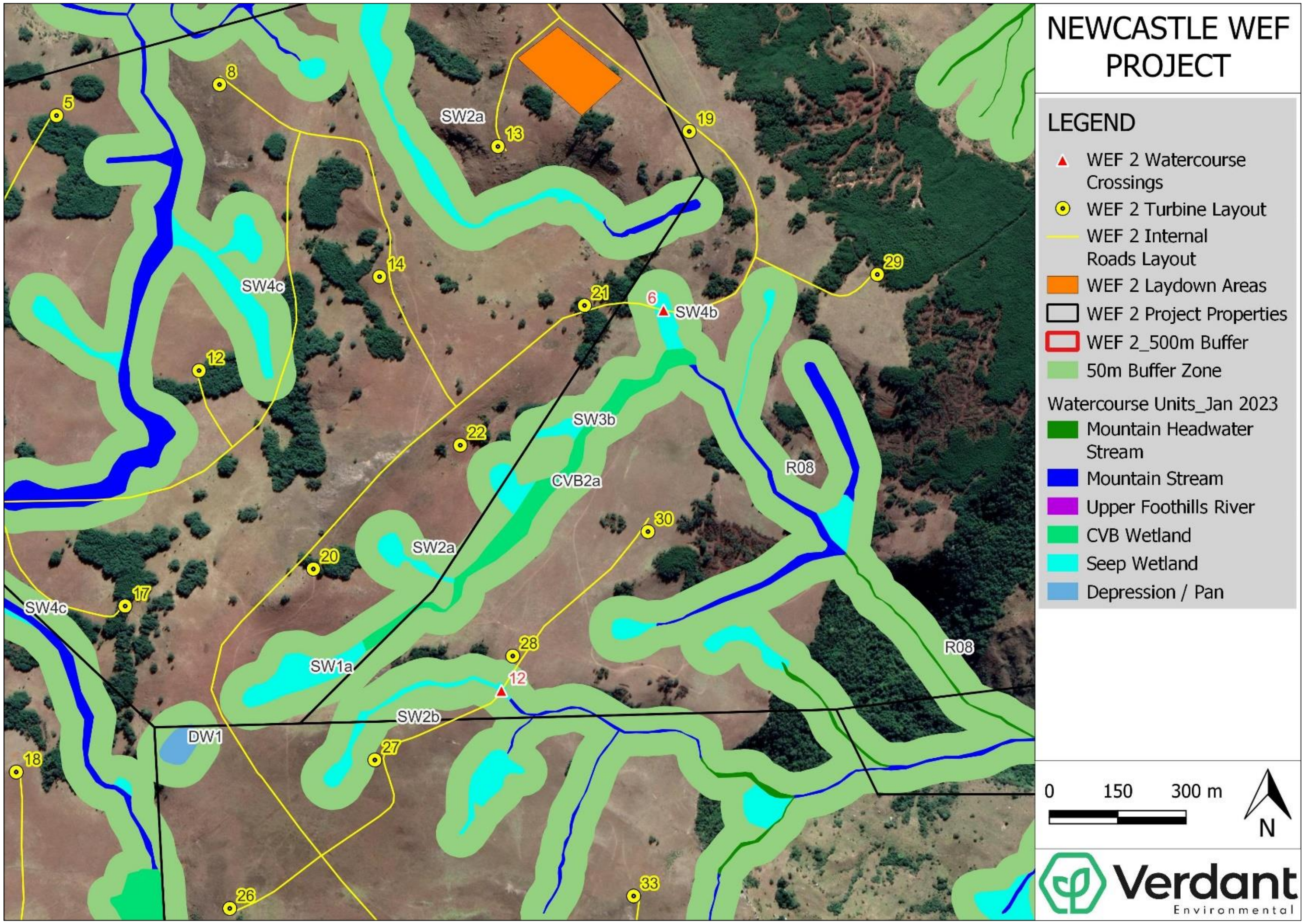

Figure 53. Proposed internal road watercourse crossings (crossing No. 6 and 12).

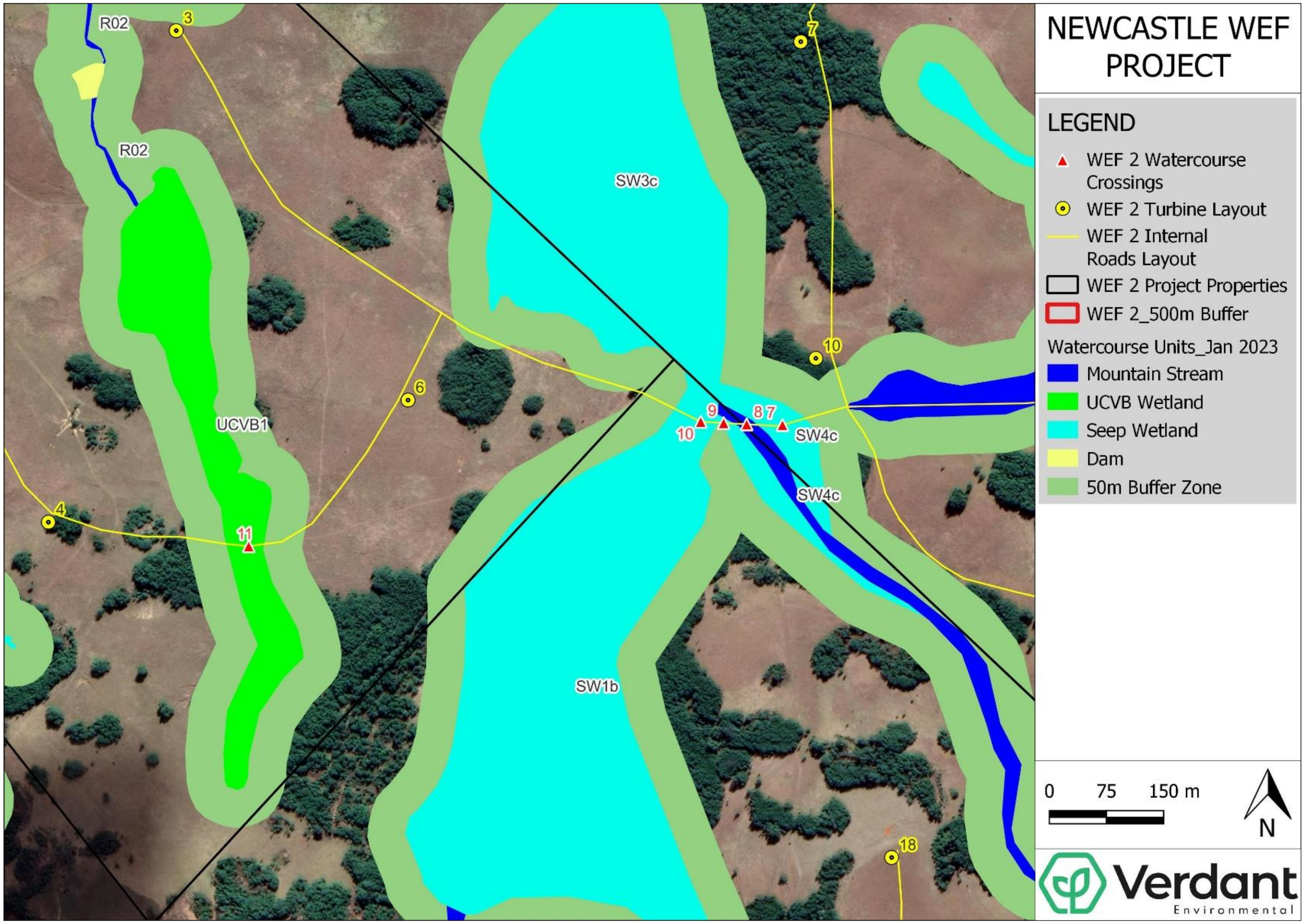

Figure 54. Proposed internal road watercourse crossings (crossing No. 7 – 11).

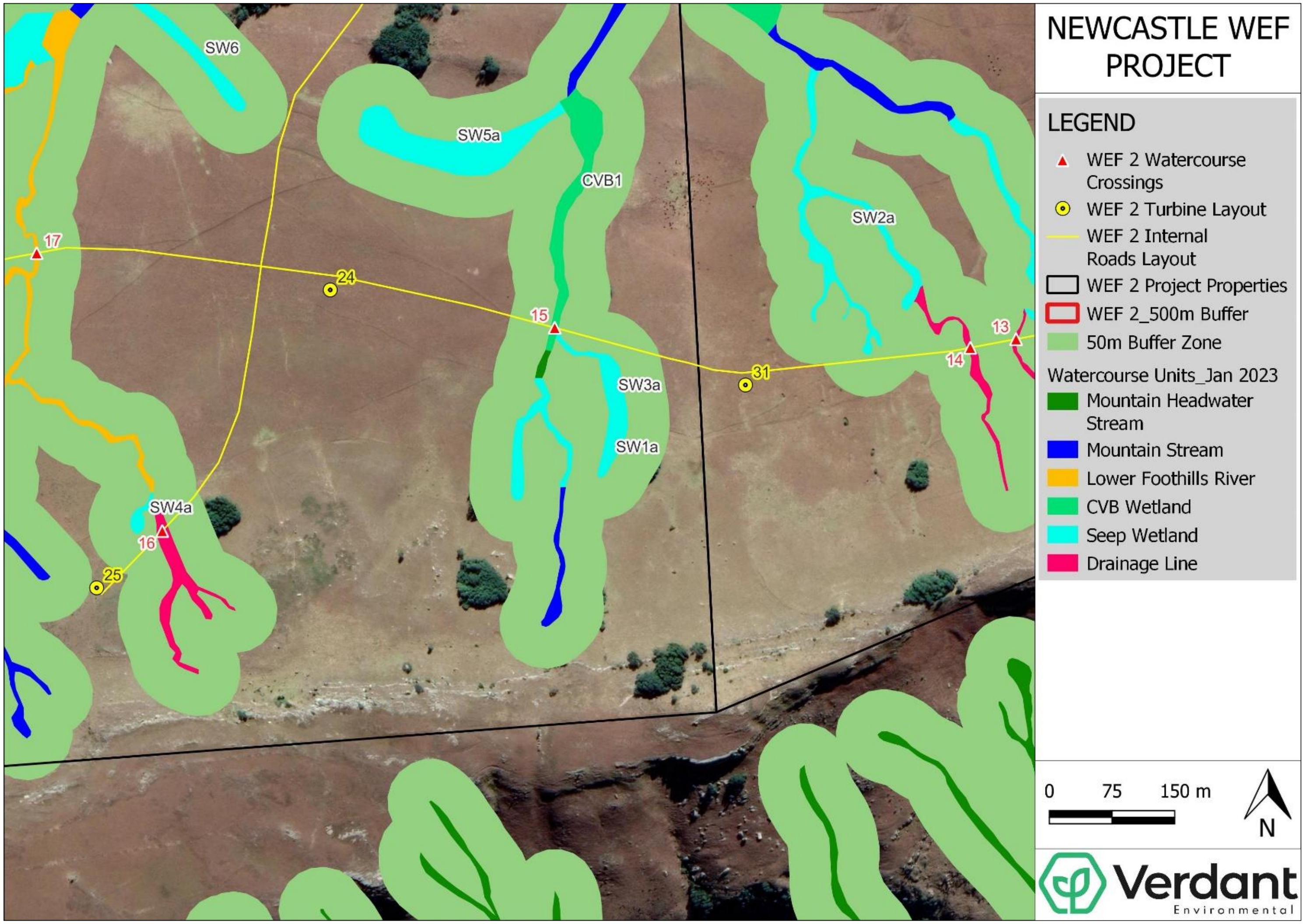

Figure 55. Proposed internal road watercourse crossings (crossing No. 13 – 17).

