AQUATIC SPECIALIST STUDY:

Technical Specification Upgrades to the Modderfontein Wind Energy Facility, located in the Beaufort West REDZ - Part 2 Amendment Application

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SPECIALIST EXPERTISE: ANTONIA BELCHER

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Areas of specialisation:	Environmental water requirement studies River maintenance and management plans (MMP) Aquatic ecosystem monitoring and assessments Design of water quality and monitoring programmes for aquatic ecosystems Compilation of State of River reports (aquatic data collection, interpretation, presentation, graphic layout and design and preparation of technical and glossy print ready copies) Environmental Impact Assessments River classification and environmental water requirements (Ecological Reserve determinations) Integrated Water Resource Management River, Wetlands and Estuary management Water quality assessment and management reporting Water resource legislation Water resource institutions Water education
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Employment Record:	2020 – present Self-employed 2013 -2020 BlueScience (Pty) Ltd (Principal Specialist Scientist) 2007 – 2012 Self-employed 1999 – 2007 Assistant and Deputy Director, Water Resource Protection, Western Cape Regional Office, Department of Water Affairs, Cape Town 1995 – 1999 Institute for Water Quality Studies, Department of Water Affairs 1991 – 1995 Water Pollution Control Officer, Water Quality Management, Department of Water Affairs, Pretoria 1989 – 1990 Mathematics tutor and administrator, Master maths, Randburg and Braamfontein Colleges, Johannesburg 1987 – 1988 Part-time field researcher, Department of Oceanography, University of Port Elizabeth
Awards and Achievements:	Woman in Water award for Environmental Education (2006) Runner up for the Woman in Water prize for Water Research (2006)
Summary of recent experience	2008 – **Environmental water requirement studies** for various rivers in South Africa and Lesotho; Berg (Zones 1-3), Kingna, Baden, Konings and Poesjesnel **rivers maintenance and management plans**; **Water quality impact assessment** for the upgrade of more than 15 waste water treatment works in the Western Cape and consideration of reuse of the treated wastewater from many of these works for potable water supply; More than **350 freshwater impact assessments studies** as input into EIA decision making processes. Toni has conducted more than **150 water use authorisation**

	applications. This included more than 40 freshwater impact assessments for roads, power line and substation and renewable energy projects. Development of RDM (**Resource Directed Measures**) curriculum for a Master degree programme at University of science institutions in South Africa. Free State **river health monitoring** programme (monitoring for 3 year period). **Classification of the water resources** of the Olifants Doorn Water Management Area. Graphic design, layout, technical compilation and preparation of print ready glossy publications for the **State-of-River reports** for the Gouritz and Breede Water Management Areas Development and piloting of a National Strategy to **Improve Gender Representation in Water Management Institution**s, where the focus is on improving the capacity (specifically amongst women) to participate in water related decision making in Limpopo, Eastern Cape and KZN. Compilation of a background document as well as a framework management plan towards the development of an **integrated water resources management plan for the Sandveld**; Aquatic specialist to the City of Cape Town project: Determination of additional resources to **manage pollution in stormwater and river systems**; Framework for Education and Training in Water (FETWATER), Resource Directed Measures Network partner which has undertaken **training initiatives on environmental water requirements** in the SADC region; Resource Directed Management of Water Quality: **Development of training materials**, Department of Water Affairs and Forestry; and 2000 –2007: Manager responsible for the implementation of the Reserve Directed Measures component of the National Water Act Western Cape Regional Office; and Provincial Champion for the River Health Programme in the Western Cape and designed, implemented and compiled State-of-River reports for 7 catchment areas in the Western Cape. 1995 - 2000: Project manager and coordinator for the freshwater and marine water quality guidelines for South Africa; and Provided specialist input into various aspects of the new National Water Act and its implementation 1991 -1995: Water quality catchment studies Development and implementation of marine water quality policy for South Africa.

SPECIALIST DECLARATION

I, **Antonia Belcher**, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist: 

Name of Specialist: Antonia Belcher

Date: 25 June 2021

EXECUTIVE SUMMARY

The risk assessment determined that the proposed development of the Modderfontein WEF poses a **low** risk of impacting aquatic habitat, water flow and water quality. With these findings of the risk assessment, the water use activities associated with the proposed project could potentially be authorised by means of the general authorisations for the Section 21(c) and (i) water uses. A Water Use Licence (WUL) may however be required for the abstraction of water for the WEF which would require that an application for a WUL be submitted to the Department of Water and Sanitation (DWS) for the entire project related activities.

Based on the above findings, there is no reason from a freshwater perspective, why the proposed activity (with implementation of the above-mentioned mitigation measures) should not be authorized. The revised layout has further reduced any potential impacts to the aquatic ecosystems in the area.

LIST OF ABBREVIATIONS

BA	Basic Assessment
BGCMA	Breede Gouritz Catchment Management Agency
CBA	Critical Biodiversity Area
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DWA(F)	Department of Water Affairs (and Forestry)
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EI&ES	Ecological Importance and Ecological Sensitivity
EMPr	Environmental Management Programme
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Area
GA	General Authorisation
GIS	Global Information System
GN	Government Notice
ha	hectare
HI	Habitat Integrity
IUCN	International Union for Conservation of Nature
kW	kilowatt
MMP	Maintenance Management Plan
MW	megawatt
ONA	Other Natural Areas
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
PA	Protected Area
PES	Present Ecological Status
REC	Recommended Ecological Condition
REDZ	Renewable Energy Development Zone
SANBI	South African National Biodiversity Institute
SEA	Strategic Environmental Assessment
WCBSP	Western Cape Biodiversity Spatial Plan
WEF	Wind Energy Facility
WMA	Water Management Area
WUL	Water Use License
WULA	Water Use License Application

GLOSSARY

DEFINITIONS	
Catchment	The area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points
Critical Biodiversity Areas	Areas that are required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure.
Ecological Importance and Sensitivity	The rating of any given wetland or river reach that provides an indication of the ecological importance of the aquatic system using criteria such as conservation needy habitat or species, protected ecosystems or unique habitat observed. The sensitivity is then derived by assessing the resilience the habitat exhibits under stress as a result of changes in flow or water quality.
Ecological Support Areas	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas or Critical Biodiversity Areas and are often vital for delivering ecosystem services.
Other Natural Areas	Areas that have not been identified as a priority in the biodiversity spatial plans but retain most of their natural character and perform a range of biodiversity and ecological infrastructure functions. Although they have not been prioritised for meeting biodiversity targets, they are still an important part of the natural ecosystem.
Present Ecological State	The current ecological condition of a watercourse as measured against the deviation from the natural or pre-impacted condition of the system
Protected Areas	Areas that are formally protected by law and recognised in terms of the National Environmental Management: Protected Areas Act. This includes gazetted private Nature Reserves and Protected Environments concluded via a stewardship programme.
Riparian habitat	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
River FEPA	Rivers currently in a good condition (A or B ecological category) that have been identified to achieve biodiversity targets for river ecosystems and threatened/near-threatened fish species. They should remain in a good condition to contribute to the biodiversity goals of the country.
Upstream Management Areas	Sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream River FEPAs
Valley-bottom wetlands	Wetlands located on the valley floors that are mostly fed by overland inflow, hillslope interflow and groundwater. They may be channelled or un-channelled.
Watercourse	(a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister of DWS may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;
Water management area	An area established as a management unit in the national water resource strategy within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources
Wetland	Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.
Wetland FEPA	Wetlands currently in a good condition (A or B ecological category) that have been identified to achieve biodiversity targets for river ecosystems and threatened/near-threatened fish species. They should remain in a good condition in order to contribute to the biodiversity goals of the country.

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1. INTRODUCTION AND METHODOLOGY

1.1 Scope and Objectives

This Aquatic Specialist Assessment is intended to inform a Part 2 Amendment Application for the proposed Modderfontein Wind Energy Facility (WEF) located within the Beaufort West Renewable Energy Development Zone (REDZ), published in terms of Section 24(3) of the National Environmental Management Act, 1998 (NEMA) in Government Notice (GN) R114 of 16 February 2018.

1.2 Terms of Reference

The terms of reference for the Aquatic Impact Assessment are as follows:

- Compilation of a Specialist Impact Assessment Report in compliance with the NEMA EIA Regulations 2014 to inform the Amendment Report for the Public Participation Process
- All Reports and Processes must meet the requirements of the NEMA EIA Regulations (2014, as amended), including any specific requirements for a Site Sensitivity Verification Report and any applicable best practice guidelines and policies within your discipline and any other applicable statutory requirements within your discipline.
- All Reports and Processes must also be compliant with the terms of reference specified above.

<u>Revised Specialist Report notes:</u>

- Specialist Reports are required to accurately contextualise the site and assessment for a REDZ receiving environment
- The no-go alternative is the ''status quo'' and as agreed with the Competent Authority for Amendment Applications is what is currently authorised and which in this case is the currently authorised 67 WTG layout option
- The preferred alternative is the proposed layout (the 34 WTG layout with associated civils)
- Specialists are to please make a clear concluding statement in their reports with respect to their findings with the no-go alternative and the preferred alternative
- Specialists are to please make a clear concluding statement in their reports with respect to the reduced overall impacts (quantified where possible) from the no-go alternative (67 WTGs) to the preferred alternative (34 WTGs)

- Google KML or KMZ maps should be provided as appropriate to findings, demonstrating i) developable and ii) no go areas

1.3 Approach and Methodology

Input into this report was informed by a combination of desktop assessments of existing freshwater ecosystem information for the study area and surrounding catchments, as well as by a more detailed assessment of the freshwater features on the various farm portions that comprise the study area.

The site was visited for two days in December 2020. No additional site visits were deemed necessary. During the field visits, the characterisation and integrity assessments of the freshwater features were undertaken. Mapping of the freshwater features was undertaken using a GPS Tracker and mapped in PlanetGIS and Google Earth Professional.

The following techniques and methodologies were utilised to undertake this study:

1 The guideline document, "A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas" document, as published by DWAF (2005) was followed for the delineation of the wetland areas. According to the delineation procedure, the wetlands were delineated by considering the following wetland indicators: terrain unit indicator; soil form indicator; soil wetness indicator; and vegetation indicator;
2 The wetlands were subsequently classified according to their hydro-geomorphic determinants based on a classification system devised by Kotze et al (2004) and SANBI (2009). Notes were made on the levels of degradation in the wetlands based on field experience and a general understanding of the types of systems present;
3 A Present Ecological State (PES) assessment was conducted for each hydro-geomorphic wetland unit identified and delineated within the study area;
4 The functional wetland assessment technique, WET-EcoServices, developed by Kotze et al (2009) was used to indicate the ecological benefits and services provided by delineated wetland habitat. This technique consists of assessing a combination of desktop and infield criteria to identify the importance and level of functioning of the wetland units within the landscape;
5 The present ecological condition of the watercourses was determined using national River Health Programme methodologies as described in this report;
6 The ecological importance and ecological sensitivity (EI&ES) assessment of the wetlands and watercourses were conducted according to the guidelines as developed by DWAF (1999); and
7 Recommendations are made with respect to the adoption of buffer zones within the development site, based on the wetlands functioning and site characteristics.

1.4 Assumptions and Limitations

Limitations and uncertainties often exist within the various techniques adopted to assess the condition of ecosystems. The methodologies and techniques used in this assessment have been developed nationally and are typically of a rapid nature as is required for this freshwater impact assessment.

Given the topography at the site, it was not possible to cover the site in a high level of detail. Extrapolation of the areas ground-truthed to those not covered was thus done using the latest available aerial imagery for the site. No baseline long-term monitoring was undertaken as part of this assessment. In addition, there is very little existing information available for the aquatic features within the study area. Data was utilised for adjacent aquatic ecosystems and where available more detailed assessments were used for the aquatic features within the area.

The nature of the proposed activities however also allows them to be placed some distance from any mapped aquatic features such that the likely impacts would be very low. It is usually the associated infrastructure that has the potential to have a greater impact on the aquatic features. The impacts of roads and powerlines on the aquatic features are however well understood and can be effectively mitigated to ensure the impacts remain low. The preferred mitigation measure is to limit the disturbance to aquatic features as far as possible by avoiding and minimising the number of crossings and providing adequate buffer areas. This will also ensure that the cumulative impacts will remain low.

The level of aquatic assessment undertaken was considered to be adequate for this study. No further fieldwork will be required, if the proposed project activities remain outside of the delineated aquatic features and the recommended buffers.

1.5 Source of Information

Information used in this freshwater impact assessment includes:

- The 2011 specialist ecological report for the approved development;
- The satellite image used as a background to all maps was obtained from PlanetGIS and Google Earth Professional;
- The SANBI Biodiversity GIS, CapeFarmMapper and Freshwater Biodiversity Information System websites were consulted to identify any constraints in terms of geology, soils, natural vegetation cover, fine-scale biodiversity conservation mapping as well as possible freshwater features mapped in the Freshwater Ecosystem Priority Areas maps;
- Available PES and EI&ES data from the watercourses in the area was obtained from the national Desktop PES EI ES Assessment undertaken by DWA in 2012;
- Water Resources 2012 and climate data from the South African Atlas of Climatology and Agrohydrology (2009, RE Schulze) was utilised to determine the runoff; and
- Project information sourced from the client.

2. DESCRIPTION OF PROJECT ASPECTS RELEVANT TO THE AQUATIC ECOSYSTEM IMPACTS

The Modderfontein WEF is located in the catchment of the Brak River, a tributary of the Buffels / Kariega Rivers in the Groot / Gamtoos River System with the south-western portion within the upper

catchment of the Tierhoekspruit, a tributary of the Sout River in the Groot / Gamtoos River System. The rivers within the area lie within the Fish to Tsitsikamma Water Management Area, within Quaternary Catchment L21A, with the south-western portion falling within Quaternary Catchment L11C.