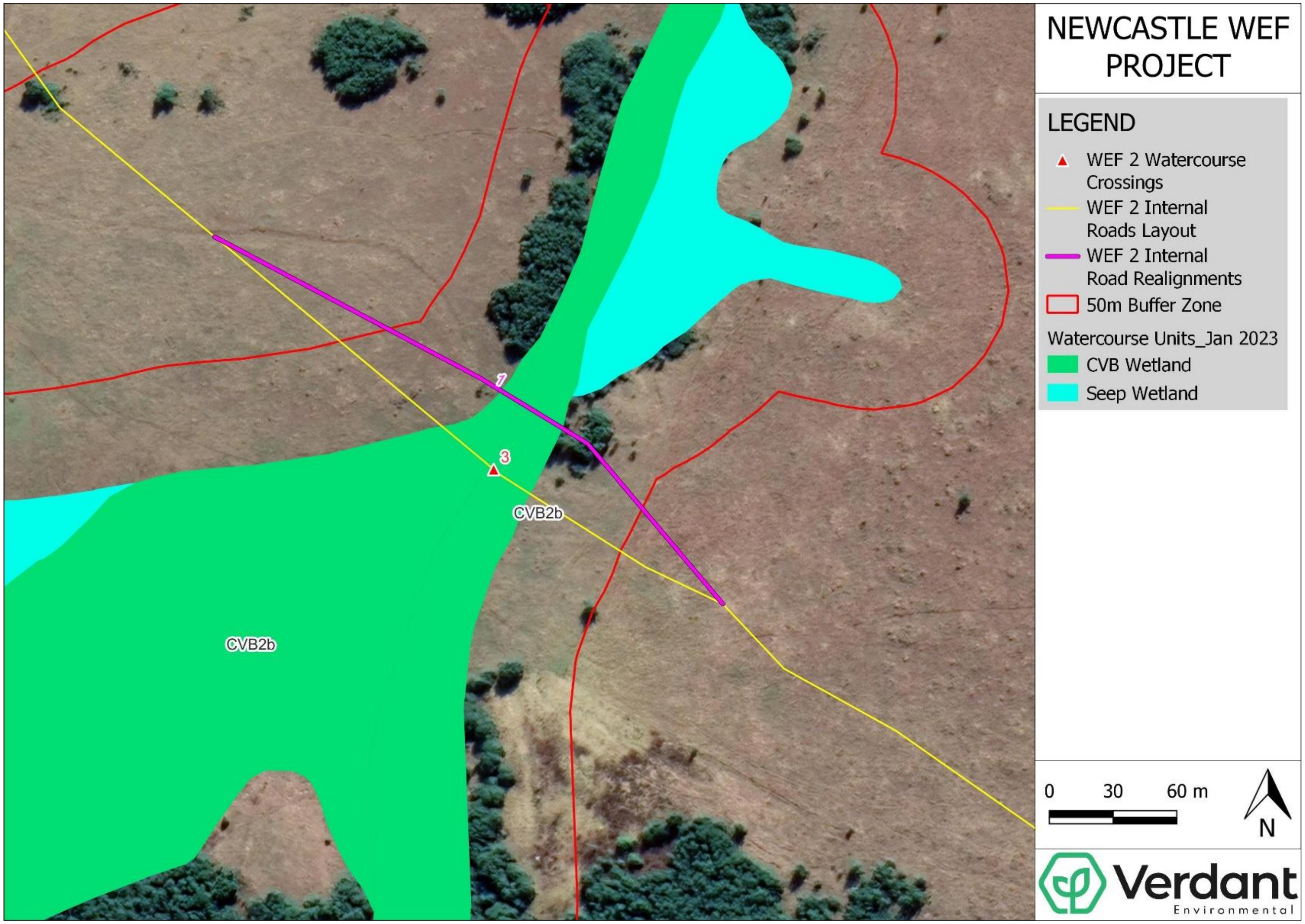

Figure 56. Recommended road re-alignment No. 1 at Crossing No. 3.

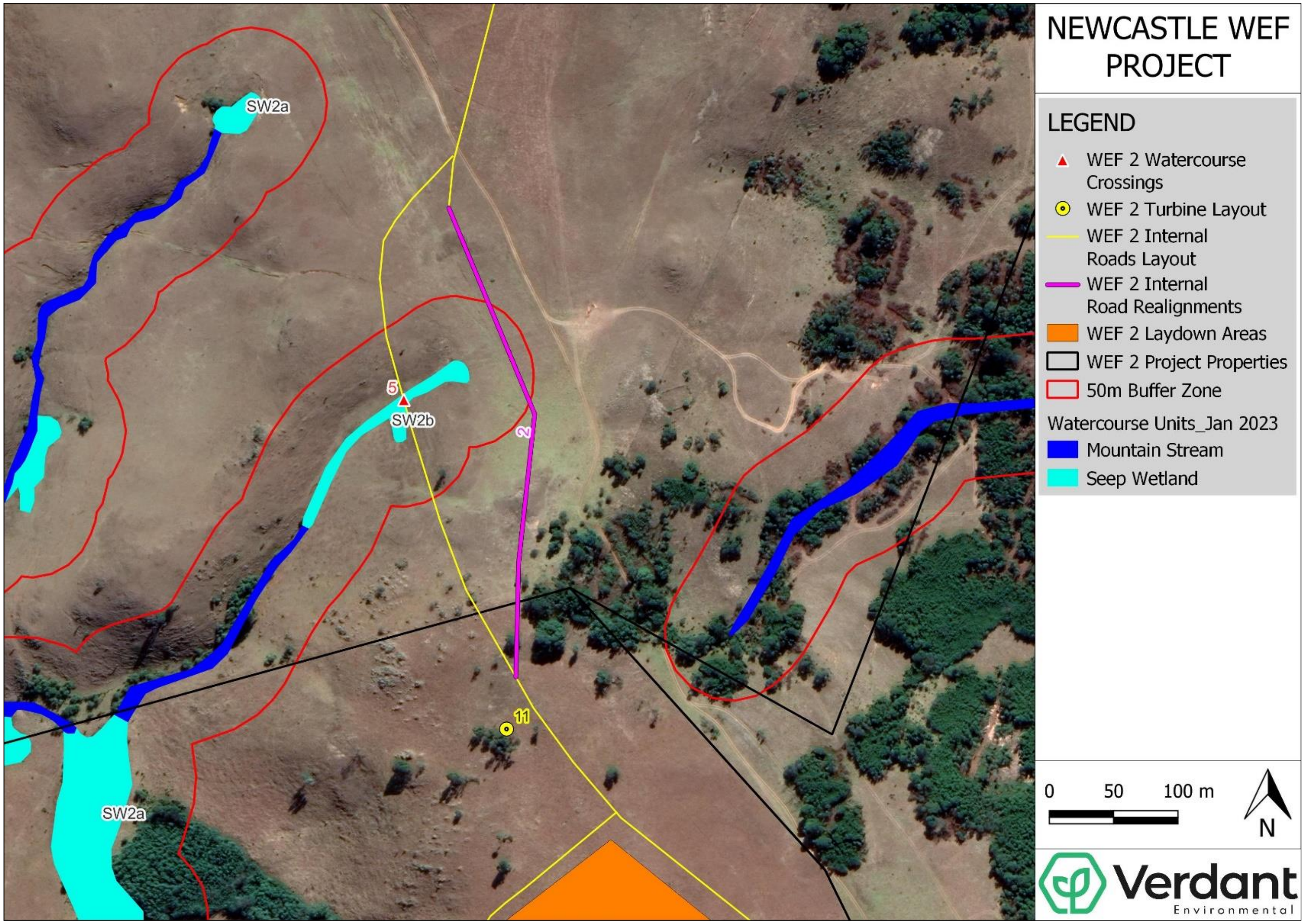

Figure 57. Recommended road re-alignment No. 2 at crossing No. 5.

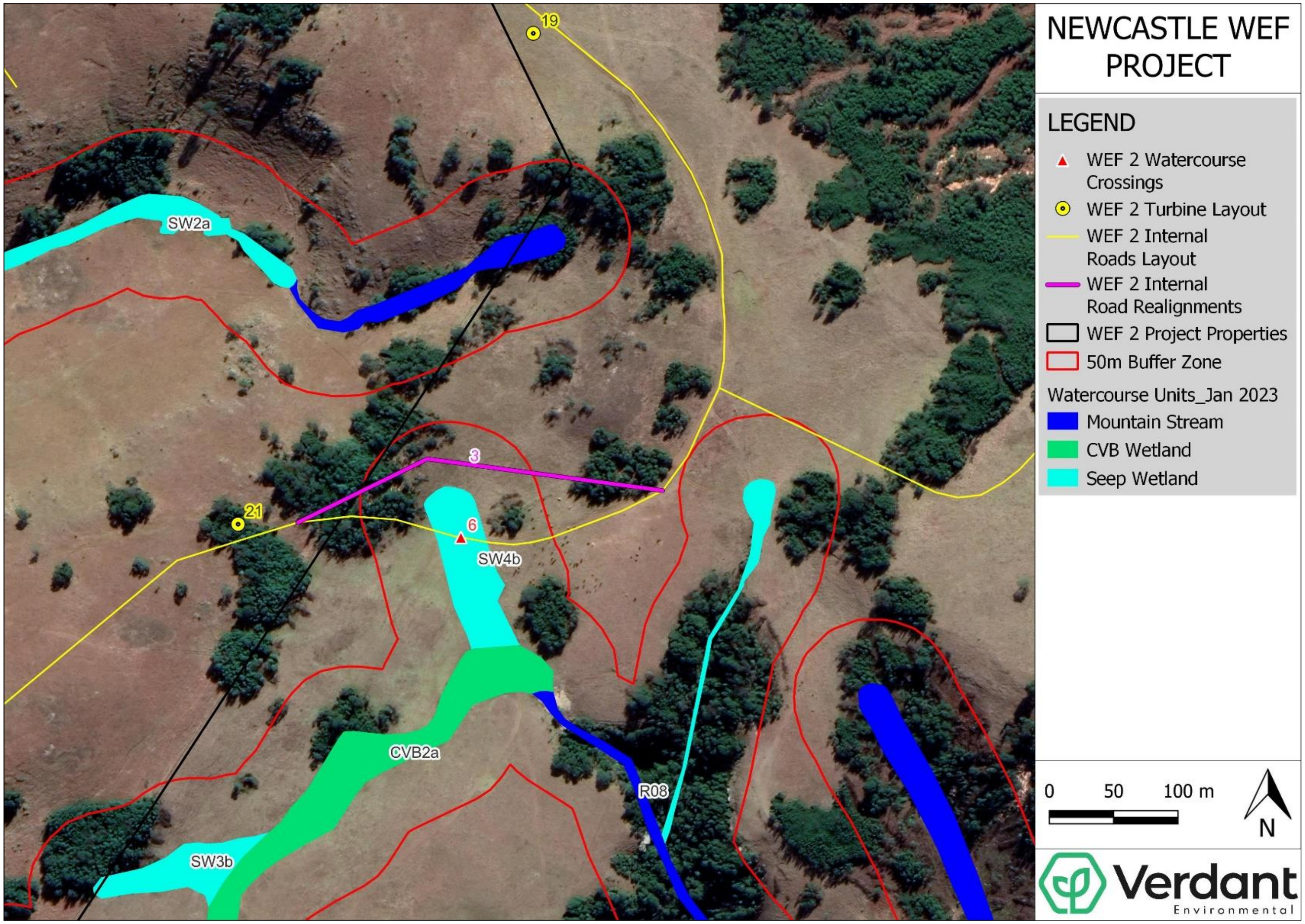

Figure 58. Recommended road re-alignment No. 3 at crossing No. 6.