The original Environmental Authorisation (EA as attached and dated February 2012 and with EA Extension date February 2020) has authorised the following specifications:

- Up to 67 WTGs with a total generating capacity of 201 MW using turbines with a generating capacity of up to 3MW

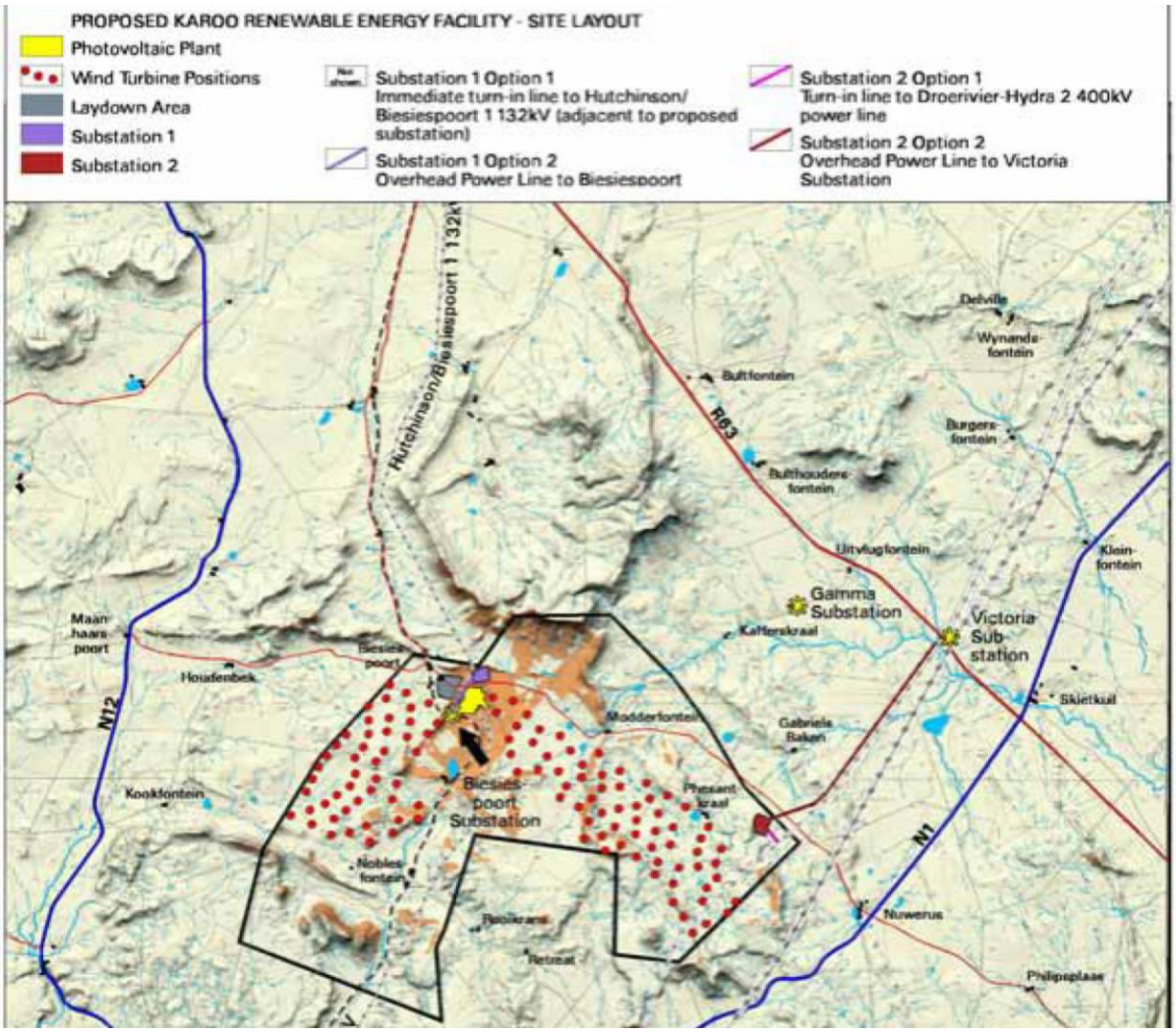


Figure 1. Map showing the authorised layout, with 67 turbines (from 2011 Savannah report) where the current study area is only the area east of the Biesiespoort Substation.

The Proposal is the following technical specification upgrades to the existing EA:

- Up to 34 WTGs with a total generating capacity of 140MW (cluster 1) and 50.4MW (cluster 2);
- A total output of 190.4MW;
- WTGs with a generating capacity of up to 5.6 MW.
- The proposed development will be an approximately 50% reduction in turbine density

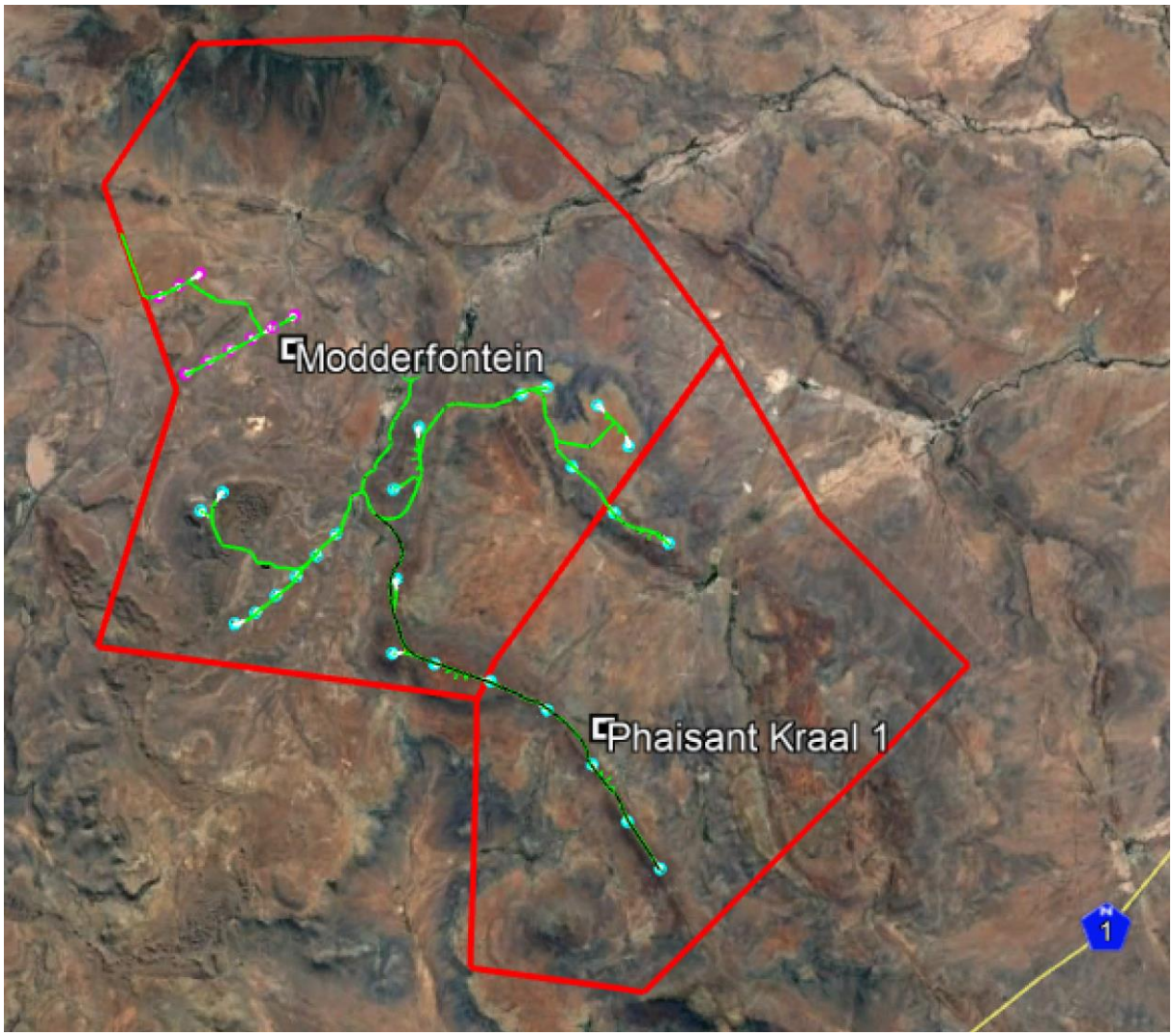


Figure 2. Google Earth image with the new proposed layout

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Topography

The proposed WEF is located within the Modderfontein and Phaisant Kraal 1 Farms north of Beaufort West. Modderfontein Farm lies within the Northern Cape while Phaisant Kraal 1 Farm lies within the Western Cape. The proposed WEF is largely located on the lower-lying hilltops in the southwestern portions of the site.

The proposed wind turbines are to be placed on the hilltops in the upper reaches of several tributaries of the Brak River in the Groot / Gamtoos River System (Figure 3). The rivers drain towards the east, with the Brak River draining the Modderfontein Farm in the northern portion of the study site and the Gabrielspruit River draining the Phaisant Kraal 1 Farm. These rivers join to form the Brak River which drains into the Buffels River a tributary of the Kariega River that feeds into the Groot / Gamtoos River. On the western extent of the site, the Kareespruit and the Tierhoekspruit drain southwards to the Sout and Buffels Tributaries of the Groot River respectively.

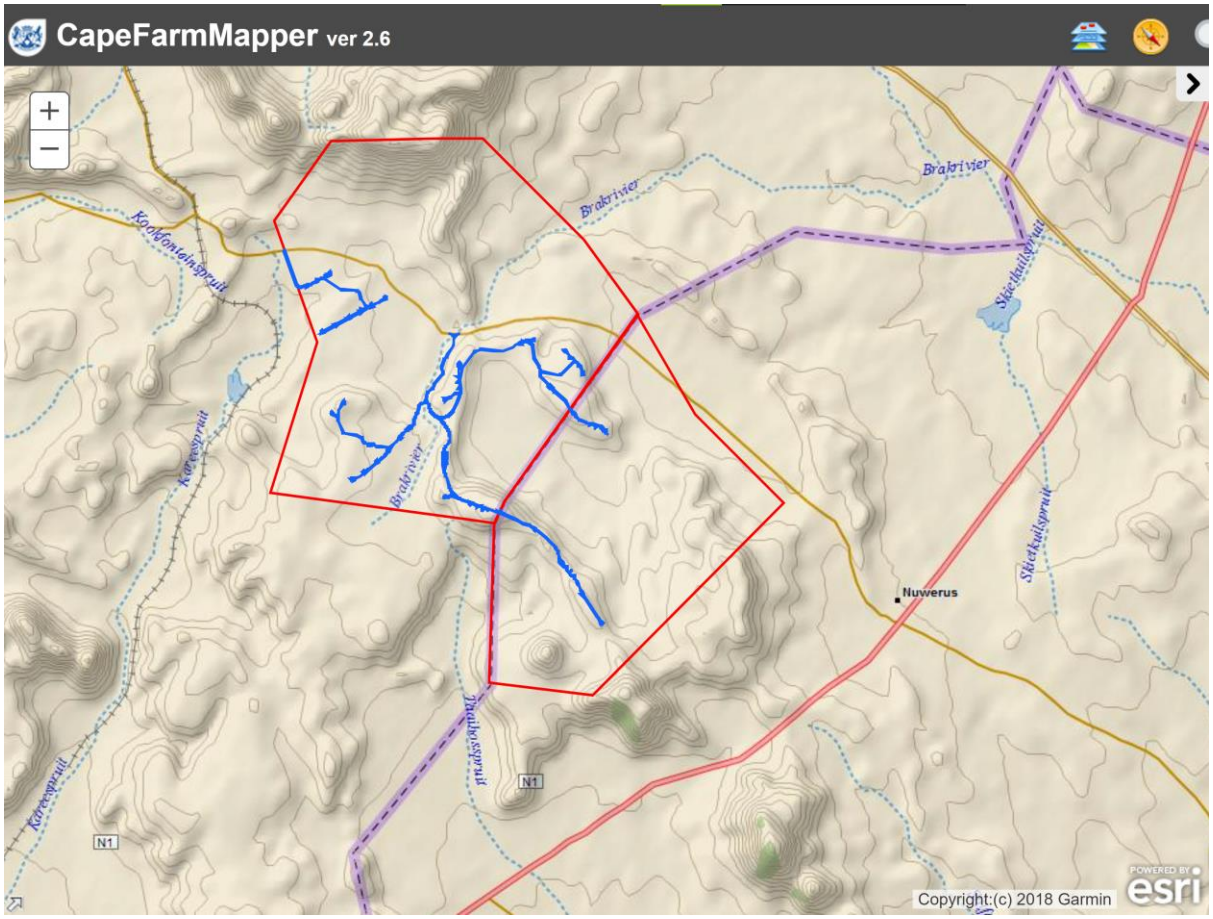


Figure 3. Relief map for the area, showing the topography and main watercourses and the location of the WEF (CapeFarmMapper, 2021)

The access road into the site from the north is located along the Brak River, following the existing road. South of this, the road network within the site also tends to be placed along the hill tops. As a result of the placement of most of the proposed project infrastructure on the hill tops, the need to avoid aquatic features is minimised.

Table 1 provides an overview and summary of the water resource information for the farm on which the development is proposed.

Table 1: **Key water resources information for the proposed project development area**

Descriptor	Name / details	Notes
Water Management Area	Fish Tsitsikamma WMA	
Catchment Area	Brak and Gabrielspruit and Tierhoekspruit, tributaries of Kariega River Kareespruit, tributary of the Sout River	Upper portion of the Groot Gamtoos Catchment
Quaternary Catchment	Brak and Gabrielspruit Rivers (L21A) Taaibos/Tierhoekspruit (L22A) Kareespruit (L11C)	
Present Ecological state	Brak and Kareespruit: C (moderately modified) Taaibos/Tierhoekspruit: B (largely natural)	DWS (2012)
Ecological Importance and Ecological Sensitivity	Brak and Taaibos- High EI and Moderate ES Kareespruit: Moderate EI and ES	
Type of water resources	Rivers, ephemeral streams and valley floor wetlands	

3.2 Climate and Hydrology

The study area experiences a low rainfall of 241mm per annum. Rainfall falls mostly in late summer/autumn with June being the highest rainfall month on average. Winters (June – August) are typically colder than summers which experience average daily highs of 20°C (December – February) (Figure 4). Flow in the smaller tributaries in the upper catchment tends to be episodic (Figure 5) with very little to no flow in the rivers for much of the year. Flow typically only occurs for a short period following localised rainfall. These rainfall events tend to mostly occur in the higher rainfall months in late summer and into autumn. When flow occurs in the watercourses it occurs as a high flow event. This flow pattern is unlikely to change significantly due to longer-term climatic changes. The flow nature does however make erosion control measures in the watercourses, particularly on the slopes, essential mitigation.

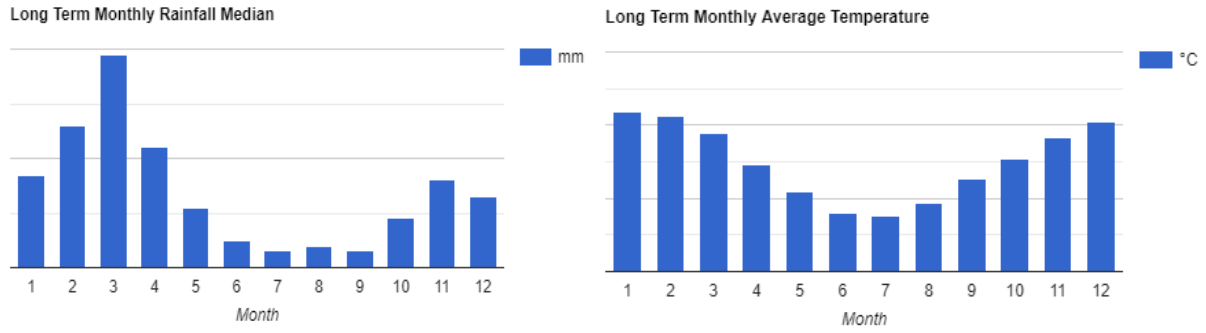


Figure 4. Average monthly rainfall (left) and temperatures (right) for the study area, collected between 1950 and 2000 (Schulze, 2009)

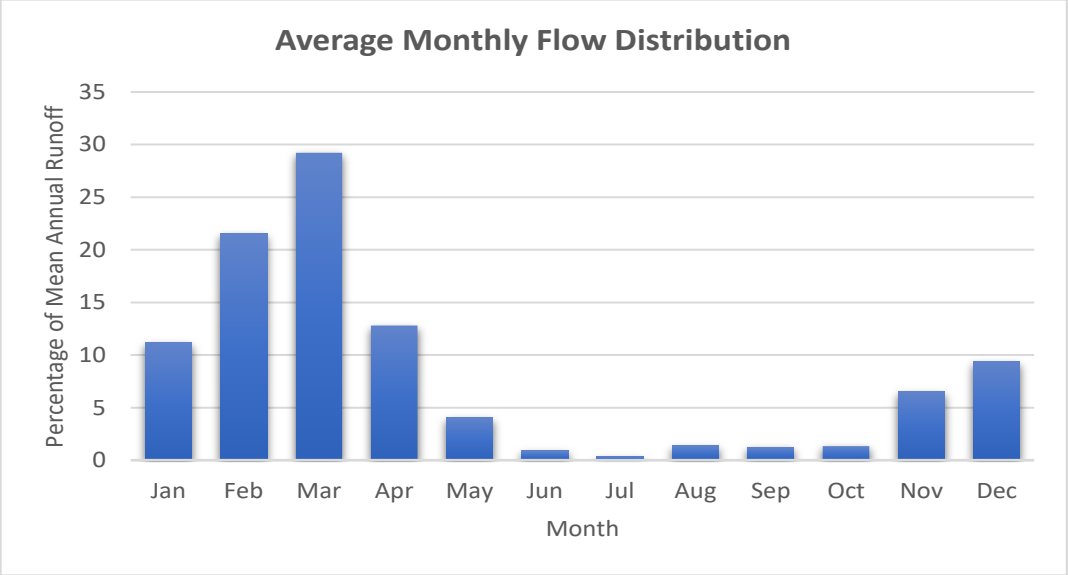


Figure 5. Monthly flow distribution within the rivers in the study area, with the month flow shown as a percentage of the natural mean annual runoff (nMAR) for the catchment

3.3 Geology and Soils

The underlying geology in the area comprises mudstone and shale of the Beaufort Group and the Karoo System with dolerite intrusions in places occur within the area. The soils are usually shallow on hard or weathering rock on higher-lying areas. Within the valley floor of the larger rivers, soils have a marked clay accumulation and moderate to high erodibility.

3.4 Vegetation

Under unmodified conditions, two vegetation types occur across the wider study area; these are Eastern Upper Karoo (Least Threatened) with a band of Upper Karoo Hardeveld (Least Threatened) (Figure 7). Southern Karoo Riviere vegetation occurs along the larger rivers in the west of the study area. The vegetation reflects the varied topography and associated geology of the area. Upper Karoo Hardeveld occurs on all the koppies, tabletops and higher-lying areas**,** while Eastern Upper Karoo occurs in the valleys and lower slopes are, and Southern Karoo Riviere within the main river valleys**.** The proposed turbines and most of the road infrastructure in the amended layout are located on the hilltops and within Upper Karoo Hardeveld. Upper Karoo Hardeveld tends to be richer in species than the other two vegetation types due to increased habitat diversity.

The Southern Karoo Riviere vegetation comprises largely of *Vachellia karroo* or *Tamarix usneoides* thickets fringed by tall *Salsola aphylla* dominated shrubland and comprising of *Stipagrostis namaquensis* grass within the sandy drainage lines. Most of the vegetation associated with the aquatic features within the valley floors in the study area is still largely natural and comprises a mix of low trees and shrubs such as *Vachellia karroo*, *Searsia lancea, Euclea undulata*, *Melianthus comosus, Lycium*

spp. and *Asparagus striatus* within the riparian zones. Patches of common *Phragmites australis* reeds, grasses such as *Stipagrostis namaquensis* with *Juncus* rushes within the instream habitat. There is a low density of invasive alien plants such as *Eucalyptus* and pepper trees (*Schinus molle*) occurring in the more disturbed aquatic habitats.

3.5 Biodiversity Conservation Value

The Department of Environment Affairs Screening Tool map for the Aquatic Biodiversity Combined Sensitivity at the site indicates the wider area to be of low sensitivity with only the wide valley floor wetland associated with the main channel of the Brak River, upper reaches of the Taaibosspruit and the upper Kareespruit Rivers are mapped as being of very high sensitivity (Figure 6).

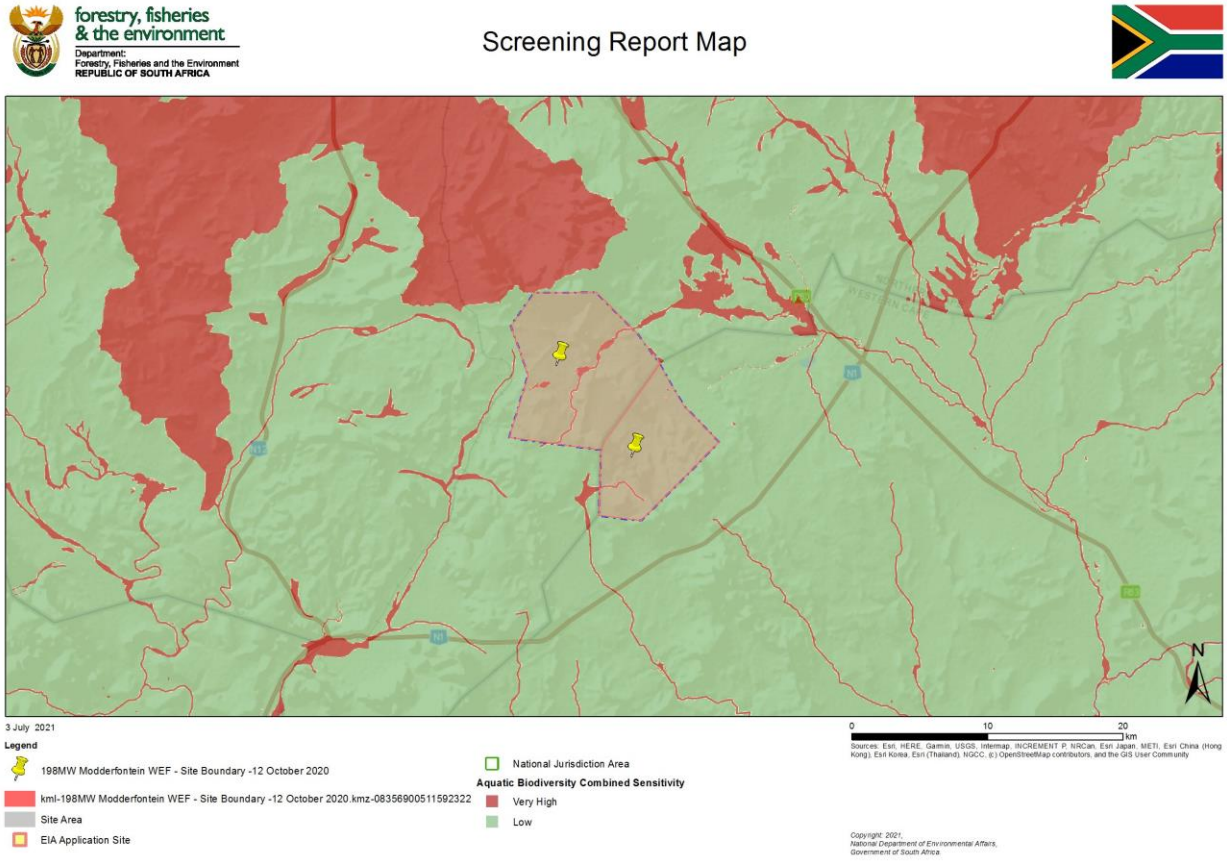


Figure 6. DEA Screening Tool mapping of the area for Aquatic Biodiversity Combined Sensitivity

There are three freshwater biodiversity conservation mapping initiatives of relevance to the study area because the site is split over two provinces: the national Freshwater Ecosystem Priority Areas (FEPAs) and the 2017 Western Cape Biodiversity Spatial Plan (WCBSP) and the 2016 Northern Cape Critical Biodiversity Area.

FEPAs are intended to provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPAs were determined through a process of systematic biodiversity planning and were identified using a range of criteria for serving

ecosystems and associated biodiversity of rivers, wetlands and estuaries. The study area is located within an Upstream River FEPA (pale green areas in Figure 8) for the Kariega River and larger Groot and Gamtoos Rivers. The goal for Upstream River FEPAs is that they should not be allowed to degrade the downstream river ecosystem further. There are several instream wetland areas within the channel of the larger watercourses that form part of the Brak River System that has been mapped as FEPA Wetlands (Upper Nama Karoo Channelled and Unchannelled valley-bottom wetland as well as seeps).

The 2017 WCBSP used available land cover data to identify areas of potential biodiversity importance. The use of land cover data means that data collected by a site visit is still required to confirm the ecological condition of the area. The WCBSP mapping comprises the following categories:

- CBA1- Critical Biodiversity Areas likely to be in a natural condition (terrestrial, forest, river, estuary and wetland);
- CBA2 – Potentially degraded Critical Biodiversity Areas or those that contain secondary vegetation (terrestrial and aquatic);
- ESA1 – Natural or near natural Ecological Support Areas (terrestrial and aquatic);
- ESA2 – Ecological Support Areas degraded and require restoration where feasible; and
- ONA – Other Natural Areas have not been identified as a priority to meet biodiversity targets.

Within the WCBSP the watercourses are all mapped as aquatic ESAs (ESA1). Very limited aquatic ESAs (ESA2) occur only where there is localised disturbance within the watercourses such as at the gravel road crossings. Within the Northern Cape CBA mapping of 2016, the larger Brak River is mapped as an ESA with a 500m buffer. The river is linked as an ecological corridor with the adjacent high lying areas.

3.6 Aquatic Habitat and Species of Concern

The watercourses in the study area are non-perennial, however, some rock pools and dams are likely to contain water for most of the year. As a result, no indigenous fishes occur within the rivers and the amphibian diversity within the study area is likely to be relatively low. No species of conservation concern are known to occur in the study area from an aquatic perspective. The species likely to be present are quite widespread and of low conservation concern. These include the Karoo Dainty Frog, *Cacosternum karooicum* (Data Deficient), the Cape Sand Frog, *Tomopterna delalandii* and the Raucous Toad, *Amietophrynus rangeri*. The latter two amphibian species are listed as “Not Threatened”.