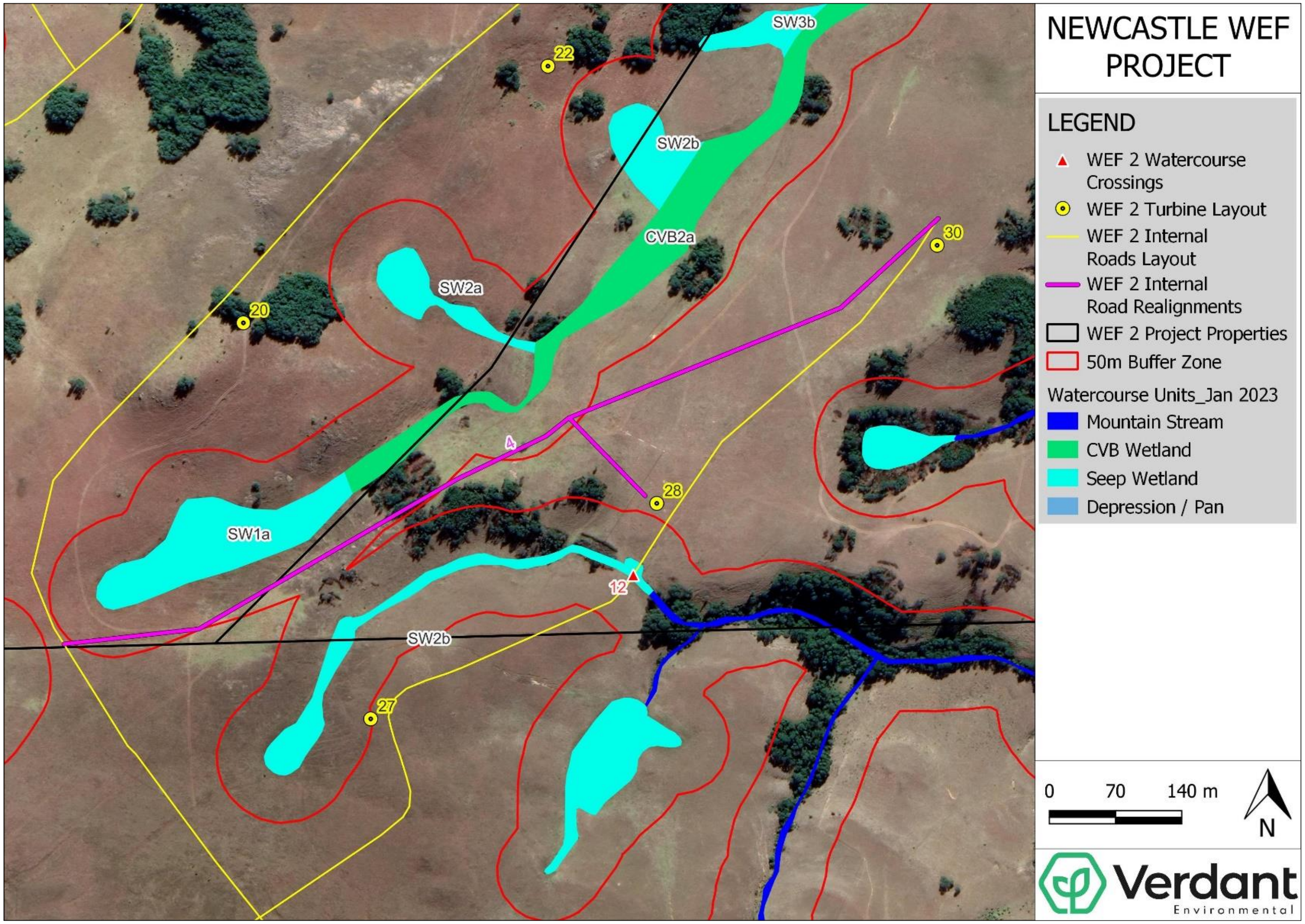

Figure 59. Recommended road re-alignment No. 4.

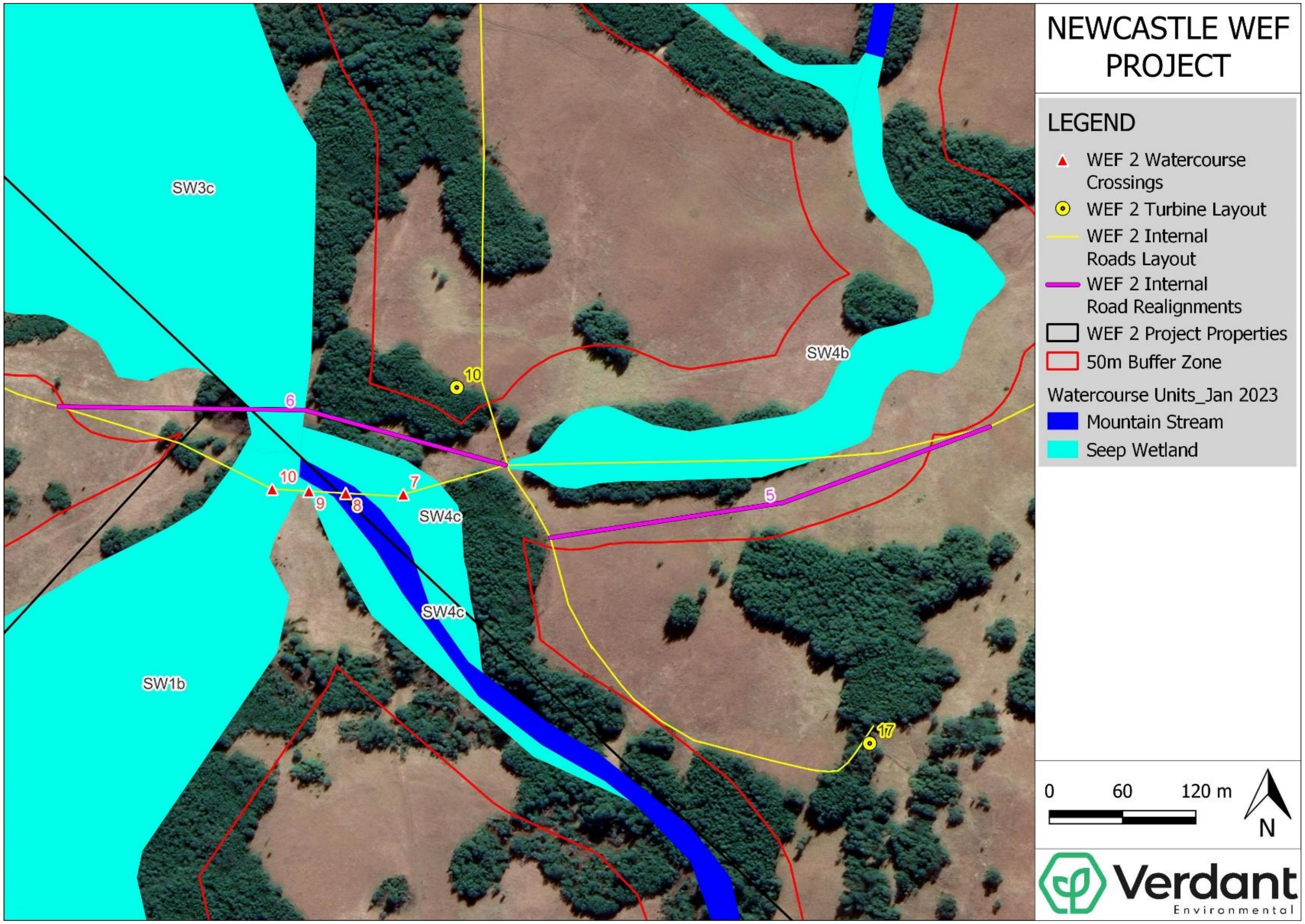

Figure 60. Recommended road re-alignment No. 5 and 6.

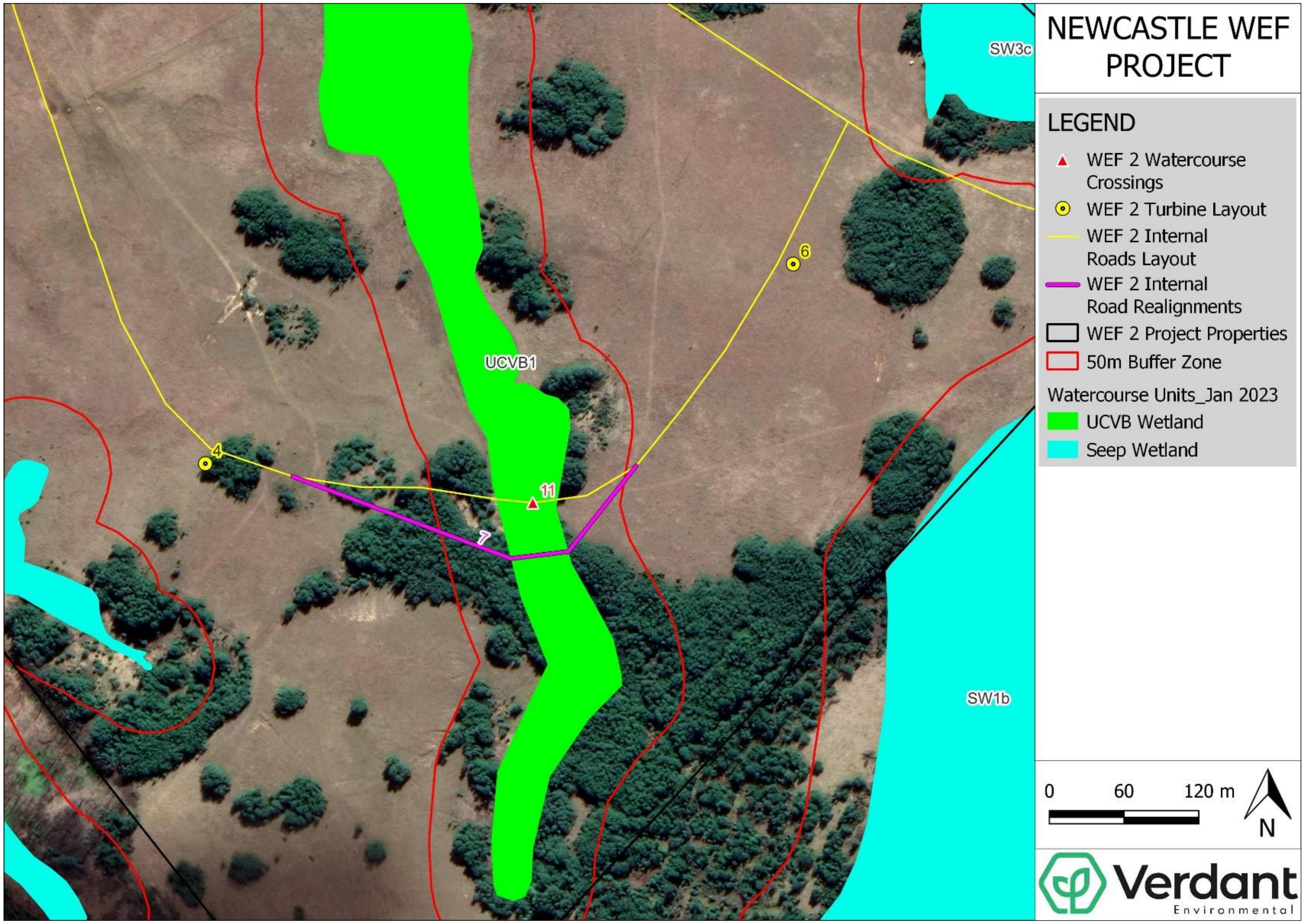

Figure 61. Recommended road re-alignment No. 7 at crossing No. 11.