A faunal species potentially in the area and associated with the watercourses in the landscape is the Riverine Rabbit that is listed as Critically Endangered. The habitat preference of Riverine Rabbits is alluvial seasonal watercourses, browsing on *Pteronia erythrochaetha, Kochia pubescens, Salsola glabrescens* and Mesembryanthemaceae. They are unable to survive on heavily overgrazed or agriculturally transformed habitats.

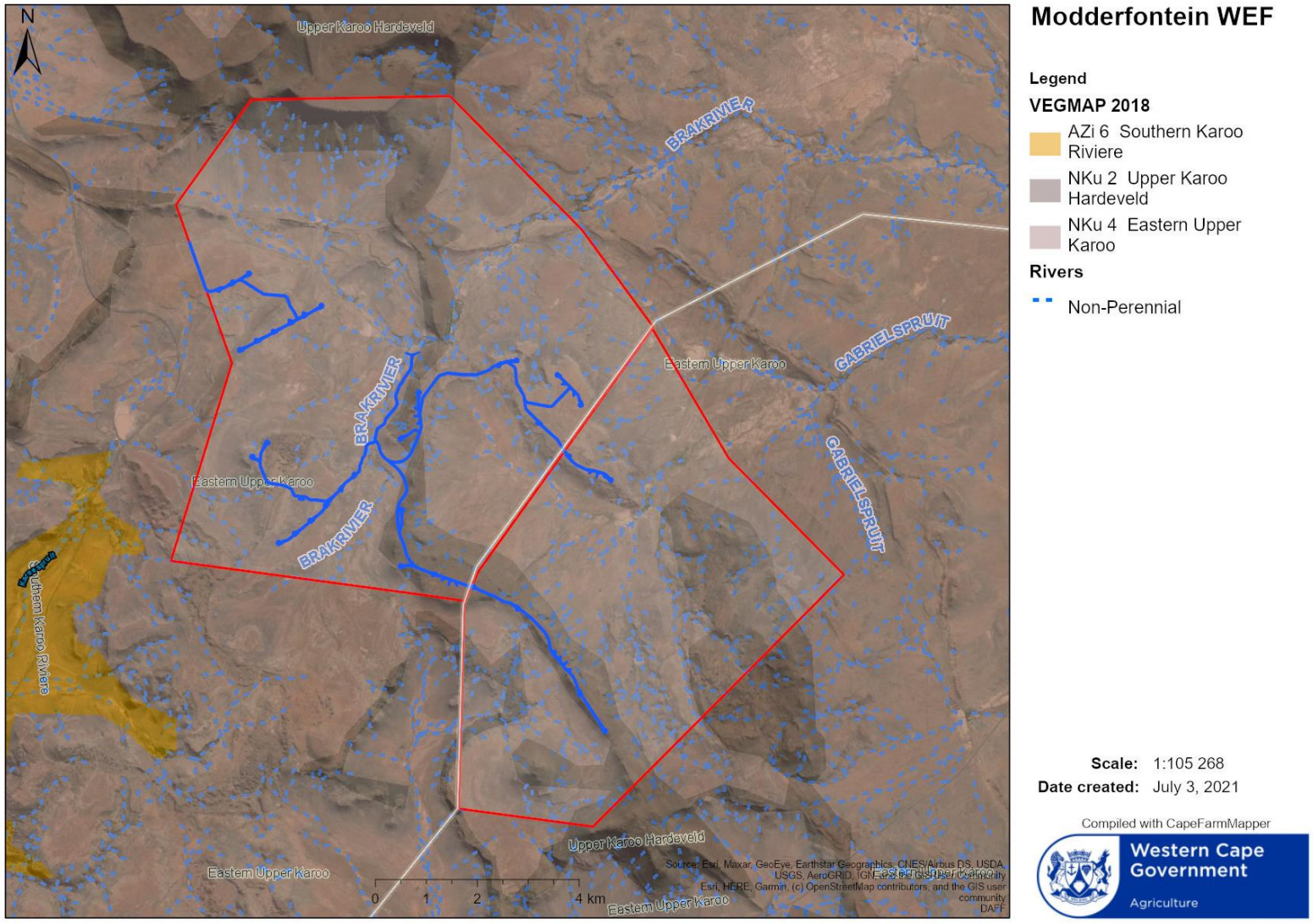


Figure 7. National Vegetation Map (2018 VegMap) for the study area (red outlined area) (CapeFarmMapper, 2021)

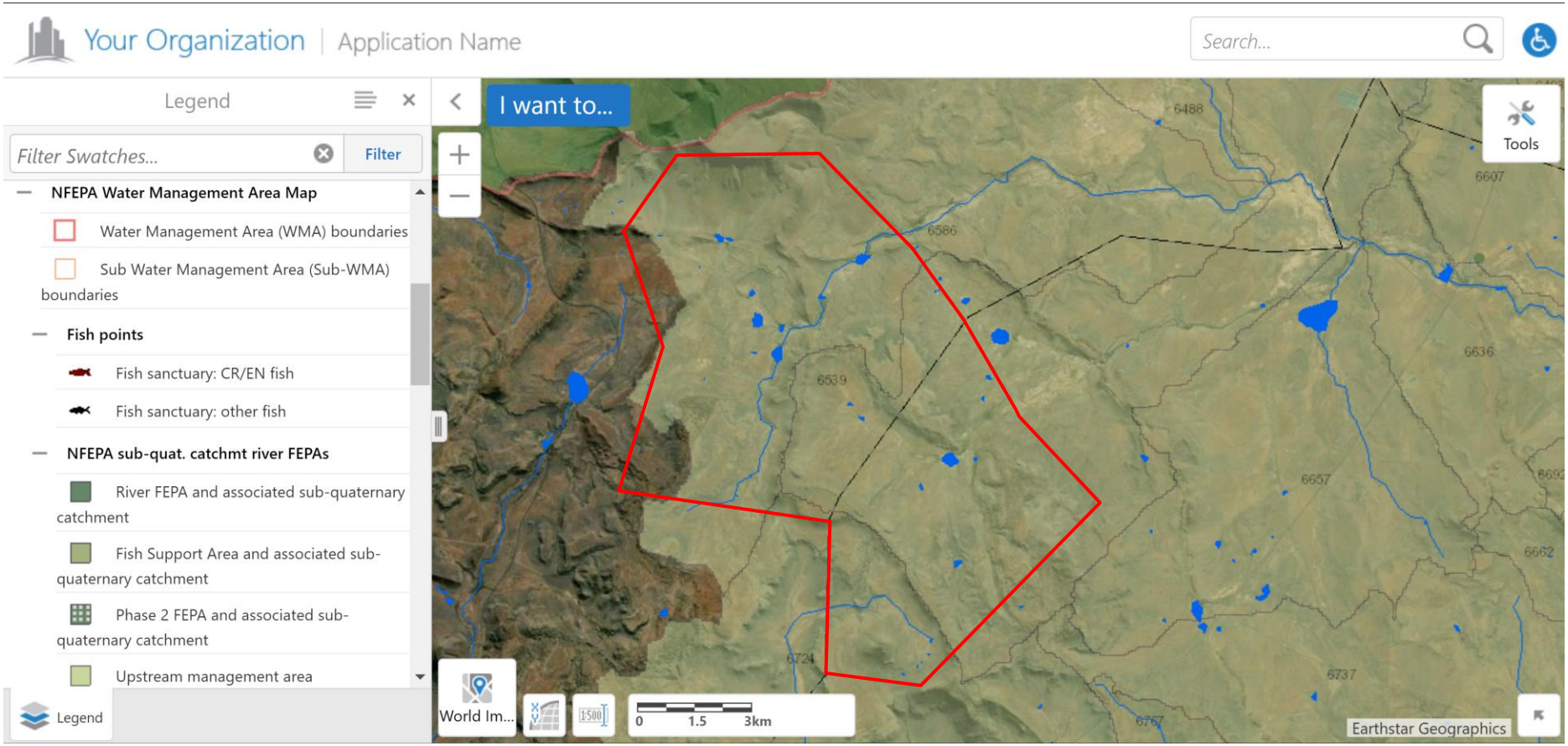


Figure 8. National Freshwater Ecosystem Priority Areas for the study area (red outline) (SANBI Biodiversity GIS, 2021)

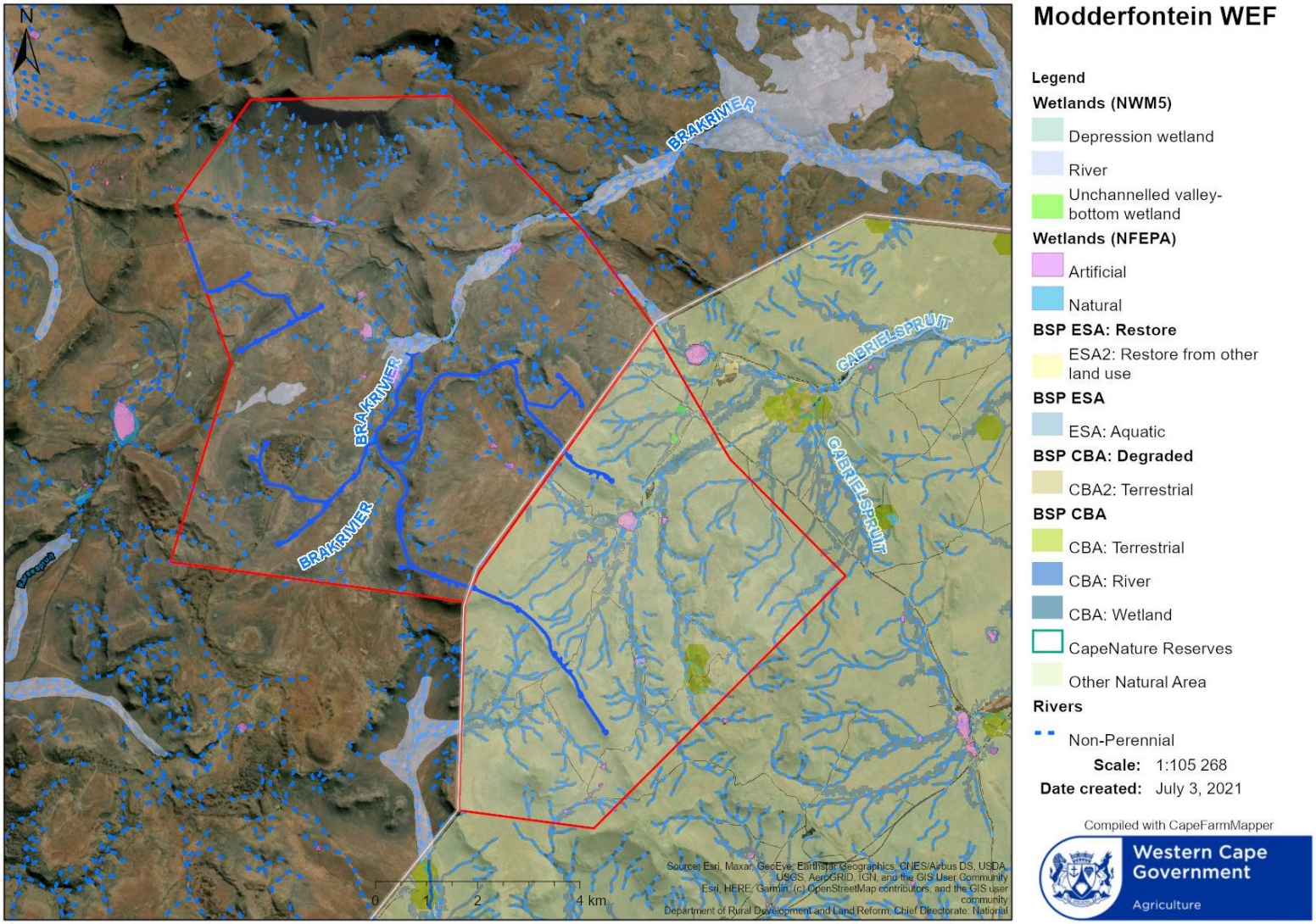


Figure 9. The 2017 Western Cape Biodiversity Spatial Plan (CapeFarmMapper, 2021)

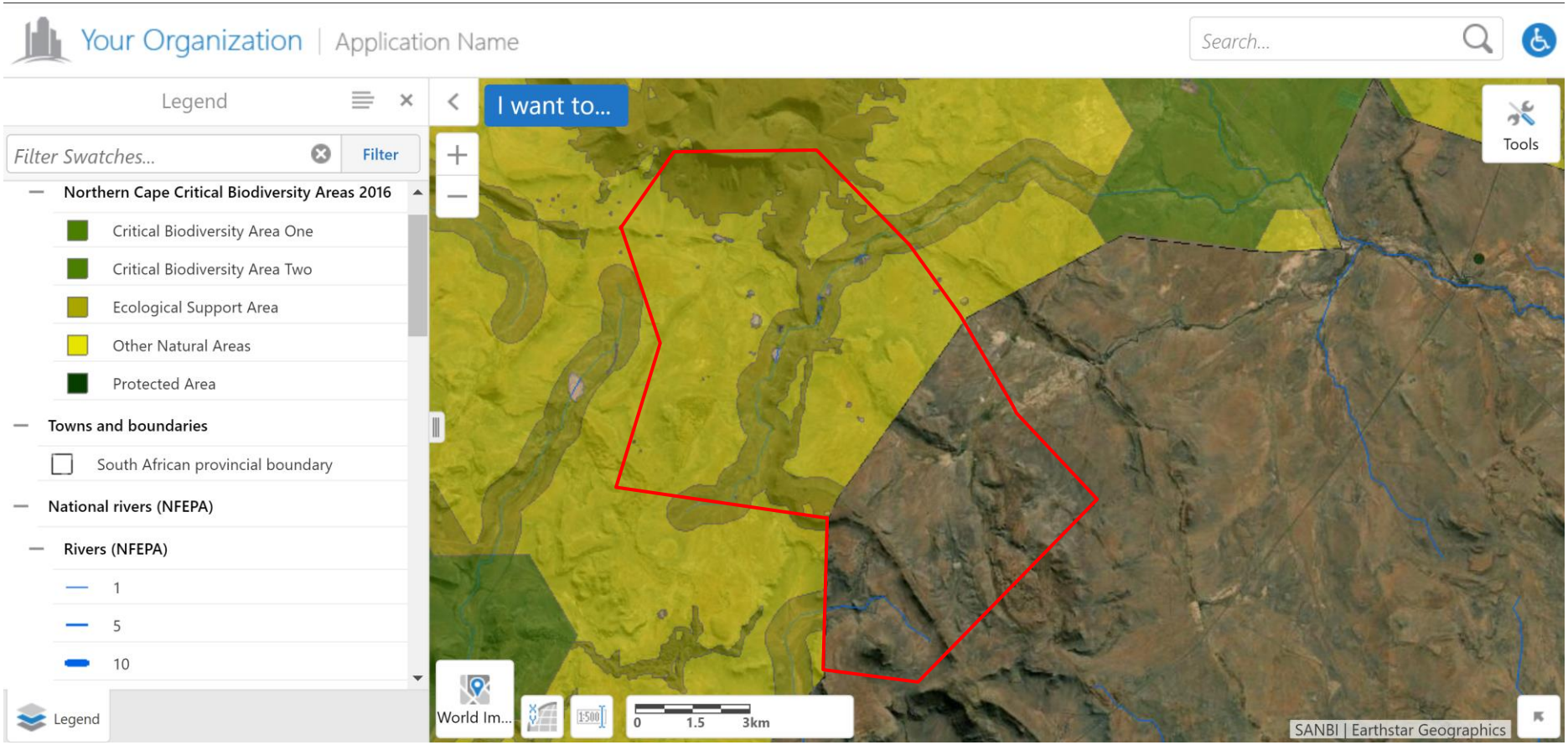


Figure 10. The 2016 Northern Cape Critical Biodiversity Areas for the study area (red outlined area) (SANBI Biodiversity GIS, 2021)

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The proposed activity needs to take cognizance of the legislative requirements, policies, strategies, guidelines and principles of the relevant regulatory documents of the Eden District, as well as the National Water Act (NWA) and the National Environmental Management Act (NEMA).

4.1 The National Environmental Management Act (Act No. 107 of 1998)

NEMA is the overarching piece of legislation for environmental management in South Africa and includes provisions that must be considered to give effect to the general objectives of integrated environmental management.

Chapter Seven of the NEMA states that:

"Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment".

The Act also clearly states that the landowner, or the person using or controlling the land, is responsible for taking measures to control and rectify any degradation. These may include measures to:

"(a) investigate, assess and evaluate the impact on the environment;

(b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment:

(c) cease, modify or control any act, activity or process causing the pollution or degradation:

(d) contain or prevent the movement of pollutants or degradation: or

(e) eliminate any source of pollution or degradation: or

(f) remedy the effects of the pollution or degradation."

4.2 NEMA Environmental Impact Assessment Regulations, 2014, as amended

NEMA provides for the identification of activities that will impact the environment, in terms of Section 24. These activities were promulgated in terms of Government Notice No. R. 324, 325 and 327, dated 4 December 2014, as amended, and requires environmental authorisation. The impacts of the listed activities must be investigated in April 2017, assessed and reported to the competent authority before authorisation to commence with such listed activities can be granted.

4.3 National Water Act, 1998 (Act No. 36 of 1998)

The purpose of the National Water Act, 1998 (NWA) is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorisation and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The Act aims to regulate the use of water and activities (as defined in Part 4, Section 21 of the NWA), which may impact water resources through the categorisation of 'listed water uses' encompassing water abstraction and flow attenuation within catchments as well as the potential contamination of water resources, where the DWS is the administering body in this regard. Defined water use activities require the approval of DWS in the form of a General Authorisation (GA) or WUL. There are restrictions on the extent and scale of listed activities for which General Authorisations apply.

Section 22(3) of the NWA allows for a responsible authority (DWS) to dispense with the requirement for a WUL if it is satisfied that the purpose of the Act will be met by the grant of a licence, permit or authorisation under any other law.

4.3.1 Regulations requiring that a water user be registered, GN R.1352 (1999)

Regulations requiring the registration of water users were promulgated by the Minister of Water Affairs in terms of provision made in Section 26(1)(c), read together with Section 69 of the National Water Act, 1998. Section 26(1)(c) of the Act allows for registration of all water uses including existing lawful water use in terms of Section 34(2). Section 29(1)(b)(vi) also states that in the case of a GA, the responsible authority may attach a condition requiring the registration of such water use. The Regulations (Art. 3) oblige any water user as defined under Section 21 of the Act to register such use with the responsible authority and effectively to apply for a Registration Certificate as contemplated under Art.7(1) of the Regulations.

4.3.2 General Authorisations in terms of Section. 39 of the NWA

According to the preamble to Part 6 of the NWA, 1998, "*This Part established a procedure to enable a responsible authority, after public consultation, to permit the use of water by publishing general authorisations in the Gazette*…" and further states that "*The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary*…"

The GAs for Section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA have recently been revised (Government Notice R509 of 2016). The proposed works within or adjacent to the wetland areas and

river channels are likely to change the characteristics of the associated freshwater ecosystems and may therefore require authorization. Determining if a water use licence is required for these water uses is now associated with the risk of degrading the ecological status of a watercourse. A low risk of impact could be authorised in terms of a GA. A risk assessment has been undertaken for the new proposed Modderfontein WEF and is discussed in this report, under Section 1.6.6.

5. IDENTIFICATION OF KEY ISSUES

5.1 Key Issues Identified

Most of the potential aquatic ecosystem impacts of the proposed WEF are likely to take place during the construction phase. These potential impacts and the associated issues identified include:

- Disturbance of aquatic habitats within the watercourses and wetland areas with the associated impacts to sensitive aquatic biota;
- The removal of indigenous riparian and instream vegetation that will reduce the ecological integrity and functionality of the watercourses;
- Demand for water for construction could place stress on the existing available water resources;
- Alien vegetation infestation within the aquatic features due to disturbance; and
- Increased sedimentation and risks of contamination of surface water runoff during construction.

During the operational phase of the proposed WEF, potential impacts would include:

- Ongoing disturbance of aquatic features and associated vegetation along access roads or adjacent to infrastructure that needs to be maintained;
- Modified runoff characteristics from hardened surfaces that have the potential to result in erosion of hillslopes and watercourses; and
- Water supply (and possibly sanitation services) required for the operation of the facility.

No consultation process was deemed to be required during preparing this baseline freshwater specialist report.

5.2 Potential Impacts

The potential impacts identified during this basic freshwater assessment are as follows:

Construction Phase:

Modification or loss of aquatic habitat and water quality impacts;

Operational Phase: Degradation of ecological condition of aquatic ecosystems; modification of flow and water quality; erosion; and alien vegetation invasion in aquatic features

Decommissioning Phase: Disturbance of aquatic habitats and water quality impacts.

Cumulative impacts: Degradation of ecological condition of aquatic ecosystems.

6. ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The proposed WEF and associated infrastructure (internal roads) have the potential to impact the freshwater features if located within or immediately adjacent to the aquatic features. As there is some flexibility relating to the exact location of the turbines within a large project site, it is usually easy to mitigate the impact of the turbines on the freshwater features within the site by locating them sufficiently far enough away from the freshwater features. This approach has been taken with the revised layout, where all the turbine locations within the recommended buffers to the aquatic features have been moved outside of these areas. Thus, it is usually the associated infrastructure that potentially impacts more on the freshwater features, since the internal and access roads associated with the WEF usually need to cross freshwater features. Such crossings and disturbances of the freshwater features need to be minimised and mitigated as far as possible. This aspect has also been addressed in the revised layout.

6.1 Ecological Assessment of the Aquatic Features within the Study area

This section comprises a description of the aquatic ecosystems within the study area as well as an assessment of their present ecological condition and their ecological importance and ecological sensitivity. The aquatic features within the study area consist of the upper reaches of the Brak, Gabrielspruit, Tierhoekspruit and Kareespruit Rivers and their lesser, unnamed tributaries, as well as some valley bottom/floor wetlands associated with the larger watercourses and some small dams. The Present Ecological Status (PES) of the rivers and tributaries was determined using Habitat Integrity (HI) Assessments and the Site Characterisation information. The ecological importance and sensitivity of the rivers were also assessed. The patches of valley bottom/floor wetland areas are closely associated with the rivers and thus have been included in the rivers' assessments.

6.1.1 Description of Aquatic Features

Brak River

The Brak River is the main watercourse within the study area and flows westwards through the northern portions of the site, in the Modderfontein Farm, to drain into the Buffels / Kariega Rivers in the Groot / Gamtoos River System. Several minor tributaries of the river drain the hilltops on which

wind turbines are proposed. There are several larger valley floor wetlands associated with the river that are located within the site but are mostly not located near any of the proposed activities except where there are existing farm roads to be upgraded within the valley floor adjacent to the river. The mainstem of the river is in a moderately modified ecological condition with some flow modification and disturbance of habitat within its upper catchment. The tributaries on the hillslopes are all mostly still in a largely natural ecological condition. The river and its tributaries within the site are all mapped as aquatic ESAs. The river lies within an Upstream FEPA River Sub-Catchment.

Gabrielspruit River

The Gabrielspruit River is located to the south of the Brak River, in the Phaisant Kraal 1 Farm. The river also flows eastwards and confluences with Brak River downstream of the site. The main channel of the river is in a similar ecological condition to the Brak River and subject to similar flow and habitat disturbance impacts. As with the Brak River, the tributaries are all still in a largely natural ecological condition. The river and its tributaries are mapped as aquatic ESAs and the river lies within the Upstream FEPA River Sub-Catchment.

Tierhoekspruit River

The Tierhoekspruit tributary of the Brak River in the Groot / Gamtoos River System lies in the southwestern portion of the study area. The river originates as smaller streams to the southwest of where wind turbines are proposed on the south-western portion of the site. The watercourses within the site are still in a natural ecological condition with little to no disturbance except for farm roads and the Eskom servitude that cross some of the minor tributaries of the river. The watercourses associated with the river are all mapped as aquatic ESAs and the river falls within the Upstream FEPA River Sub-Catchment.

Kareespruit River

The Kareespruit tributary of the Sout River in the Groot / Gamtoos River System lies in the north-western portion of the study area. The river originates as smaller streams to the west of where wind turbines are proposed on the north-western portion of the site. The river is still in a natural ecological condition with little to no disturbance except for farm roads along the river. The larger river outside of the study area is mapped as an aquatic ESA and the river does not lie within a FEPA River Sub-catchment.

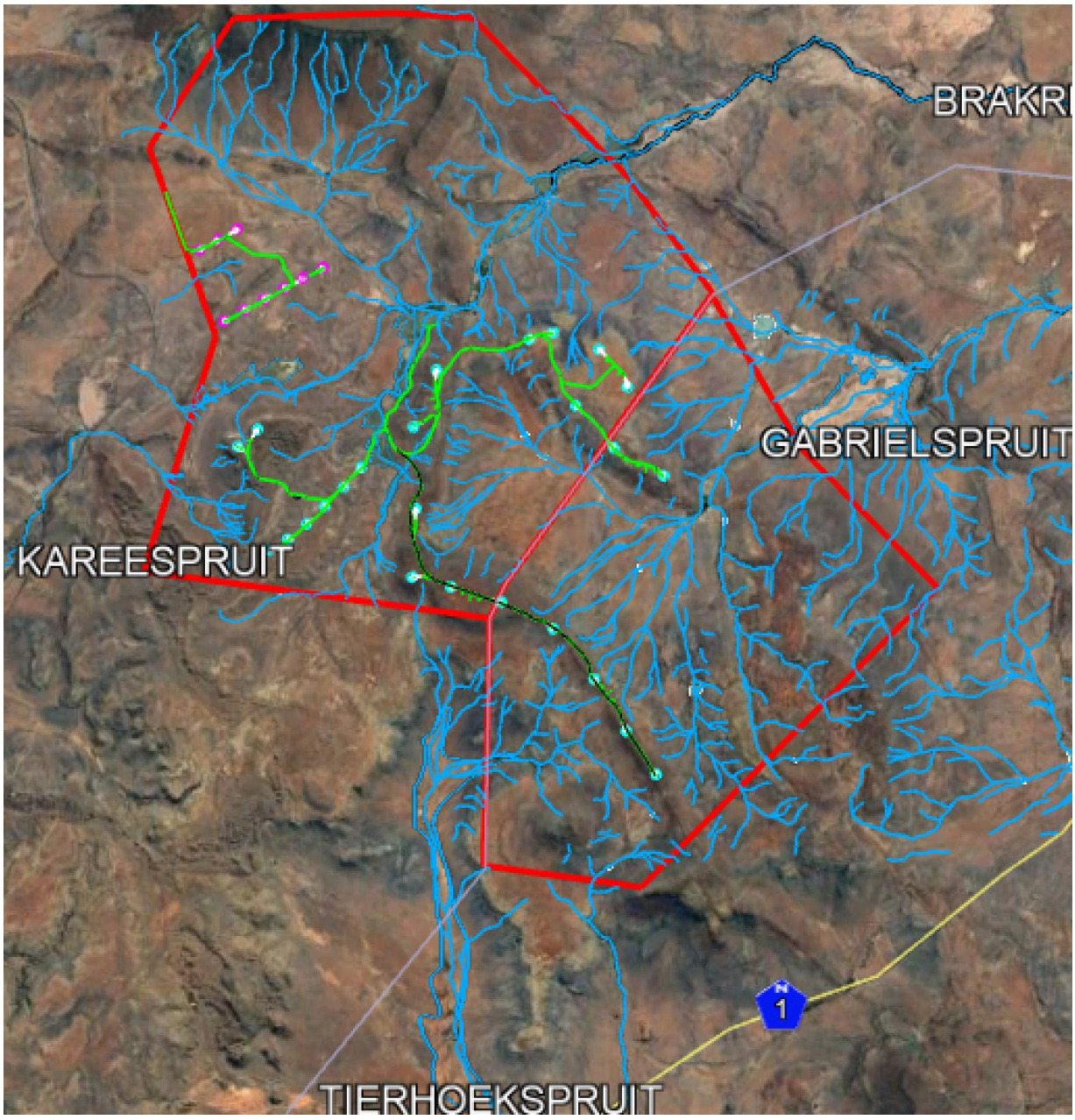


Figure 11. Google Earth showing the location of the main aquatic features within the area