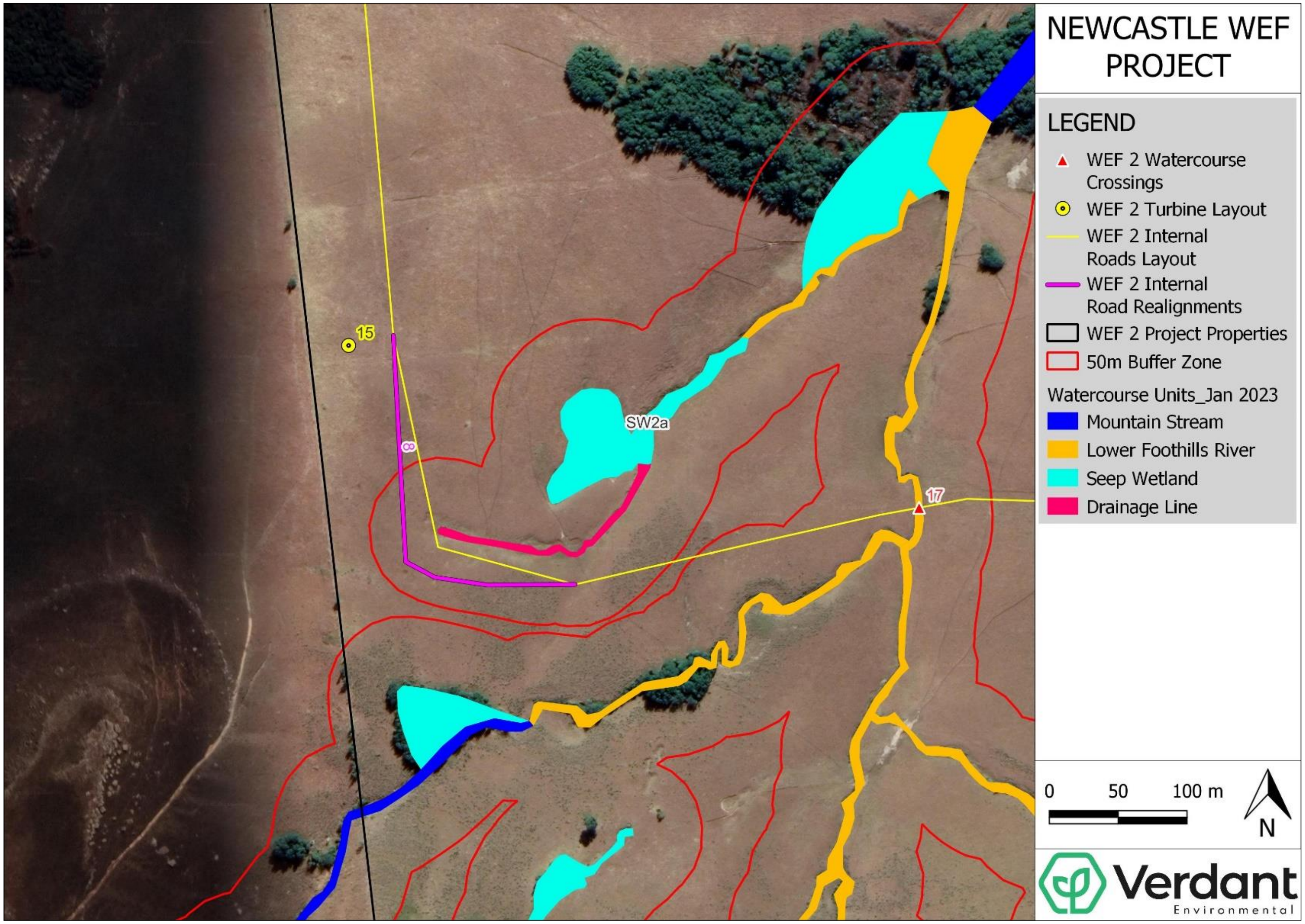

Figure 62. Recommended road re-alignment No. 8.

7.1.4. Service Road Stormwater Management

The following road stormwater management measures are recommended:

- Stormwater generated by the upgraded and new roads should be discharged at regular intervals and many small outlets should be favoured over few large.
- Stormwater outlets must not be established within wetlands or riparian zones.
- As far as practically possible, stormwater conveyance should be via open drains rather than pipes and conveyance from the road drains to the outlets should via open drains with vegetated or rough surfaces that are armoured with erosion protection.
- All outlets must be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk. In this regard, suitably designed energy for gravel roads will need to be installed at appropriate locations.
- All erosion protection measures must be established to reflect the natural slope of the surface and located at the natural ground-level.

7.1.5. Application of the Mitigation Hierarchy

The protection of water resources (wetlands & rivers/streams) begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces such impacts. Driver et al. (2011) recommend that the management of freshwater ecosystems should aim to prevent the occurrence of large-scale damaging events as well as repeated, chronic, persistent, subtle events which can in the long-term be far more damaging. This generally follows some form of 'mitigation hierarchy' (see Figure 63, below) which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology and phasing until the proposed development can best be accommodated without incurring significant negative impacts to the receiving environment.

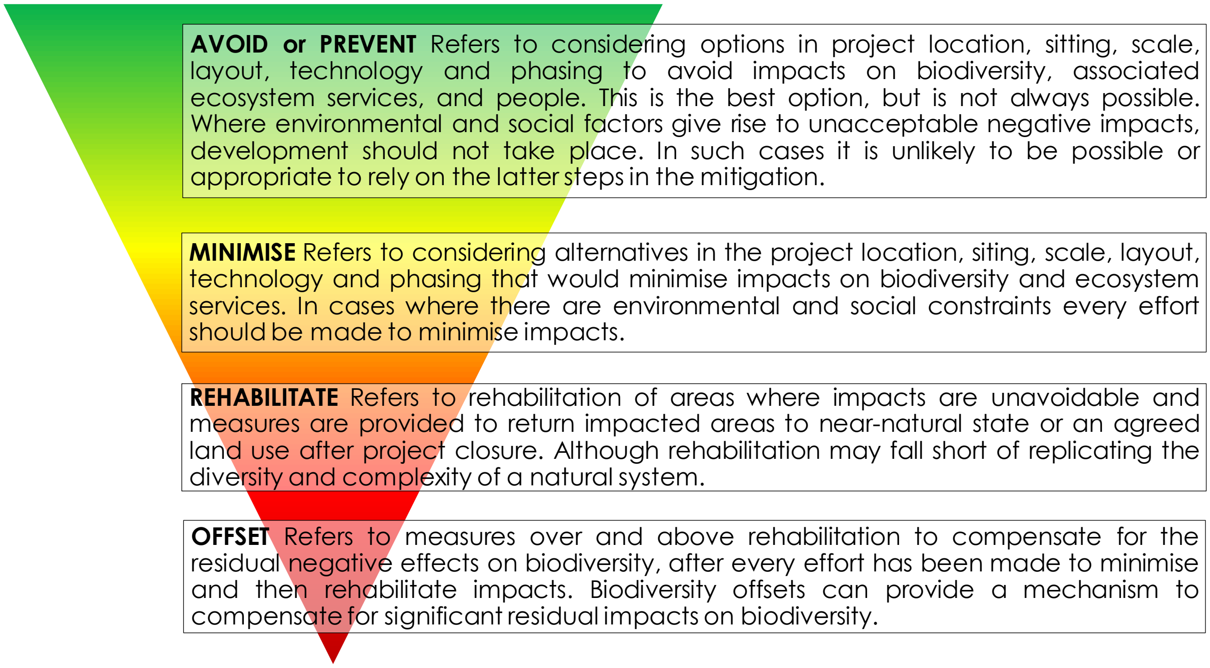

Figure 63. Diagram illustrating the 'mitigation hierarchy' (Eco-Pulse, 2019; DEA *et al*., 2013).

Site Layout Planning:

The mitigation hierarchy must be followed in the development of the project planning and design. To assist with guiding this process, following planning measures are listed in chronological order of investigation in line with the mitigation hierarchy:

Step 1: Avoidance:

- Adhere to all the planning and design recommendations provided in Section 7.1.

Step 2: Minimisation:

- Implement best practice controls and mitigation measures during the construction and operational phases.

Step 3: Remediation:

- Any planned and/or accidental watercourse disturbance should be mitigated through onsite rehabilitation.

Step 4: Offset:

- Not applicable to this project.

7.2. Construction Phase

The following mitigation measures must be implemented in conjunction with any generic measures provided in the Environmental Management Programme (EMPr).

7.2.1. Demarcation of ‘No-Go’ areas and construction corridors

- For all watercourses occurring within 50m of the development activities (e.g. turbine sites, access roads, powerline pylons, etc.), the outer edge of the 50m buffer zone to such watercourses must be staked out by a surveyor and demarcated using brightly coloured shade cloth. This must be completed and approved prior to the commencement of any construction activities.
- For all watercourses where activities encroach within the watercourses or buffer zones, the outer edge of the watercourses and/or remaining buffer zone must be staked out by a surveyor and demarcated using brightly coloured shade cloth. This must be completed and approved prior to the commencement of any construction activities.
- The construction corridor / footprint must be staked out by a surveyor and demarcated using brightly coloured shade cloth. The construction servitude should include the turbine footprints and working area and all new and existing access / haulage roads with a maximum 3m construction working area either side of the access/ haulage roads.
- All areas outside of thew delineated constriction servitude as defined above and/or the within / inside the 30m buffer zone of watercourses must be considered no-go areas for the entire construction phase. Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- The demarcations are to remain until construction and rehabilitation is complete.

7.2.2. Method Statements for working in watercourses

A detailed method statement for the construction activities to be undertaken as part of establishment of new roads and/or upgrading of existing roads at watercourses crossings must be compiled and appended to the construction (EMPr) prior to construction commencing. The final method statement must be reviewed by a wetland / freshwater specialist prior to commencement and must include all measures provided in this section where relevant and applicable. The following guidelines should be included in the method statement:

A. Wetland Crossings

Site Setup:

- All demarcation measures provided in Section 7.2.1 above applicable to the demarcation of the construction corridor/servitude across the watercourse must be implemented.
- A photographic record of the state of the watercourses prior to the commencement of clearing/construction must be kept for reference and rehabilitation monitoring purposes.
- If applicable, the levels should be accurately pegged out by an engineer and the engineer should be onsite to guide the settling of the foundation.
- The location of the topsoil and subsoil stockpile areas, dewatering filtration areas and equipment laydown areas must be agreed to and demarcated to the satisfaction of the ECO prior to any clearing. These areas must be located outside of all watercourses and sufficiently removed from them that in the event of heavy rainfall, the soil will not be carried into the watercourse.
- Before any work commences in the wetland, sediment control/silt capture measures (e.g. bidim/silt curtains) must be installed downstream of the working areas within the wetland. Quantities of silt fences/curtains shall be decided on site with the engineer, contractor and ECO. The ECO should be present during the location and installation of the silt curtains.

Site clearing and stripping:

- Indigenous vegetation within the wetland and riparian areas that are desirable for re-vegetation must be identified upfront before clearing. This vegetation should be removed via sodding so that the sods can be replaced / replanted after the working areas are backfilled and reshaped. The plant sods should be removed taking care to remove the entire sods including root systems and rhizomes.
- For vegetation within the wetland that is not desirable for re-vegetation, this vegetation can be stripped.
- Topsoil and subsoil excavated and stripped must not be mixed and must be stored separately.

Running Track and Soil Stockpile Corridor Establishment:

- Firstly, geotextile/geofabric must be laid down along the soil stockpile corridors and running track corridors. This is to avoid the mixing of foreign material with the wetland and riparian zone soils.
- The running track must be established upstream of the road and must double up as a dam wall / berm / bund wall for flow diversion purposes.
- Where applicable, the active channel banks along the running track should be re-graded to a slope that will allow for safe access by workers to the channel bed.

Temporary flow diversion and dewatering:

- The diversion of flow away from construction works within the wetland should be done be done by the construction of temporary bunding to isolate compartments.
- Under no circumstances must new channels be created for flow diversion and conveyance purposes.
- The dam wall/bund wall should be established using sand bags.
- The dam should be high enough to cope with 1.5 times the nominal volume of the upstream flows.
- If pipe outlets are required, these should also be armoured against erosion using rip-rap and dump rock to reduce wetland scour.
- The dam wall must be built to specification to minimise failure/breaching and/or flow diversion around the dam that will lead to channel erosion.
- If dewatering is required, pumped water must be discharged back into the watercourses in a manner that does not cause erosion of elevated levels of sedimentation. In this regard, pumped water should be discharged into erosion control and sediment trap structure designed for such a purpose (i.e. series of silt traps or hay-bails). Such a structure should not be located near steep banks or slopes where water re-entering the watercourses could cause erosion.
- Once the working area is dry, the pump must be kept on standby.
- The location of the filtering area should be approved by the ECO.

Runoff, erosion and sediment control:

- The duration of construction work within the watercourses must be minimised as far as practically possible through proper planning and phasing.

- Construction work within the watercourses should be limited to the dry winter season wherever possible.
- When working within watercourses, downstream silt traps / curtains should be installed to capture sediment eroded from the working area prior to construction activities commencing within the watercourses. These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures regularly checked, maintained and repaired when required to ensure that they are effective.