Tributary of the Brak River on the hilltops near the proposed turbines

The Brak River adjacent to an existing farm road to be upgraded to provide access to WEF

Tributary of the Gabrielsspruit River within Farm Phaisant Kraal 1

Figure 12. View of some of the aquatic features within the study area

6.1.2 Classification of aquatic features

Classification of the watercourses within the study area

To assess the condition and ecological importance and sensitivity of the watercourses, it is necessary to understand how they might have appeared under unimpacted conditions. This is achieved through classifying the rivers according to their ecological characteristics, so that they can be compared to ecologically similar rivers.

River typing or classification involves the hierarchical grouping of rivers into ecologically similar units so that inter- and intra-river variation in factors that influence water chemistry, channel type, substratum composition and hydrology are best accounted for. Any comparative assessment of river condition should only be done between rivers that share similar physical and biological characteristics under natural conditions. Thus, the classification of rivers provides the basis for assessing river condition to allow comparison between similar river types. The primary classification of rivers is a division into Ecoregions. Rivers within an ecoregion are further divided into sub-regions.

Ecoregions: groups of rivers within South Africa, which share similar physiography, climate, geology, soils and potential natural vegetation. For this study, the ecoregional classification presented in DWAF (1999), which divides the country's rivers into ecoregions, was used. The study area falls within the Great Karoo Ecoregion (Table 2).

Table 2. Characteristics of the Great Karoo Ecoregion

Main Attributes	Characteristics
Terrain Morphology:	Plains; Low Relief; Plains Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills, Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief; Table-Lands: Moderate and High Relief
Vegetation types	Valley Thicket; Spekboom Succulent Thicket (limited); Central Nama Karoo; Eastern Mixed Nama Karoo; Great Nama Karoo; Upper Nama Karoo; Bushmanland Nama Karoo (limited) Lowland Succulent Karoo; Upland Succulent Karoo; Escarpment Mountain Renosterveld
Altitude	300-1700m; 1700-1900m limited
MAP	0 to 500m
Rainfall seasonality	Very late summer to winter
Mean annual temp.	10 to 20 °C
Median annual simulated runoff	<5 to 60 mm for quaternary catchment

Sub-regions: sub-regions (or geomorphological zones) are groups of rivers, or segments of rivers, within an ecoregion, which share similar geomorphological features, of which gradient is the most important. The use of geomorphological features is based on the assumption that this a major factor in the determination of the distribution of the biota. Table 3 provides the geomorphological and physical features of the rivers within the study area.

From the Site Characterisation assessment, the geomorphological and physical characteristics of the channels can be classified as follows:

Table 3. Geomorphological and physical features of the watercourses on site

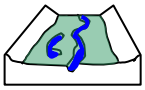
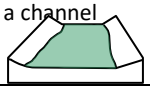
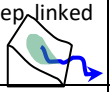
River	Larger Brak and Gabrielspruit Rivers	Minor unnamed tributaries & drainage features
Geomorph Zone	Lower Foothill Zone	Mountain streams and upper foothills zone
Lateral mobility	Semi-Confined	
Channel form	Single to multiple channels	Simple single channel
Channel pattern	Braided channel with moderate sinuosity	Single channel, moderate to low sinuosity
Channel type	Bedrock and alluvium	Bedrock, alluvial and gravel
Channel modification	Channel is fairly natural with some flow and habitat modification	Natural with very small distubances
Hydrological type	Seasonal to episodic	Episodic
Ecoregion	Great Karoo	
DWA catchment	L21A	L11C, L22A
Vegetation type	Eastern Upper Karoo with a band of Upper Karoo Hardeveld	
Rainfall region	Very late summer to autumn	

Classification of the watercourses within the study area

Wetlands can be broadly classified according to their flow and geomorphic characteristics. The wetlands associated with the larger Brak and Gabrielspruit Rivers are classified as valley bottom/floor wetlands. Flow into and out of the valley bottom wetland areas is associated with the watercourses within the study area. According to Table 4, the wetland features within the study area can be classified as described in

Table 5.

Table 4. Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa

Hydro-geomorphic types	Description	Source of water[1]	
		Surface	Sub-surface
Floodplain 	Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features and alluvial transport and deposition of sediment, leads to a net accumulation of sediment. Water inputs from main channel and from adjacent slopes.	***	*
Valley bottom with a channel 	Valley bottom areas with well-defined stream channel, lacking characteristic floodplain features. May be gently sloped, characterised by net alluvial deposit accumulation or have steeper slopes, characterised by net loss of sediment. Water inputs from main channel and from adjacent slopes.	***	*/ ***
Valley bottom without a channel 	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to net accumulation of sediment. Water inputs mainly from channel entering wetland and from adjacent slopes.	***	*/ ***
Hill slope seep linked to channel 	Slopes on hillsides, characterised by colluvial material movement. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hill slope seepage 	Slopes on hillsides, which are characterised by colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface connection.	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water. It may also receive sub-surface water. An outlet is usually absent, and is usually isolated from the stream.	*/ ***	*/ ***

1 Precipitation is an important water source and evapotranspiration an important output

Water source:
- * Contribution usually small
- *** Contribution usually large
- */ *** Contribution may be small or important depending on local circumstances

 Wetland

Table 5: Classification of wetland areas within study area

Name	Valley bottom wetlands
System	Inland
Ecoregion	Great Karoo
Landscape setting	Channeled valley floor
Longitudinal zonation	Lower foothill
Drainage	With channel in- and outflow
Seasonality	Seasonally inundated
Modification	Largely natural to Moderately modified
Geology	Shale and siltstone of the Ecca Group; Karoo Sequence
Vegetation	Eastern Upper Karoo
Substrate	Rock with alluvium
Salinity	Fresh to Slightly brackish

6.1.3 Present Ecological Condition

Habitat Integrity of the Watercourses

The evaluation of Habitat Integrity provides a measure of the degree to which a river has been modified from its natural state. The methodology (DWAF, 1999) involves a qualitative assessment of the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict upon the system. These disturbances include both abiotic and biotic factors, which are regarded as the primary causes of the degradation of a river. The severity of each impact is ranked using a six-point scale from 0 (no impact) to 25 (critical impact). The Habitat Integrity Assessment is based on an assessment of the impacts of two components of the river, the riparian zone and the instream habitat. The total scores for the instream and riparian zone components are then used to place the habitat integrity of both in a specific habitat category (Table 7).

Table 6. Instream Habitat Integrity assessment for the watercourses within the study area

Instream Criteria	Unnamed tributaries & drainage features	Larger Rivers	Riparian Category	Unnamed tributaries & drainage features	Large Rivers
Water Abstraction	2	8	Vegetation Removal	2	6
Flow Modification	3	9	Exotic Vegetation	2	6
Bed Modification	3	8	Bank Erosion	3	5
Channel Modification	3	4	Channel Modification	2	5
Water Quality	2	5	Water Abstraction	2	6
Inundation	3	6	Inundation	3	5
Exotic Macrophytes	0	0	Flow Modification	3	7
Exotic Fauna	0	0	Water Quality	2	5
Rubbish Dumping	0	2			
Instream Integrity Class	A	B/C	Riparian Integrity Category	A/B	B/C

The habitat integrity assessment was divided into the upper reaches of the watercourses that have few modifications and the lower, more modified reaches of the larger watercourses within the study area. The ecological habitat integrity of the rivers within the study area is still in a natural condition in their

upper reaches with few modifications. Downstream, the rivers become largely natural to moderately modified.

Table 7. Habitat Integrity categories (From DWAF, 1999)

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

Wetland Habitat Integrity

The Wetland PES Method (DWAF 2005) was used to establish the integrity of the wetlands in the study area and was based on the modified HI approach developed by Kleynhans (DWAF, 1999; Dickens et al, 2003). Table 8 displays the criteria and results from the assessment of the habitat integrity of the wetlands within the study area. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 8. Habitat integrity assessment and criteria for palustrine wetlands (assessment (score of 0=critically modified to 5=unmodified))

Criteria	Relevance	Valley bottom wetlands
Hydrologic		
Flow Modification	Abstraction, impoundments or increased runoff from developed areas. Change in flow regime, volume, velocity & inundation of habitats resulting in floralistic changes or incorrect cues to biota.	3.9
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	4.0
Water Quality		
Water Quality Modification	From point or diffuse sources such as upstream agriculture, human settlements and industry. Aggravated by volumetric decrease in flow delivered to the wetland.	3.8
Sediment Load Modification	Reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rate of erosion, accretion, infilling of wetlands &habitat change.	3.6
Hydraulic/Geomorphic		
Canalisation	Desiccation or change to inundation of wetland and change in habitat	4.8
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities that reduce or change wetland habitat	4.6
Biota		
Terrestrial Encroachment	Desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat	4.9
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	5
Invasive Plants	Affects habitat characteristics through changes in community structure and water quality changes	5

Alien Fauna	Presence of alien fauna affecting faunal community structure.	5
Biota Over use	Overgrazing, over fishing, etc.	5
Total Mean		4.9
Category		**A**

The valley bottom wetlands have been modified but are still in a largely natural ecological condition.

Table 9. Relation between scores given and ecological categories

Scoring Guidelines	Interpretation of Scores: Rating of Present Ecological Status Category (PESC)
Natural, unmodified – score=5.	CATEGORY A >4; Unmodified, or approximates natural condition.
Largely natural – score=4.	CATEGORY B >3 and ≤4; Largely natural with few modifications, with some loss of natural habitat.
Moderately modified-score=3.	CATEGORY C >2 and ≤3; moderately modified, but with some loss of natural habitats.
Largely modified – score=2.	CATEGORY D ≤2; largely modified. Large loss of natural habitat & basic ecosystem function
	OUTSIDE GENERALLY ACCEPTABLE RANGE
Seriously modified – rating=1.	CATEGORY E >0 and <2; seriously modified. Extensive loss of natural habitat & basic ecosystem function.
Critically modified – rating=0.	CLASS F 0; critically modified. Modification reached critical levels with system completely modified.

The WET-Health method was then used to determine the overall PES for the wetlands. PES scores were determined for geomorphology, hydrology, water quality and vegetation to generate the overall score and ecological category Table 10).

Table 10: WET-Health assessment of valley bottom wetland areas in the study area

Components	Method used for assessment	PES% Score	Ecological Category
Hydrology PES	WET-Health Hydro Module	90 %	A/B
Geomorphology PES	WET-Health Geomorph Module	92 %	A/B
Water quality PES	Landuse-WQ Model	91 %	A/B
Vegetation PES	WET-Health Veg Module	83 %	B
Overall Wetland PES	WET-Health default weightings	88 %	A/B

The valley bottom wetlands are largely natural with modification to the indigenous vegetation being the most impacted component of the wetlands as a result of direct disturbances of adjacent land use activities and infrastructure (road) development.

6.1.4 Ecological Importance and Sensitivity

The Ecological Importance and Ecological Sensitivity (EI&ES) assessment for both watercourses and wetlands consider a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table 11).

Table 11. Scale used to indicate either ecological importance or sensitivity

Scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale

The median of the resultant score is calculated to derive the EI&ES category (Table 12). The results of the EIS assessment are shown in Table 13. The EI&ES have been determined for the larger watercourses and the smaller unnamed tributaries separately.

Table 12. Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General description	Median
Very high	Quaternaries/delineations unique on a national and international level based on unique biodiversity. These rivers are usually very sensitive and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations unique on a national scale based on biodiversity. These rivers may be sensitive to flow modifications and may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations unique on a provincial/ local scale due to biodiversity. These rivers are not very sensitive to flow modification and have substantial capacity for use.	>1-≤2
Low/ marginal	Quaternaries/delineations not unique on any scale. These rivers are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

Table 13. Results of the EI&ES assessment of the watercourses in the study area

Biotic and Aquatic Habitat Determinants	Larger Rivers	Unnamed tributaries & drainage features
Rare and endangered biota	1.5	2
Unique biota	2	1
Intolerant biota	2	2
Species/taxon richness	1.5	1.5
Diversity of aquatic habitat types or features	2.5	2
Refuge value of habitat type	2.5	2
Sensitivity of habitat to flow changes	2.5	3
Sensitivity of flow related water quality changes	2	2.5
Migration route/corridor for instream & riparian biota	2.5	1
National parks, wilderness areas, Nature Reserves & areas, PNEs	1.5	1.5
EIS CATEGORY	High	Moderate

The larger watercourses in the study area, have a high ecological importance and sensitivity while the smaller tributaries/drainage features are of a moderate ecological importance and sensitivity. The larger watercourses tend to be more ecologically important but less sensitive to impacts while the smaller tributaries are less ecologically important but more sensitive to flow, water quality and habitat modification.