Rehabilitation:

- Once instream works are completed, subsoils and topsoils must be reinstated, and wetland surface including channel bed and banks reshaped.
- All surfaces must be adequately ripped/loosened where compacted, as informed by the ECO.
- The bund wall and running track within the watercourse must be removed systematically moving backwards out of the wettest areas. All foreign material (e.g. sand bags, rock fill, imported soils, aggregate, geofabric etc.) must be removed from the watercourse, taking care not to remove natural sediment/rock from the watercourse.
- The rescued sods must be replanted in wetland and an appropriate spacing as advised by a wetland ecologist, and if applicable, channel bank stabilisation and erosion protection should be applied where applicable.
- All channel banks must be protected with a biodegradable geofabric. Temporary measures to prevent soil loss on the banks must be implemented which may include laying rows of sand bags/silt fences and silt fences at the water's edge.
- If there are not enough rescued sods, the wetland must be re-vegetated by the translocation / transplanting of sods from the surrounding wetland as advised by a wetland ecologist.
- For dryland areas adjoining watercourses, the construction right-of-way should be re-vegetated by hydroseeding with a locally suitable grass mix that must be approved by the ECO or wetland specialist / ecologist.
- The re-vegetation should be timed to occur before the wet season (ideally at the onset of the wet season in early spring – August to October) so that watering requirements are minimized and plant growth is most vigorous.
- Watering should be gentle so that rill erosion is avoided and minimised.
- Any erosion damage resulting from watering/irrigation must be repaired immediately.

- Alien and weed vegetation that colonize the rehabilitation areas must be removed and eradicated immediately via hand pulling and should be adequately disposed of.
- Once the initial re-vegetation is completed, the planting contractor will need to conduct weekly site visits to remove alien plants (in accordance with the latest revised NEMBA requirements) and address any re-vegetation concerns until re-vegetation is considered successful (i.e. >90% indigenous cover). Thereafter, the rehabilitation must be signed off by the ECO.

7.2.3. Runoff, erosion and sediment control

- Wherever possible, existing vegetation cover on the development site should be maintained during the construction phase. The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes which will not be developed.
- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Sediment barriers (e.g.: silt fences/sandbags/hay bales) must be installed immediately downstream of active work areas (including soil stockpiles) as necessary to trap any excessive sediments generated during construction.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of hay-bales, sandbags and/or silt fences aligned along the contours and spaced at regular intervals (e.g. every 2m) to break the energy of surface flows.
- Once shaped, all exposed/bare surfaces and embankments must be re-vegetated immediately.
- If re-vegetation of exposed surfaces cannot be established immediately due to phasing issues, temporary erosion and sediment control measures must be maintained until such a time that re-vegetation can commence.
- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. All temporary erosion and sediment control structures must only be removed once vegetation cover has successfully recolonised the affected areas.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with

appropriate material and silt fences or fascine work must be established along the gulley for additional protection until vegetation has re-colonised the rehabilitated area.
- Regular maintenance of any sediment control dams must be undertaken during the construction / establishment period to ensure that these structures continue to function appropriately.

7.2.4. Hazardous substances / materials management

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, etc.) needs to be administered.
- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of stormwater.
- Drip trays should be utilised at all dispensing areas.
- No refuelling, servicing or chemical storage should occur within 30m of any watercourse.
- No vehicles transporting concrete, asphalt or any other bituminous product may be washed on site.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Hazardous storage and refuelling areas must be bunded prior to their use on site during the construction period following the appropriate SANS codes. The bund wall should be high enough to contain at least 110% of any stored volume. The surface of the bunded surface should be graded to the centre so that spillage may be collected and satisfactorily disposed of.
- All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.
- Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.

7.2.5. Invasive Alien Plant control

- All alien invasive vegetation that colonise the construction site must be removed, preferably by uprooting. The contactor should consult the ECO regarding the method of removal.
- All bare surfaces across the construction site must be checked for IAPs every two weeks and IAPs removed by hand pulling/uprooting and adequately disposed.
- Herbicides should be utilised where hand pulling/uprooting is not possible. ONLY herbicides which have been certified safe for use in wetlands by independent testing authority are to be used. The ECO must be consulted in this regard. The herbicide contractor must be certified to apply/utilise the herbicide in question.

7.2.6. Noise, dust and light pollution minimisation

- Temporary noise pollution due to construction works should be minimized by ensuring the proper maintenance of equipment and vehicles and tuning of engines and mufflers as well as employing low noise equipment where possible.
- Water trucks will be required to suppress dust by spraying water on affected areas producing dust. This will likely be required daily in the drier months or during dry periods.
- No lights must be established within the construction area near the watercourses and buffer zones.

7.2.7. Prohibitions related to animals

- The handling and/or killing of any animal species present is strictly prohibited and all staff/personnel must be notified of such incidents.
- Wetland fauna (e.g. snakes, frogs, small mammals) that are encountered during the construction phase must be relocated to other parts of the wetland under the guidance of the EO or ECO.
- Poaching/snaring is strictly prohibited.

7.2.8. General rehabilitation guidelines

- All disturbed areas beyond the construction site that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO.
- All land impacted by the proposed development must be rehabilitated by undertaking the following general tasks:
    - All foreign material must be removed from site.
    - Land must be regraded / re-shaped and topsoils must be reinstated.
    - Compacted soils must be adequately ripped/loosened where compacted, as informed by the ECO.
    - Re-vegetation should take place as follows:
        - For any permanently and seasonally saturated areas - via translocation / transplanting of resecured sods and, where there are not enough rescued sods, via the translocation / transplanting of sods from the surrounding wetland as advised a wetland ecologist.
        - For temporary and dryland areas - via hydroseeding using an appropriate indigenous seed mix as advised by a qualified ecologist.

7.2.9. Construction phase monitoring measures

- Compliance monitoring will be the responsibility of a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that monitoring is undertaken effectively and appropriately.
- A photographic record of the state of the onsite wetlands prior to the commencement of clearing/construction must be kept for reference and rehabilitation monitoring purposes.
- The ECO must undertake bi-monthly compliance monitoring audits. Freshwater ecosystem aspects that must be monitored related to monitoring freshwater ecosystem impacts include:
    - The condition of the demarcation fence.
    - Evidence of any no-go area incursions.
    - The condition of the temporary runoff, erosion and sediment control measures and evidence of any failures.

- Evidence of sedimentary deposits / plumes and elevated rates of sedimentation (i.e. vegetation smothering / burial).
- Evidence of elevated river / stream turbidity levels.
- Evidence of gully or bed/bank erosion.
- Visual assessment of stormwater quality and instream water quality.
- The condition of waste bins and the presence of litter within the working area.
- Evidence of solid waste within the no-go areas.
- Evidence of hazardous materials spills and soil contamination.
- Presence of alien invasive and weedy vegetation within the working area.
- Rehabilitation and re-vegetation methods and success.

- Once the construction and rehabilitation has been completed, the ECO should conduct a close out site audit 1 month after the completion of rehabilitation.

7.3. Operational Phase

7.3.1. Maintenance and management

- It is the applicant's responsibility to ensure the proper functioning of infrastructure that is likely to require regular on-going maintenance. This includes the stormwater management infrastructure and road infrastructure.
- It is important that the location and extent of the rivers and wetlands in the vicinity of project activities be incorporated into all formal maintenance and repair plans for the project.
- In terms of management, alien invasive plant control must be practiced on an on-going basis in line with the requirements of Section 2(2) and Section 3 (2) the National Environmental Management: Biodiversity Act (NEM:BA), which obligates the landowner/developer to control IAPs on their property.

7.3.2. Monitoring

It will be important that long-term monitoring of the potential freshwater ecosystem impacts be undertaken to proactively to identity any environmental issues and impacts that may arise as a result of the operational phase of the project. The following key aspects should be monitored:

- Erosion and/or sedimentation in the onsite and downstream wetlands;

- Water table monitoring to determine any impacts to subsurface inputs; and
- Presence of alien invasive plants;

7.3.3. Remediation / Rehabilitation

Where appreciable direct vegetation/habitat impacts and/or indirect erosion/sedimentation impacts or hydrological impacts occur resulting from project activities, these must be reported immediately to the relevant environmental authorities, and an independent aquatic or wetland specialist appointed to conduct a site inspection to assess the residual impacts and determine the need for any onsite remediation or rehabilitation requirements. Following this assessment, an implementable remediation and/or wetland rehabilitation plan may need to be compiled and implemented to the satisfaction of KZN EDTEA and DWS.

8. Impact and Risk Assessment

This section deals with the assessment of the construction and operational and phase impacts of the project on local freshwater ecosystems (i.e. rivers and wetlands).

8.1. Activities and Impacts Assessed

The activities requiring assessment for this study and the associated potential impacts are summarised in Tables 31 and 32, on the next page. Two activities have been assessed, namely:

- Activity 1 – Development of turbines and laydown areas.
- Activity 2 – Development of internal access / haulage roads.

8.2. Key Assumptions

The following assumptions apply to the impact assessment:

- The realistic good mitigation scenario assumes the following:
  - All the planning and design measures recommended in Section 7.1 will be adhered to. If any of the recommended mitigation measures provided in Section 7.1 cannot be adhered to, the impact and risk assessments will need to be revised.
  - The impacts of the abstraction of water during the construction phase is not considered in this assessment.

Table 31. Summary of impacts assessed for Activity 1 – **turbines and laydown areas**.

Project Phasing & Activities	Impact Group	Impact Description
C1. Construction activities - Establishment (construction) of turbines and laydown areas including vegetation clearing, soil stripping / grubbing, earthworks, installing infrastructure, establishment of laydown yards/construction camps, soil stockpiling and movement of soils and construction materials, storage and use of chemicals, fuels and oils; and associated environmental management activities like erosion control and rehabilitation	**C1-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to rivers and/or wetlands by heavy machinery during construction due to poor construction practices and environmental management. Degradation of wetland and river PES and loss of ecosystem services may occur if accidental damage is extensive and/or rehabilitation of the damage is poor.
	C1-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of rivers and/or wetlands due to catchment soil and vegetation clearing and landcover disturbance during construction. Soil erosion could result if not properly managed given the steep terrain and erodible soils of the site. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat. • Erosion and/or sedimentation of rivers and/or wetlands due to the disturbance of soil and vegetation in catchment. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat.
	C1-3: Water quality impacts	• Pollution of rivers and/or wetlands on the site and possibly also downstream, due to the mishandling of hazardous substances and/or improper maintenance of machinery during construction (e.g. oil and diesel leaks and spills). • Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality.
	C1-4: Fragmentation and ecological disturbance impacts	• Laydown areas will result in a temporary reduction in localised ecological connectivity for fauna. • Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities near to rivers and wetlands.

Project Phasing & Activities	Impact Group	Impact Description
		• Noise pollution and vibrations associated with earthworks and the use of heavy machinery could affect local wildlife (birds, amphibians and small mammals especially). • Light pollution associated with construction crews and the use of heavy machinery use at night which could affect locally occurring nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year.
O1: Operational activities - Operation, maintenance and monitoring of all established infrastructure including turbines, stormwater management and servitudes.	**O1-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to rivers and/or wetlands by heavy machinery during infrastructure repair and maintenance activities, particularly if ad-hoc laydown areas required. • Increased local and regional wetland bird fatalities as a result of turbine strikes. **Please note that this impact is not assessed as part of this assessment and will be assessed as parr of the avifaunal impact assessment for the project**.
	O1-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of rivers and/or wetlands as a result of land surface hardening at turbine sites. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat. • Reduced water inputs if activities cause additional soil piping and sinkholes that could intercept subsurface flows.
	O1-3: Water quality impacts	• Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality. • Pollution of onsite and downstream rivers and onsite wetlands due to the mishandling of hazardous substances and/or improper maintenance of machinery during repair and maintenance activities (e.g. oil and diesel leaks).
	O1-4: Fragmentation and ecological disturbance impacts	• Expanded / more intense edge impacts could occur as a result of deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities taking place near to wetlands and rivers.

Table 32. Summary of impacts assessed for Activity 1 – **internal access / haulage roads**.

Project Phasing & Activities	Impact Group	Impact Description
C2. Construction activities - Establishment (construction) of access roads including vegetation clearing, soil stripping / grubbing, earthworks, installing infrastructure, establishment of laydown yards/construction camps, soil stockpiling and movement of soils and construction materials, storage and use of chemicals, fuels and oils; and associated environmental management activities like erosion control and rehabilitation	**C2-1: Direct ecosystem destruction and modification impacts**	• Direct disturbance and modification of rivers and/or wetlands and/or permanent loss due to the establishment of new access road watercourses crossings and/or due to the upgrade of existing watercourses road crossings. Degradation of wetland and river PES and loss of ecosystem services may occur if such crossings are poorly planned / design and implemented. • Accidental direct impacts to rivers and/or wetlands by heavy machinery during construction due to poor construction practices and environmental management. Degradation of wetland and river PES and loss of ecosystem services may occur if accidental damage is extensive and/or rehabilitation of the damage is poor.
	C2-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of rivers and/or wetlands due to catchment soil and vegetation clearing and landcover disturbance during construction. Soil erosion could result if not properly managed given the steep terrain and erodible soils of the site. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat. • Erosion and/or sedimentation of rivers and/or wetlands due to the disturbance of soil and vegetation and alteration / diversion of flows during the establishment and/or upgrade or access road watercourse crossings. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat. • Reduced water inputs where poorly planned and aligned roads intercept subsurface water movement and preferential subsurface flows paths and/or if activities cause additional soil piping and sinkholes that could intercept subsurface flows.
	C2-3: Water quality impacts	• Pollution of rivers and/or wetlands on the site and possibly also downstream, due to the mishandling of hazardous substances and/or improper maintenance of machinery during construction (e.g. oil and diesel leaks and spills).

Project Phasing & Activities	Impact Group	Impact Description
		• Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality.
	C2-4: Fragmentation and ecological disturbance impacts	• Decreased local ecological connectivity as a result of the establishment of new road watercourses crossings and/or the upgrade of existing crossings. The construction corridor will act as a temporary barrier to faunal movement. • Formation of artificial barriers to local aquatic fauna movement (macroinvertebrates, fish and frogs) during temporary flow diversions and impoundments during construction. • Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities near to rivers and wetlands. • Noise pollution and vibrations associated with earthworks and the use of heavy machinery could affect local wildlife (birds, amphibians and small mammals especially). • Light pollution associated with construction crews and the use of heavy machinery use at night which could affect locally occurring nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year.
O2: Operational activities - Operation, maintenance and monitoring of all established infrastructure including roads, culverts, stormwater and servitudes.	**O2-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to rivers and/or wetlands by heavy machinery during infrastructure repair and maintenance activities, particularly culverts at crossings.
	O2-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of rivers and/or wetlands as a result of poor stormwater management at access roads. Erosion and sedimentation impacts to wetlands include reduced wetland soil saturation due to flow concentration and/or vegetation burial. Erosion and sedimentation impacts to rivers include channel bank and bed modification and alteration in instream aquatic biotopes and riparian habitat. • Reduced water inputs where poorly planned and aligned roads intercept subsurface water movement and preferential subsurface flows paths and/or if activities cause additional soil piping and sinkholes that could intercept subsurface flows.

Project Phasing & Activities	Impact Group	Impact Description
	O2-3: Water quality impacts	• Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality. • Pollution of onsite and downstream rivers and onsite wetlands due to the mishandling of hazardous substances and/or improper maintenance of machinery during repair and maintenance activities (e.g. oil and diesel leaks).
	O2-4: Fragmentation and ecological disturbance impacts	• Decreased local ecological connectivity as a result of the operation of new or and upgraded road watercourse crossings. If poorly sited, aligned or designed across sensitive systems, the road could act as a barrier to aquatic and wetland fauna. In particular, poorly designed culverts across aquatic habitat could result in the formation of a barrier local aquatic fauna movement (macroinvertebrates, fish and frogs). • Expanded / more intense edge impacts could occur as a result of deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities taking place near to rivers.

8.3. Impact Significance Assessment

The results of the impact significance assessment for impacts to rivers and wetlands in the study area are summarised in Tables 33 and 34, on the next page.

Activity 1 – Turbines and laydown areas:
Under the realistic poor mitigation scenario, the most significant impacts to freshwater ecosystems is predicted to be the indirect erosion and sedimentation impacts of both the construction (Impact C1-2) and operation (Impact O1-2) of the turbine sites and the construction laydown areas in close proximity to watercourses. Both Impacts C1-2 and O1-2 were assessed as being of **moderate significance** under a poor mitigation scenario. Due to the steep headwater setting and erodible soils, the watercourses are predicted to be highly sensitive to changes in flows and soil disturbance. In a situation where stormwater management, erosion and sediment control and flow diversions are poorly implemented during the construction phase, it is predicted that erosion of the watercourses will occur resulting in increased rates of erosion and sedimentation downstream, with resultant changes in aquatic habitat and riparian and wetland vegetation communities. These impacts were assessed as being of moderate significance due to the watercourses in proximity to the turbines and laydown areas being high to very high EIS and highly sensitive to erosion and sedimentation. Any erosion impacts are likely to result in at least a one class PES drop for A and B PES class watercourses, which would not be in line with the REC for the units. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impacts C1-2 and O1-2 can be reduced to **moderately-low** and acceptable. The most important mitigation measures to implement and adhere to are the planning and design measures and the strict adherence to construction phase runoff, erosion and sediment control measures.

Under the realistic poor mitigation scenario, the potential water pollution impacts during the construction phase (Impact C1-3) was also assessed as being of **moderate significance**. The moderate rating for Impact C1-3 is driven by the watercourses to be impacted being in a very good state, being relatively small, and being highly sensitive to changes in local water quality. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impact C1-3 can be reduced to **low** and acceptable.

The remaining impacts were all assessed as being of **low to moderately-low significance** under a poor mitigation scenario due largely to no direct impacts planned to the watercourses (Impacts

C1-1 and O1-1), the operational water quality impacts being negligible (O1-3), and the negative ecological connectivity impacts of the construction of the turbines being small in extent, temporary in nature, short in duration and outside of watercourses and buffers. With the effective implementation of the mitigation measures provided in this report, the impact significance of these impacts can all be reduced.

All impacts can be reduced to **low to moderately-low significance** with the strict application and implementation of the mitigation measures provided, Therefore, there are no predicted fatal flaws in terms of impacts to freshwater ecosystems and biodiversity as long as the mitigation measures provided in this report are effectively implemented.

Activity 2 – Access / haulage roads:
Under the realistic poor mitigation scenario, the most significant impacts to freshwater ecosystems is predicted to be the indirect erosion and sedimentation impacts of both the construction (Impact C2-2) and operation (Impact O2-2) of the new and upgraded watercourse road crossings and access / haulage roads in close proximity to watercourses. To a lesser degree reduced water inputs of the interception of subsurface flows by access roads is also considered as part of these impacts as well. Both Impacts C2-2 and O2-2 were assessed as being of **moderately-high significance** under a poor mitigation scenario for the similar reasons as provided for Activity 1. Dirt roads in steep and erodible settings are known to result in gully erosion and stream channel modification where runoff is not managed properly. Poorly managed road runoff is also predicted to result in increased rates of erosion and sedimentation downstream, with resultant changes ecosystem health. These impacts were assessed as being of moderately-high significance due to the watercourses in proximity to the access roads being high to very high EIS and highly sensitive to erosion and sedimentation. In addition, the internal road route in the south of the project area is proposed to traverse a series of steep mountain streams with steep valley slopes (Crossings No. 6 – 10) that feed several important wetlands. Any erosion impacts are likely to result in at least a one class PES drop for A and B PES class watercourses, which would not be in line with the REC for the units. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impact C2-2 and O2-2 can be reduced to **moderately-low** and acceptable. The most important mitigation measures to implement and adhere to are the planning and design measures and the strict adherence to a detailed method statement for working in rivers and streams.

Under the realistic poor mitigation scenario, the potential water pollution impacts during the construction phase (Impact C2-3) and the ecological connectivity impacts of the operation of the new and upgraded access / haulage road watercourse crossings (Impact O2-4) were assessed as being of **moderate significance**. The moderate rating for Impact C2-3 is driven by the watercourses to be impacted being in a very good state, being relatively small, and being highly sensitive to changes in local water quality. The moderate rating for Impact O2-4 is related to the watercourse crossings blocking aquatic and wetland faunal movement. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impact C2-3 and O2-4 can be reduced to **low and moderately-low** respectively, and acceptable.

The remaining impacts were all assessed as being of **low to moderately-low significance** under a poor mitigation scenario due largely to the small area of physical watercourses to be directly impacted (Impacts C2-1 and O2-1), the operational water quality impacts being negligible and the negative ecological connectivity impacts of the construction of the new / upgraded watercourse crossings being temporary in nature and short in duration. With the effective implementation of the mitigation measures provided in this report, the impact significance of these impacts can all be reduced.

All impacts can be reduced to **low to moderately-low significance** with the strict application and implementation of the mitigation measures provided, Therefore, there are no predicted fatal flaws in terms of impacts to freshwater ecosystems and biodiversity as long as the mitigation measures provided in this report are effectively implemented.

Table 33. Summary of the impact significance assessment for Activity 1 – **turbines and laydown areas**.

Phase	Impacts	Intensity	Extent	Duration	Probability	Significance
'Poor' Mitigation Scenario						
Construction	C1-1: Direct ecosystem destruction and modification impacts	Site	Moderately-High	Medium-term	Probable	**Moderately-Low**
	C1-2: Indirect hydrological and geomorphological impacts	Local	Moderately-High	Medium-term	Highly Probable	**Moderate**
	C1-3: Water quality impacts	Local	Moderately-High	Medium-term	Highly Probable	**Moderate**
	C1-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderate	Medium-term	Highly Probable	**Moderately-Low**
Operation	O1-1: Direct ecosystem destruction and modification impacts	Surrounding Area	Moderate	Long-term	Probable	**Moderately-Low**
	O1-2: Indirect hydrological and geomorphological impacts	Local	Moderately-High	Long-term	Highly Probable	**Moderate**
	O1-3: Water quality impacts	Surrounding Area	Moderately-Low	Long-term	Possible	**Low**
	O1-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderately-Low	Long-term	Probable	**Low**
'Good' Mitigation Scenario						
Construction	C1-1: Direct ecosystem destruction and modification impacts	Site	Moderately-Low	Short-term	Unlikely	**Low**
	C1-2: Indirect hydrological and geomorphological impacts	Local	Moderate	Medium-term	Probable	**Moderately-Low**
	C1-3: Water quality impacts	Site	Low	Short-term	Possible	**Low**
	C1-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderately-Low	Medium-term	Probable	**Low**
Operation	O1-1: Direct ecosystem destruction and modification impacts	Site	Moderately-Low	Long-term	Possible	**Low**
	O1-2: Indirect hydrological and geomorphological impacts	Surrounding Area	Moderately-Low	Long-term	Probable	**Low**
	O1-3: Water quality impacts	Site	Low	Long-term	Possible	**Low**
	O1-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderately-Low	Long-term	Probable	**Low**

Table 34. Summary of the impact significance assessment for Activity 2 – **internal access / haulage roads**.