The results from the wetland EIS assessment are provided in Table 14. The assessment of the ecosystem services supplied by the wetland areas (divided into Hydrological Functional Importance and Direct Human Benefits) is included in the table and was conducted according to the guidelines as described by Kotze et al (2005).

Table 14: Results of the EIS assessment for the wetland areas

Ecological Importance	Valley bottom wetlands
Biodiversity support	2.17
Presence of Red Data species	1
Populations of unique species	2
Migration/breeding/feeding sites	3.5
Landscape scale	1.40
Protection status of the wetland	1
Protection status of the vegetation type	1
Regional context of the ecological integrity	2
Size and rarity of the wetland type/s present	1
Diversity of habitat types	2
Sensitivity of the wetland	1.93
Sensitivity to changes in floods	2.8
Sensitivity to changes in low flows/dry season	2
Sensitivity to changes in water quality	1
ECOLOGICAL IMPORTANCE & SENSITIVITY	2.17
Flood attenuation	3
Streamflow regulation	1
Sediment trapping	2.5
Phosphate assimilation	1
Nitrate assimilation	1.5
Toxicant assimilation	1
Erosion control	2
Carbon storage	1
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.63
Water for human use	1.5
Harvestable resources	1.5
Cultivated foods	0
Cultural heritage	0
Tourism and recreation	2
Education and research	1
IMPORTANCE OF DIRECT HUMAN BENEFITS	1.00
OVERALL IMPORTANCE (highest score of ecological, hydrological and direct human benefits)	2.17

The wetland features within the study area are considered of moderate ecological importance and sensitivity. The valley bottom wetlands are closely associated with the rivers in the area and the importance of the habitat in providing ecological corridors for the movement of biota.

6.1.5 Recommended Ecological Condition of Aquatic Ecosystems

Considering the largely natural ecological condition of the aquatic ecosystems within the study area and their moderate to high ecological importance and ecological sensitivities, the recommended ecological condition (REC) of these features would be that they remain in a natural ecological condition. This is except for the middle reaches of the larger Brak and Gabrielspruit Rivers that are largely natural to moderately modified as a result of direct habitat modification from the surrounding activities. These rivers should be maintained in their current ecological condition and should not be allowed to degrade further.

6.2 Aquatic Ecosystem Constraints Mapping

This section provides an assessment of the proposed project components in relation to the mapped and assessed aquatic ecosystems. Based on the PES, and EI&ES and REC, buffers have been recommended to protect these ecosystems. The recommended buffer area between the aquatic features and the project components to ensure these aquatic ecosystems are not impacted by the proposed activities is as follows:

- Smaller streams and drainage lines, together with their seeps: at least 50m from the centre of these streams or the delineated wetland edge (whichever is the furthest);
- The larger rivers within the valley floor, together with their valley bottom wetlands: at least 100m, measured from the top of bank of the river channels or the delineated wetland edge (whichever is the furthest); and

These recommended buffers are in line with the watercourse and wetland buffers that have been recommended in the Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa (CSIR, 2015) and are deemed appropriate to the aquatic features and the proposed activities within the study area.

From Figure 13, it can be seen that all of the proposed turbines are placed outside of the recommended setbacks. The only project components within the recommended buffers are the internal access roads. Where the roads are proposed to cross the watercourse corridors it is associated with existing farm roads that would need to be upgraded.

The placing of the access roads within the recommended buffers and through the watercourses, and the mitigation thereof, is discussed separately in the following table that further assesses the potential freshwater constraints.

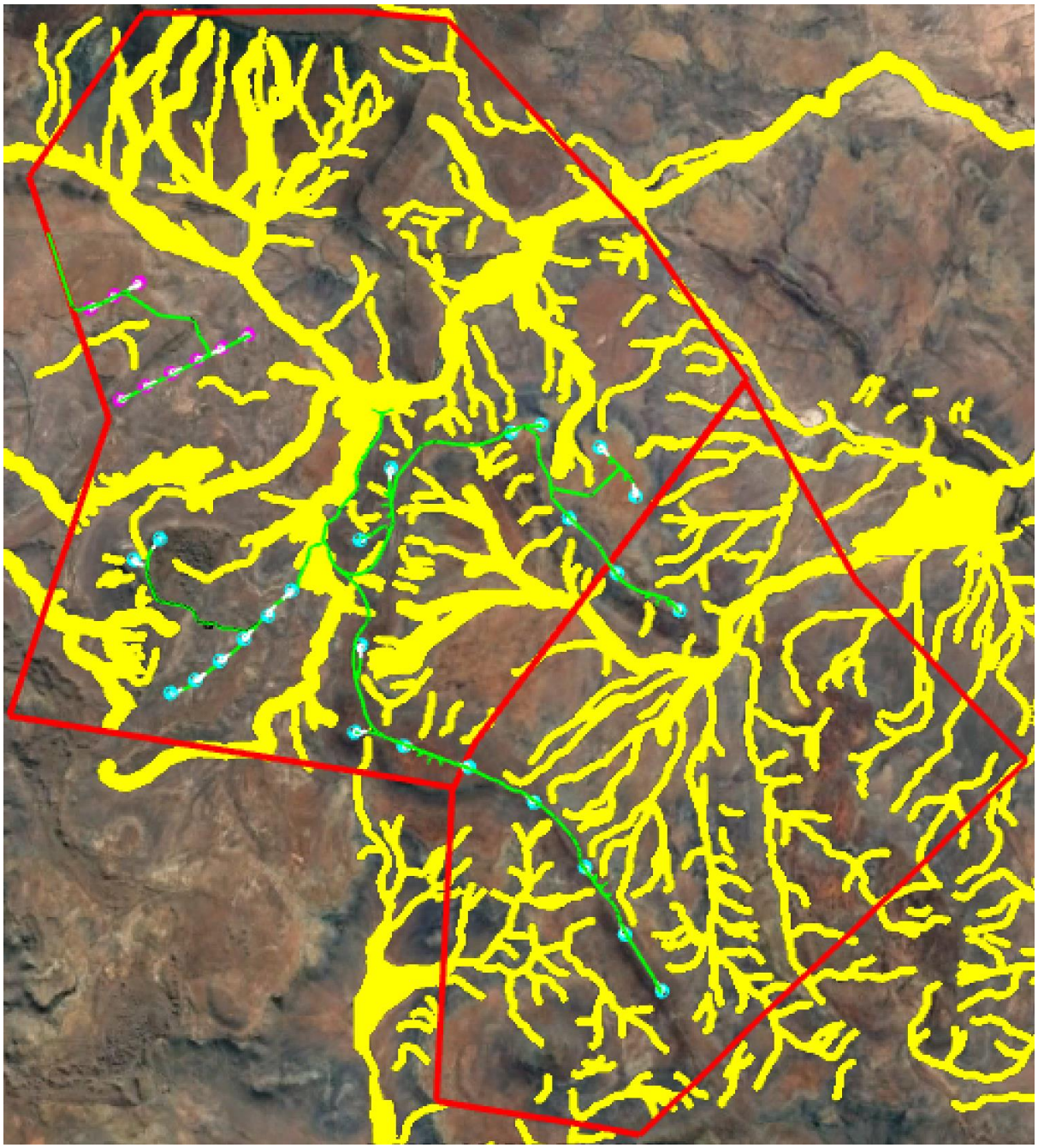


Figure 13. Google Earth image showing the recommended aquatic buffer/setback areas as constraints to the proposed project within the properties

6.3 Aquatic Ecosystem Impacts

6.3.1 Impact of proposed Wind Turbine Facility: Degradation of ecological condition of aquatic ecosystems; modification of flow and water quality; erosion; and alien vegetation invasion in aquatic features

Construction Phase: WEF requires high-intensity disturbance of a limited surface area at the site of each wind turbine. Concrete foundations for the turbine towers will need to be constructed as well as permanent hard standing bases of compacted gravel adjacent to each turbine location for the cranes used to construct the turbines. A construction camp with a temporary laydown area and the concrete batching plant would need to be placed within the site for the construction works. All of the proposed turbines are located outside of the recommended setbacks from the watercourses. The laydown areas should also be placed outside of the recommended buffers.

Activities during the construction phase of the project could thus be expected to result in little to no disturbance of aquatic vegetation cover for clearing and preparation of the turbine footprints. There is also the potential for some water quality impacts associated with the batching of concrete, from hydrocarbon spills or associated with the other construction activities on the site. As the location of the construction works would be outside of the recommended buffers, this impact would be likely to be negligible. Only a limited amount of water is utilised during construction for the batching of cement for wind turbines and other construction activities.

A localised short-term impact of low intensity could be expected that has a very low to negligible overall significance in terms of its impact on the identified aquatic ecosystems in the area.

Operation Phase: During the operation phase the turbines will operate continuously, unattended and with low maintenance required for more than 20 years. The WEF is likely to be monitored and controlled remotely, with maintenance only taking place when required.

The hard surfaces created by the development may lead to increased runoff, in particular on surfaces with a steeper gradient. This may lead to increased erosion and sedimentation of the downslope areas. A localised long-term impact (more than 20 years) of low intensity (depending on the distance between the turbines and the freshwater features) could be expected that would have a very low to negligible overall significance post-mitigation in terms of its impact on the identified aquatic ecosystems in the area.

The only potentially toxic or hazardous materials which would be present in relatively small amounts would be lubricating oils and hydraulic and insulating fluids. Therefore, contamination of surface or groundwater or soils is highly unlikely. There is no water consumption impact associated with the operation of wind turbines.

Decommission Phase: During decommissioning, the potential freshwater impacts will be very similar to that of the Construction Phase, although the potential for water quality and flow-related risks will be lower.

Proposed mitigation:

Construction Phase: A buffer of at least 100 m between the delineated aquatic ecosystems and all the proposed project activities should be maintained adjacent to the river in which larger river and valley bottom wetlands occur as well as at least 50m buffer adjacent to the smaller tributaries and drainage features.

Any indigenous vegetation clearing within or adjacent to the watercourses should occur in a phased manner to minimise erosion and/or run-off. An Environmental Control Officer (ECO) or an appropriate specialist with knowledge and experience of the local flora be appointed during the construction phase to be able to make clear recommendations with regards to the revegetation of disturbed areas.

During the construction phase, site management must be undertaken at the laydown area, batching plant and the individual turbine construction area. This should specifically address on-site stormwater management and prevention of pollution measures from any potential pollution sources during the construction activities such as hydrocarbon spills. Any stormwater that does arise within the construction sites must be handled appropriately to trap sediments and reduce flow velocities.

Operation Phase: Invasive alien plant growth and signs of erosion should be monitored on an ongoing basis to ensure that the disturbed areas do not become infested with invasive alien plants.

Stormwater run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any stormwater leaving the WEF site. No stormwater runoff must be allowed to discharge directly into the watercourses. The runoff should rather be dissipated over a broad area covered by natural vegetation or managed using appropriate channels and swales when located within steep embankments. Should any erosion features develop, they should be stabilised as soon as possible.

Any water supply, sanitation services as well as solid waste management services that should be required for the site should preferably be provided by an off-site service provider.

Decommission Phase: During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. Disturbed areas may need to be rehabilitated and revegetated. Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required.

Significance of impacts after mitigation: A localised, short-term impact will still occur during the construction phase; however, the overall significance of the impact on the aquatic ecosystems is expected to be very low.

IMPACT NATURE	Impact – Nature of Impact Aquatic Impact		STATUS	~~POSITIVE~~/NEGATIVE
Impact Description	Disturbance of aquatic habitat; modification to flow and water quality due to the proposed activities in or adjacent to aquatic ecosystems			
Impact Source(s)	Construction and operation of WEF			
Receptor(s)	Minor and larger watercourses within the associated properties			
PARAMETER	WITHOUT MITIGATION	SCORE	WITH MITIGATION	SCORE
EXTENT (A)	Preferred Alternative:	Local	Preferred Alternative:	Local
	No-Go Alternative:	Local	No-Go Alternative:	Local
DURATION (B)	Preferred Alternative:	Short term	Preferred Alternative:	Short term
	No-Go Alternative:	Long term	No-Go Alternative:	Short term

PROBABILITY (C)	Preferred Alternative:	Improbable	Preferred Alternative:	Improbable
	No-Go Alternative:	Probable	No-Go Alternative:	Probable
INTENSITY OR MAGNITUDE (D)	Preferred Alternative:	Low	Preferred Alternative:	Low
	No-Go Alternative:	Medium/Low	No-Go Alternative:	Low
SIGNIFICANCE RATING (F) = (A*B*D)*C	Preferred Alternative:	Low	Preferred Alternative:	Low
	No-Go Alternative:	Low	No-Go Alternative:	Low
CUMULATIVE IMPACTS	Low cumulative impact – see Section 1.6			
CONFIDENCE	High/~~Med/Low~~			
MITIGATION MEASURES	As provided above			

6.3.2 Impact of the road infrastructure associated with the WEF: Degradation of ecological condition of aquatic ecosystems; modification of flow and water quality; erosion; and alien vegetation invasion in aquatic features

Construction and Operation Phase: The internal access roads will need to cross some watercourses, most of which will be on existing farm roads. The major impacts associated with the internal roads relate to the loss of habitat and associated vegetation within the watercourse corridors at the crossings, as well as the potential invasive alien plant growth, flow and water quality impacts and the direct impacts on the soil (erosion of watercourse channels). A localised short- and longer-term impact of low significance is expected on the aquatic ecosystems in the area at the points at which the roads cross the rivers/drainage lines, during and after the construction phase. The disturbance would largely take place during the construction phase. However, a long-term disturbance of the aquatic habitat at the road crossings could also be expected during the operation phase.