Phase	Impacts	Intensity	Extent	Duration	Probability	Significance
'Poor' Mitigation Scenario						
Construction	C2-1: Direct ecosystem destruction and modification impacts	Surrounding Area	Moderately-High	Permanent	Definite	**Moderate**
	C2-2: Indirect hydrological and geomorphological impacts	Local	High	Medium-term	Highly Probable	**Moderately-High**
	C2-3: Water quality impacts	Local	Moderately-High	Medium-term	Highly Probable	**Moderate**
	C2-4: Fragmentation and ecological disturbance impacts	Local	Moderate	Medium-term	Highly Probable	**Moderately-Low**
Operation	O2-1: Direct ecosystem destruction and modification impacts	Surrounding Area	Moderate	Long-term	Probable	**Moderately-Low**
	O2-2: Indirect hydrological and geomorphological impacts	Local	High	Long-term	Highly Probable	**Moderately-High**
	O2-3: Water quality impacts	Surrounding Area	Moderately-Low	Long-term	Probable	**Low**
	O2-4: Fragmentation and ecological disturbance impacts	Local	Moderately-High	Long-term	Highly Probable	**Moderate**
'Good' Mitigation Scenario						
Construction	C2-1: Direct ecosystem destruction and modification impacts	Surrounding Area	Moderate	Permanent	Definite	**Moderately-Low**
	C2-2: Indirect hydrological and geomorphological impacts	Surrounding Area	Moderate	Medium-term	Highly Probable	**Moderately-Low**
	C2-3: Water quality impacts	Site	Low	Short-term	Possible	**Low**
	C2-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderate	Medium-term	Highly Probable	**Moderately-Low**
Operation	O2-1: Direct ecosystem destruction and modification impacts	Surrounding Area	Moderately-Low	Long-term	Possible	**Low**
	O2-2: Indirect hydrological and geomorphological impacts	Local	Moderate	Long-term	Probable	**Moderately-Low**
	O2-3: Water quality impacts	Surrounding Area	Low	Long-term	Possible	**Low**
	O2-4: Fragmentation and ecological disturbance impacts	Surrounding Area	Moderate	Long-term	Highly Probable	**Moderately-Low**

8.4. DWS Risk Matrix Assessment

It is our understanding that the purpose of the risk matrix tool developed by the DWS is to give a preliminary indication of the likely impact / degree of change (consequence) of activities (water uses) to local and regional water resource quality. For the purposes of this study, the degree of change is reflected in PES change and/or the change in the supply of regulating ecosystem services onsite and/or downstream of activities.

The results of the risk assessment for impacts to freshwater ecosystems are shown in Tables 35 and 36, on the pages that follows. Under a good mitigation scenario:

- For both activities, (2) risks are predicted to be moderate with the remaining risks being low, namely:
    - C1-2: Indirect hydrological and geomorphological impacts.
    - O1-2: Indirect hydrological and geomorphological impacts.
    - C2-1: Direct impacts of watercourses crossings.
    - C2-2: Indirect hydrological and geomorphological impacts.
    - O2-2: Indirect hydrological and geomorphological impacts.

This assumes that all the mitigation measures recommended in this report will be adhered to. However, it is also assumed that even under a good mitigation scenario, approximately 10 watercourses road watercourse crossings will be required and, as such, the risks cannot be avoided.

Table 35. Summary of the DWS 'Risk Assessment Matrix' results under a 'good' mitigation scenario for Activity 1.

Phase(s)	Activity	Impact	Severity: Flow Regime	Severity: Physico & chemical (water Quality)	Severity: Habitat (Geomorph & Vegetation)	Severity: Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
Construction	CONSTRUCTION PHASE (C1)	C1-1: Direct ecosystem destruction and modification impacts	1	1	1	1	**1**	1	2	**4**	5	1	5	1	**12**	**48**	**Low**
		C1-2: Indirect hydrological and geomorphological impacts	1	1	1	1	**1**	2	2	**5**	3	3	5	2	**13**	**65**	**Moderate**
		C1-3: Water quality impacts	1	1	1	1	**1**	1	1	**3**	3	2	5	2	**12**	**36**	**Low**
		C1-4: Fragmentation and ecological disturbance impacts	1	1	1	1	**1**	1	1	**3**	5	2	5	1	**13**	**39**	**Low**
Operation	OPERATIONAL PHASE (O1)	O1-1: Direct ecosystem destruction and modification impacts	1	1	1	1	**1**	1	1	**3**	2	2	5	1	**10**	**30**	**Low**
		O1-2: Indirect hydrological and geomorphological impacts	1	1	1	1	**1**	2	2	**5**	3	2	5	2	**12**	**60**	**Moderate**
		O1-3: Water quality impacts	1	1	1	1	**1**	1	1	**3**	3	1	5	2	**11**	**33**	**Low**
		O1-4: Impacts to ecological connectivity and/or ecological disturbance impacts	1	1	1	1	**1**	1	1	**3**	2	2	5	1	**10**	**30**	**Low**

Table 36. Summary of the DWS 'Risk Assessment Matrix' results under a 'good' mitigation scenario for Activity 2.

Phase(s)	Activity	Impact	Severity: Flow Regime	Severity: Physico & chemical (water Quality)	Severity: Habitat (Geomorph & Vegetation)	Severity: Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
Construction	CONSTRUCTION PHASE (C2)	C2-1: Direct ecosystem destruction and modification impacts	1	1	2	1	**1.25**	1	2	**4.25**	5	3	5	1	**14**	59.5	**Moderate**
		C2-2: Indirect hydrological and geomorphological impacts	1	1	2	2	**1.5**	2	2	**5.5**	3	3	5	2	**13**	71.5	**Moderate**
		C2-3: Water quality impacts	1	1	1	1	**1**	1	1	**3**	3	2	5	2	**12**	36	**Low**
		C2-4: Fragmentation and ecological disturbance impacts	1	1	1	1	**1**	2	1	**4**	5	2	5	1	**13**	52	**Low**
Operation	OPERATIONAL PHASE (O2)	O2-1: Direct ecosystem destruction and modification impacts	1	1	1	1	**1**	1	1	**3**	2	2	5	1	**10**	30	**Low**
		O2-2: Indirect hydrological and geomorphological impacts	1	1	2	1	**1.25**	2	2	**5.25**	3	3	5	2	**13**	68.25	**Moderate**
		O2-3: Water quality impacts	1	1	1	1	**1**	1	1	**3**	3	1	5	2	**11**	33	**Low**
		O2-4: Impacts to ecological connectivity and/or ecological disturbance impacts	1	1	1	1	**1**	1	1	**3**	2	2	5	1	**10**	30	**Low**

9. License and Permit Requirements

Two pieces of legislation are relevant to the proposed activities, namely the National Environmental Management Act (Act No. 107 of 1998) (NEMA) and the National Water Act (Act No. 36 of 1998) (NWA). The former stipulates listed activities that require an Environmental Authorisation (EA) and the latter water uses that require a Water Use License(s) (WUL). The legislative requirements associated with the activities is summarised in Table 37 below. Please note that only the legislative requirements associated with activities that can impact watercourses are discussed. The proposed development activities require both an Environmental Authorisation for several listed activities under the NEMA and a water use licenses under the NWA.

Table 37. Legislative requirements associated with watercourses.

Intervention	NEMA	NWA
Turbine development and operation	• Listed Activity 12 of Listing Notice 1 • Listed Activity 14 of Listing Notice 3	Section 21c and 21i water uses. Low risk.
Turbine access roads / haulage roads development and operation	• Listed Activity 12 of Listing Notice 1 • Listed Activity 19 of Listing Notice 1 • Listed Activity 4 of Listing Notice 3 • Listed Activity 12 of Listing Notice 3	Section 21c and 21i water uses. Moderate risk.
Powerline development and operation	• Listed Activity 12 of Listing Notice 1 • Listed Activity 14 of Listing Notice 3	Section 21c and 21i water uses. Low risk.
Powerlines access roads / haulage roads development and operation	• Listed Activity 12 of Listing Notice 1 • Listed Activity 19 of Listing Notice 1 • Listed Activity 4 of Listing Notice 3 • Listed Activity 12 of Listing Notice 3	Section 21c and 21i water uses. Moderate risk.

10. Assumptions and Limitations

The following limitations and assumptions apply to this assessment:

- Although all watercourses occurring within 500m of the proposed activities were mapped at a desktop level, field investigations were confined to only those rivers and wetlands where an appreciable 'risk of potential impact' was determined. Furthermore, landowner details could not be provided for most of the properties traversed by the powerline corridors. Thus, the desktop mapping of watercourses within these corridors could not be verified in the field.
- The mapping and classification of the watercourse units outside of the study area but occurring within a 500m radius of activities should be considered preliminary and coarse in resolution. These units were not verified in the field.
- Sampling by its nature means that not all parts of the study area were visited. The assessment findings are thus only applicable to those areas sampled, which were extrapolated to the rest of the study area.
- A Soil Munsell Colour Chart was used to determine the soil matrix colour of the soil sampled. However, it is important to note that the recording of the colours using the soil chart is highly subjective and varies significantly depending on soil moisture and the prevailing light conditions. In this case, all the soils sampled were dry and sampling was undertaken in sunny conditions.
- Soil wetness indicators (i.e. soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality has no influence on the delineation of wetland areas.
- All vegetation information recorded was based on the onsite visual observations of the author and no formal vegetation sampling was undertaken. Furthermore, only dominant and noteworthy plant species were recorded. Thus, the vegetation information provided has limitations for true botanical applications.
- Although every effort was made to correctly identify the plant species encountered onsite, wetland plants, particularly the Cyperaceae (sedge) family, are notoriously difficult to identify to species level. Every effort as made to accurately identify plants species but

where identification to species level could not be determined, such species were only identified to genus level.

- Seasonality can also influence the species of flora encountered at the site, with the flowering time of many species often posing a challenge in species identification. Since the wetland vegetation in the study area was found to be largely secondary/degraded with low native plant diversity, seasonality would not be as significant a limitation when compared with a vegetation community that is largely natural or high in native plant diversity.
- The assessment of impacts is predictive and was based on the information and site development provided by the client. The 'realistic good mitigation scenario' impact significance ratings and assessment outcomes assumes that all the mitigation measures recommended in Section 7 will be adhered to.
- Impact to wetland fauna were not considered as part of this assessment.

11. Conclusion

The infield baseline assessment of the watercourses to be impacted by the proposed development activities revealed that the study area has a high density and large abundance of watercourses that are in a good state, highly sensitive and of high ecological importance, especially associated with the higher lying mountain ridges and plateaus.

In terms of impact significance, the most significant impacts to freshwater ecosystems resulting from both activities is predicted to be the indirect erosion and sedimentation impacts of both the construction (Impacts C1-2 and C2-2) and operation (Impacts O1-2 and O2-2) of the new and upgraded watercourse road crossings and the turbine sites and access / haulage roads in close proximity to watercourses. To a lesser degree reduced water inputs of the interception of subsurface flows by access roads is also considered as part of these impacts as well. Impacts C1-2 and O1-2 were assessed as being of **moderately-high significance** and Impacts C2-2 and O2-2 were assessed as being of **moderately-high significance**, under a poor mitigation scenario. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impacts C1-2, O1-2, C2-2 and O2-2 can be reduced to **moderately-low** and acceptable. The most important mitigation measures to implement and adhere to are the planning and design measures and the strict adherence to a detailed method statement for working in rivers and streams.

Under the realistic poor mitigation scenario, the potential water pollution impacts during the construction phase (Impacts C1-3 and C2-3) and the ecological connectivity impacts of the operation of the new and upgraded access / haulage road watercourse crossings (Impacts O1-4 and O2-4) were assessed as being of **moderate significance**. With the effective implementation of the mitigation measures provided in this report, the impact significance of Impacts C1-3, O1-4, C2-3 and O2-3 and can be reduced to **low / moderately-low**, and acceptable.

The remaining impacts were all assessed as being of **low to moderately-low significance** under a poor mitigation scenario due largely to the small area of physical watercourses to be directly impacted, the operational water quality impacts being negligible and the negative ecological connectivity impacts of the construction of the new / upgraded watercourse crossings being temporary in nature and short in duration. With the effective implementation of the mitigation measures provided in this report, the impact significance of these impacts can all be reduced.

Therefore, there are no predicted fatal flaws in terms of impacts to freshwater ecosystems and biodiversity as long as the mitigation measures provided in this report are effectively implemented.

In terms of the DWS risk matrix assessment, for both activities, (2) risks are predicted to be moderate under a good mitigation scenario, namely:

- C1-2: Indirect hydrological and geomorphological impacts.
- O1-2: Indirect hydrological and geomorphological impacts.
- C2-1: Direct impacts of watercourses crossings.
- C2-2: Indirect hydrological and geomorphological impacts.
- O2-2: Indirect hydrological and geomorphological impacts.

All remaining risks were assessed as being low.

This assumes that all the mitigation measures recommended in this report will be adhered to. However, it is also assumed that even under a good mitigation scenario, approximately 10 watercourses road watercourse crossings will be required and, as such, the risks cannot be avoided.

The proposed development activities require both an Environmental Authorisation for several listed activities under the NEMA and a water use licenses under the NWA.

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Annexure A – Impact Assessment Method

For the purposes of this assessment, the assessment of potential impacts was undertaken using the "Impact Assessment Methodology for EIAs" designed by Eco-Pulse Consulting (2020).

The assessment of impact significance is based on the basic risk formula: **Risk = consequence x probability**. However, the calculation of consequence has been modified to assess significance rather than risk. The basic significance formula utilised is:

Impact significance = impact consequence x impact probability, where Impact consequence = (impact intensity + impact extent) x impact duration

In order to improve the repeatability of the system, concise descriptions have been developed to assist the user in rating extent and intensity criteria (Table A1). These have been specifically tailored for each of the four ultimate consequences considered as part of the significance assessment. An overall statement of impact significance is then obtained by qualitatively assessing the cumulative effect of all impacts on each aspect of the water resource being assessed.

Table A1. Criteria and numerical values for rating environmental impacts to freshwater ecosystems.

Score	Rating	Description
Extent (E) – relates to the expected extent of the impact in spatial and population terms		
10	**National**	***The effects of an impact are experienced over a very large geographic area. Given the extent of impacts, they are likely to be relevant at a national scale.*** ***Water resource management:*** • Water resources are affected across a very extensive geographic area (e.g. spanning a number of water management areas / crossing international boundaries); and / or • Indirect impacts continue to affect water resources far from the development site (e.g. impacts continue to be experienced > 100km downstream). ***Ecosystem conservation:***

Score	Rating	Description
		• The extent of direct impacts results in extensive impacts to water resources relative to the remaining extent (e.g. affecting >100ha wetlands / >10km watercourses); and / or • The extent of direct impacts is high relative to the extent of affected habitat types (e.g. affecting >10% of a remaining ecosystem type); and / or • The proposed development affects large areas (e.g. > 1000 ha) across a broad geographic area and affecting a range of terrestrial habitat types. ***Species conservation:*** • Impacts affect a large proportion of the population of an important species at a national level (e.g. >10% of species population affected); and / or • The proposed development will affect a wide range of important species populations across a very large geographic area. ***Direct use values***: • Impacts will affect a society at a national scale (e.g. large number of stakeholders across multiple district municipalities / provinces).
8	**Regional**	***The effects of an impact are experienced over a large geographic area. Given the extent of impacts, they are likely to be relevant at a regional scale.*** ***Water resource management:*** • Water resources are affected across a broad geographic area (e.g. extending across a large number of quaternary catchments); and / or • Indirect impacts continue to affect water resources a considerable distance from the development site (e.g. 10 - 100km downstream). ***Ecosystem conservation:*** • The extent of direct impacts results in large-scale impacts to water resources relative to the remaining extent, (10-100ha wetlands / 2-10km watercourses); and / or • The extent of direct impacts is notable relative to the extent of affected habitat types (e.g. affecting 1 - 10% of a remaining ecosystem type); and / or • The proposed development affects *a large area (100 – 1000ha) and typically extends across a range of terrestrial habitat types.* ***Species conservation:*** • Impacts affect a large proportion of the population of an important species at a regional level (e.g. 1 - 10% of species population affected); and / or • The proposed development will affect a wide range of important species populations across a large geographic area. ***Direct use values:*** • Impacts will affect a society at a regional scale (e.g. large number of communities and stakeholders across a number of local municipalities).
5	**Local**	***The effects of an impact are experienced over a limited geographic area. Given the extent of impacts, they are likely to be relevant at a local scale.*** ***Water resource management:*** • Water resources are affected within a localised geographic area (e.g. single quaternary catchment); and / or

Score	Rating	Description
		• Indirect impacts continue to affect water resources some distance from the development site (e.g. 1 - 10km downstream). ***Ecosystem conservation:*** • The extent of direct impacts results in localised impacts to water resources relative to the remaining extent, (1 - <10ha wetlands / 200m - <2km watercourses); and / or • The extent of direct impacts is limited relative to the extent of affected habitat types (e.g. affecting <1% of a remaining ecosystem type); and / or • The proposed development affects *a moderately large area (10 – 100ha) but may extend across a wide range of terrestrial habitat types.* ***Species conservation:*** • Impacts affect species populations that are important at a local scale (e.g. < 1% of population affected); and / or • The proposed development will affect a number of important species across a local geographic area. ***Societal impacts***: • Impacts will affect society at a local scale (e.g. a number of communities across a single local municipality).
2	**Surrounding Area**	***The effects of an impact are experienced over a very small area. Given the extent of impacts, they are likely to be relevant at a very localised scale.*** ***Water resource management:*** • Water resources are affected within a small geographic area (e.g. single quinery catchment); and / or • Indirect impacts affect water resources a limited distance downstream of the development site (e.g. <1km downstream). ***Ecosystem conservation:*** • Direct impacts affects a small area proportion of water resources (e.g. 0.1-1ha wetlands / 20 – <200m watercourses); and / or • The proposed development affects a small localised area (1 – 10ha) and is often confined to a very few terrestrial habitat types. ***Species conservation:*** • Impacts affect populations of important species beyond the site level; ***Direct use values:*** • Impacts will affect society at a very local scale (e.g. a number of households within a single community).
0.5	**Site**	***The effects of an impact are confined to a very small footprint. Given the extent of impacts, they are likely to be relevant at a site scale.*** ***Water resource management:***

Score	Rating	Description
		• Impacts are largely confined to the development footprint with limited downstream impact (<100m downstream effect). ***Ecosystem conservation:*** • Direct impacts are typically confined to a single water resource or few water resources within a small focal area (typically <0.1ha wetlands / 20m watercourses); and / or • The proposed development affects a small area (<1ha) and is typically confined to very few terrestrial habitat types. ***Species conservation:*** • Impacts are very localised and are unlikely to affect important species beyond the site level; ***Direct use values:*** • Impacts will affect society at a very local scale (single or few households within a single local community)
Intensity (I) – defines the severity and importance of the impact to water resources / habitats / species or human populations within defined impact extent		
10	**High**	***Water resource management:*** • Loss of regulating and supporting services critical to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss will compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Loss of largely intact critically endangered habitat; and / or • Loss of habitat associated with validated FEPA Rivers & wetlands; and / or • Loss of particularly unique / especially important special habitat features. ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of critically endangered species; and / or • Loss of or seriously compromises viable landscape-level corridors and longitudinal connectivity (e.g. dams on free-flowing rivers) ***Direct use values:*** • Loss of human life; and / or • Marked deterioration in human health; and / or • Loss of ecosystem services that are critical to support / protect livelihoods of dependant vulnerable communities; and / or

Score	Rating	Description
7	**Moderately-High**	***Water resource management:*** • Loss of regulating and supporting services important to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs) ; and / or • Loss is very likely to compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Serious modification (2 or more classes) of critically endangered habitat; and / or • Loss of largely intact endangered habitat types; and / or • Loss of moderately modified critically endangered habitat types (and with reasonable rehabilitation potential) ; and / or • Loss of habitat that has special habitat attributes (e.g. high habitat diversity / species richness). ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of endangered species; and / or • Loss of regionally important species populations (e.g. at municipal scale). ***Direct use values:*** • Loss of human livelihoods; and / or • Some deterioration in human health; and / or • Loss of ecosystem services that are important (highly valued but not critical to) supporting / protecting vulnerable communities. Alternative options / resources are not available to meet community needs without incurring significant costs.
4	**Moderate**	***Water resource management:*** • Loss of regulating and supporting services important to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss could compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Moderate modification (1 classes) of critically endangered habitat / serious modification (2 classes) of endangered habitat; and / or • Loss of largely intact vulnerable habitat types; and / or • Loss of moderately modified endangered habitat types (and with reasonable rehabilitation potential). ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of vulnerable / endemic / specially protected species; and / or • Loss of or seriously compromises viable corridors that are locally important for species movement. ***Direct use values:*** • Notable impact on human livelihoods; and / or • Moderate reduction in the availability of ecosystem services that are important for supporting / protecting vulnerable communities; and / or

Score	Rating	Description
		• Loss of ecosystem services that are moderately valued by local communities. Alternative options / resources are available but limited.
2	**Moderately-Low**	***Water resource management:*** • Loss of regulating and supporting services which are not particularly important for water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss is unlikely to compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Moderate modification (1 classes) of endangered habitat / serious modification (2 classes) of vulnerable habitat; and / or • Loss of largely intact least-threatened habitat types; and / or • Loss of moderately modified vulnerable habitat types (and with reasonable rehabilitation potential). ***Species conservation:*** • Reduction in populations of vulnerable / endemic / specially protected species (without compromising viability of locally occurring populations); and / or • Loss of populations of locally important species. ***Direct use values:*** • Limited but identifiable impact on human livelihoods; and / or • Moderate reduction in the availability of ecosystem services with a noticeable but limited impact to livelihoods.
0	**Low**	***Water resource management:*** • Loss of regulating and supporting services which are not particularly important for water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss will not compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Loss of highly degraded threatened vegetation types (and with low rehabilitation potential) ; and / or • Moderate modification (1 classes) of vulnerable habitat; and / or • Loss of moderately modified least threatened habitat types. ***Species conservation:*** • Limited impact to any locally important species populations. ***Direct use values:*** • None / very limited impact on human livelihoods; and / or • None / limited reduction in the availability of ecosystem services with very limited impact to livelihoods.
Duration (D) – relates to the duration of the impact in time (consideration should be given to reversibility which may reduce the duration of impact)		

Score	Rating	Description
1	**Permanent**	The impact will continue indefinitely (>30 years) and is essentially regarded as irreversible.
0.95	**Long-term**	The impact and its effects will continue over the long-term (10 - 30 years).
0.85	**Medium-term**	The impact and its effects will persist for a number of years (1 – 10).
0.75	**Short-term**	The impact and its effects will persist for a number of months after the impact has occurred (2 -12 months) but is unlikely to persist for more than a year.
0.5	**Immediate**	The impact and its effects will cease within days or weeks after the impact has occurred (0 – 2 months).
Probability (P) – relates to the expected likelihood and frequency of the impact causing event occurring		
1	**Definite**	More than 80% likelihood of occurrence. The impact is typically recorded under similar conditions and settings.
0.95	**Highly Probable**	The impact has a 50-80% chance of occurring and thus expected to occur. The impact is known to occur regularly in similar conditions and settings.
0.8	**Probable**	The impact has a 20-50% chance of occurring and thus is quite likely to occur. The impact is known to occur quite frequently in similar conditions and settings (less than once in 10 years).
0.6	**Possible**	The impact has a 5-20% chance of occurring. This impact could occur and is known to occur irregularly under the similar conditions and settings (less than once in 20 years).
0.4	**Unlikely**	The possibility of the impact occurring is low with less than 5% chance of occurring. The impact has little chance of materialising (less than once in 50 years).

Table A2. Impact significance categories and definitions.

Impact Significance	Impact Significance Score Range	Definition
High	**14.5 - 20**	**Totally unacceptable** and fatally flawed from an environmental perspective. The proposed activity should only be approved under very special circumstances (i.e. national priorities with large societal benefit). If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms.
Moderately High	**12 – 14.4**	**Generally unacceptable** and should ideally be avoided. The potential impact will affect a decision regarding the proposed activity and require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks. If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms
Moderate	**8.5 – 11.9**	**Potentially unacceptable** and should ideally be reduced to lower significance levels. The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the project to justify the risks. If authorised, offsets should be considered to compensate for residual impacts.
Moderately Low	**4.5 - 8.4**	**Acceptable** with low to moderate risks. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.

Impact Significance	Impact Significance Score Range	Definition
Low	**0 – 4.4**	**Acceptable**. The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity.

Thank you. If you have any questions, please contact us via the contact details below.

Verdant Environmental

+27 73 121 339

ryan@verdantenv.co.za

Durban Office

12 Umkuhla Lane

Glen Anil

4051

Johannesburg Office

2nd Floor, Golden Oak House

Ballyoaks Office Park

35 Ballyclare Dr

Bryanston, 2191

Verdant Environmental