Decommission Phase: During decommissioning, the potential freshwater impacts will be very similar to that of the Construction Phase, although the potential for water quality and flow-related risks will be lower.

Proposed mitigation: The existing road infrastructure should be utilised as far as possible to minimise the overall disturbance created by the proposed WEF. Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated to reduce the disturbance of the area within the river beds. For new roads to the turbines, these should be located outside of the recommended buffers of the drainage/riverbeds. Where access routes need to be constructed through the watercourses, the disturbance of the channels should be limited. All crossings over watercourses should be such that the flow within the drainage channel is not impeded and should be constructed perpendicular to the river channel. Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth.

During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. Disturbed areas may need to be rehabilitated and revegetated. Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required.

Significance of impacts after mitigation: A localised, short-term impact will still occur during the construction phase; however, the overall significance of the impact on the aquatic ecosystems is expected to be low.

IMPACT NATURE	Impact – Nature of Impact Aquatic Impact		STATUS	~~POSITIVE~~/NEGATIVE
Impact Description	Disturbance of aquatic habitat; modification to flow and water quality due to the proposed activities in or adjacent to aquatic ecosystems			
Impact Source(s)	Construction and operation of roads within the WEF			
Receptor(s)	Minor and larger watercourses within the associated properties			
PARAMETER	WITHOUT MITIGATION	SCORE	WITH MITIGATION	SCORE
EXTENT (A)	Preferred Alternative:	Local	Preferred Alternative:	Local
	No-Go Alternative:	Local	No-Go Alternative:	Local
DURATION (B)	Preferred Alternative:	Long term	Preferred Alternative:	Short term
	No-Go Alternative:	Long term	No-Go Alternative:	Short term
PROBABILITY (C)	Preferred Alternative:	Probable	Preferred Alternative:	Improbable
	No-Go Alternative:	Probable	No-Go Alternative:	Probable
INTENSITY OR MAGNITUDE (D)	Preferred Alternative:	Low	Preferred Alternative:	Low
	No-Go Alternative:	Medium/Low	No-Go Alternative:	Low
SIGNIFICANCE RATING (F) = (A*B*D)*C	Preferred Alternative:	Low	Preferred Alternative:	Low
	No-Go Alternative:	Low	No-Go Alternative:	Low
CUMULATIVE IMPACTS	Low cumulative impact– see Section 1.6			
CONFIDENCE	High/~~Med/Low~~			
MITIGATION MEASURES	As provided above			

6.3.3 Cumulative impact of the Proposed projects on freshwater ecosystems

Land use in the area currently consists of low-density livestock farming due to the limited water supply and poor carrying capacity of the cover vegetation. Current land and water use impacts on the tributaries of the Brak, Gabrielspruit, Tierhoekspruit and Kareespruit Rivers within the larger study area is therefore low to very low. The nature of the proposed WEF projects allows them to have minimal impact on the surface water features since the turbines can be placed far enough away from the freshwater features to not impact them.

The largest potential impact of these projects is as a result of the associated infrastructure which can be mitigated such that its impact on the aquatic ecosystems will be of a low significance. For the project concerned, the road layout avoids the important wetland areas/rivers and where possible existing roads have been used. This further reduces the impacts on the aquatic ecosystems, but also provides an opportunity to improve the current road crossings, by providing better erosion protection measures

and through the construction of low water crossings or properly sized box culverts instead of pipe culverts that are prone to blocking. Thus, the project designs post-mitigation will prove to have a net benefit to the river and catchment. ***One could thus expect that the cumulative impact of the proposed project would not be significant provided mitigation measures are implemented.*** Availability of water is a limiting factor on the further development of this area, however, the water requirements of the project during the operation phase will be low. Consideration of the No-Go Alternative.

6.3.4 No Go Alternative

The No-go Alternative implies that the original Environmental Authorisation of up to 67 turbines would be constructed. This would entail more disturbance than the proposed amended up to 34 turbines. One could thus expect that the amended WEF layout would have less of a potential aquatic ecosystem impact than that of the No Go Alternative.

6.4 Risk Assessment

A risk assessment was carried out for the proposed Modderfontein WEF and associated activities. The assessment indicates the level of risk certain activities pose to freshwater resources where the outcomes are used to guide decisions regarding water use authorisation of the proposed activity. A summary of the potential risks can be seen in Table 15. The risk rating classes can be seen in Table 16.

Table 15: Summary risk assessment for the proposed project

Phases	Activity	Impact	Likelihood	Significance	Risk Rating
Construction	Construction works associated with WEF	Loss of biodiversity & habitat, impeding flow & water quality impact	12	51	L
Operation	Operational activities associated with WEF	Disturbance to aquatic habitat - Facilitation of erosion and invasion by alien plants	12	48	L
Decommission	Removal of WEF infrastructure	Habitat disturbance and some flow and water quality impacts	12	48	L

* With mitigation, the risk is deemed to be low

Table 16: Risk rating classes for the Risk Assessment

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

The risk assessment determined that the proposed Modderfontein WEF for its current amended layout poses a low risk of impacting aquatic habitat, water flow and water quality. With these findings of the

risk assessment, the water use activities associated with the proposed project could potentially be authorised by means of the general authorisations for the Section 21(c) and (i) water uses. A water use licence may however be required for the abstraction of water for the WEF that would require that a water use licence application be submitted for the entire project related activities.

6.5 Monitoring Requirements:

Daily compliance monitoring of the implementation of the measures as laid out in the EMPr and associated method statements should be undertaken by the Site Manager in conjunction with the ECO. A record of the monitoring undertaken during the maintenance management activities should be kept.

Visual inspections and Photographs should be taken weekly upstream and downstream of sites where construction activities will need to take place within aquatic features. Once the construction activities have ceased, the frequency of the monitoring can be reduced to monthly until DWS is satisfied that the site is adequately rehabilitated.

As mentioned above, ongoing monitoring of invasive alien plant growth and erosion within the aquatic features and the recommended buffers on bi-annually (every six months) for the construction phase and the first three operational years of the project. That monitoring should preferably take place before the winter rainfall period and following high rainfall events.

7. CONCLUSION AND RECOMMENDATIONS

The aquatic features within the study area consist of the upper reaches of the Brak, Gabrielspruit, Tierhoekspruit and Kareespruit Rivers and their smaller, unnamed tributaries, as well as some valley bottom wetlands associated with the larger watercourses. The ecological habitat integrity of the rivers within the study area is still natural in the upper reaches with few modifications. Downstream, the larger rivers are largely natural to moderately modified by the surrounding activities. The valley bottom wetlands associated with the river have been modified but are still in a largely natural ecological condition. In terms of biodiversity importance, the study area is located within an Upstream River Freshwater Ecosystem Priority Area. The watercourses are mapped as aquatic ESAs.

The recommended ecological condition of the aquatic features in the area would be that they remain in their current ecological condition and should not be allowed to degrade further. The recommended buffer area between the aquatic features and the project components to ensure these aquatic ecosystems are not impacted by the proposed activities is as follows:

- Smaller streams and drainage lines, together with their seeps: at least 50 m from the centre of these streams; and
- The larger rivers within the valley floor, together with their valley bottom wetlands: at least 100 m, measured from the top of bank of the river channels or the delineated wetland edge.

With mitigation, the potential freshwater impacts of the proposed amended Modderfontein WEF for the construction, operation and decommissioning phases are likely to be low. One can also expect that the cumulative impact of the proposed project would not be significant provided mitigation measures are implemented. Recommended mitigation measures to be included in the environmental authorisation are as follows:

- The existing road infrastructure should be utilised as far as possible to minimise the overall disturbance created by the proposed project. Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary temporary roads decommissioned and rehabilitated to reduce the disturbance of the area and within the river beds. For new roads to the turbines, these should be located at least 100m outside of the drainage/riverbeds. Where access routes need to be constructed through the watercourses, the disturbance of the channels should be limited. Wetland areas should be avoided and any road adjacent to a wetland feature should also remain outside of the 50m buffer zone.
- All crossings over watercourses should be such that the flow within the drainage channel is not impeded and should be constructed perpendicular to the river channel, where possible based on the contours.
- Any indigenous vegetation clearing within or adjacent to the watercourses should occur in a phased manner to minimise erosion and/or run-off. An Environmental Control Officer or a specialist with knowledge and experience of the local flora, should be appointed during the construction phase to be able to make clear recommendations with regards to the revegetation of disturbed areas.
- During the construction phase, site management must be undertaken at the laydown area, batching plant and the individual turbine construction areas. This should specifically address on-site stormwater management and prevention of pollution measures from any potential pollution sources during the construction activities such as hydrocarbon spills. Any stormwater that does arise within the construction sites must be handled appropriately to trap sediments and reduce flow velocities.
- Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth.
- Invasive alien plant growth and signs of erosion should be monitored on an ongoing basis to ensure that the disturbed areas do not become infested with invasive alien plants.
- Stormwater run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any stormwater leaving the WEF site. No stormwater runoff must be allowed to discharge directly into the watercourses. The runoff should rather be dissipated over a broad area covered by natural vegetation or managed using appropriate channels and swales when located within steep embankments. Should any erosion features develop, they should be stabilised as soon as possible.

- Any water supply, sanitation services as well as solid waste management services that should be required for the site should preferably be provided by an off-site service provider.
- During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. Disturbed areas may need to be rehabilitated and revegetated. Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required.

The risk assessment determined that the proposed development of the Modderfotnein WEF poses a low risk of impacting aquatic habitat, water flow and water quality. With these findings of the risk assessment, the water use activities associated with the proposed project could potentially be authorised by means of the general authorisations for the Section 21(c) and (i) water uses. A Water Use Licence (WUL) may however be required for the abstraction of water for the WEF which would require that an application for a WUL be submitted to the Department of Water and Sanitation (DWS) for the entire project-related activities.

The No-go Alternative implies that the original Environmental Authorisation of up to 67 turbines would be constructed. This would entail more disturbance than the proposed amended up to 34 turbines. One could thus expect that the amended WEF layout would have less of a potential aquatic ecosystem impact than that of the No Go Alternative.

Based on the above findings, there is no reason from an aquatic ecosystem perspective, why the proposed activity (with the implementation of the above-mentioned mitigation measures) should not be authorized. The revised layout has further reduced any potential impacts to the aquatic ecosystems in the area and thereby has improved the acceptability of the proposed WEF from an aquatic ecosystem point of view.

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APPENDICES

APPENDIX A: PES, EI AND ES FOR THE MAJOR WATERCOURSES IN THE STUDY AREA (DWS, 2012)

SELECT SQ REACH	SQR NAME	LENGTH km	STREAM ORDER	PES ASSESSED BY XPERTS? (IF TRUE="Y")	REASONS NOT ASSESSED	PES CATEGORY DESCRIPTION	PES CATEGORY BASED ON MEDIAN OF METRICS
L11C-06656	0.00	20.79	1	Y		MODERATELY MODIFIED	C
MEAN EI CLASS	**MEAN ES CLASS**	**DEFAULT ECOLOGICAL CATEGORY (EC)**	**RECOMMENDED ECOLOGICAL CATEGORY (REC)**				
MODERATE	MODERATE	C	#NUM!				

PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	LARGE	FISH SPP/SQ		INVERT TAXA/SQ	18.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE	#DIV/0!	INVERT AVERAGE CONFIDENCE	1.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	MODERATE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	SMALL	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	VERY HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	LARGE	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES	LOW
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	SMALL	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	HABITAT DIVERSITY CLASS	VERY LOW	STREAM SIZE SENSITIVITY TO MODIFIED FLOW/WATER LEVEL CHANGES	HIGH
		RIPARIAN-WETLAND NATURAL VEG RATING BASED ON % NATURAL VEG IN 500m (100%=5)	VERY HIGH	HABITAT SIZE (LENGTH) CLASS	MODERATE	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES	**LOW**
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	LOW	INSTREAM MIGRATION LINK CLASS	MODERATE		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	HIGH		

SELECT SQ REACH	SQR NAME	LENGTH km	STREAM ORDER	PES ASSESSED BY XPERTS? (IF TRUE="Y")	REASONS NOT ASSESSED	PES CATEGORY DESCRIPTION	PES CATEGORY BASED ON MEDIAN OF METRICS
L21A-06586	Brak	22.82	1	Y		MODERATELY MODIFIED	C
MEAN EI CLASS	**MEAN ES CLASS**	**DEFAULT ECOLOGICAL CATEGORY (EC)**	**RECOMMENDED ECOLOGICAL CATEGORY (REC)**				
HIGH	MODERATE	B	#NUM!				

PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	MODERATE	FISH SPP/SQ		INVERT TAXA/SQ	12.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE	#DIV/0!	INVERT AVERAGE CONFIDENCE	1.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	MODERATE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	LOW	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	SMALL	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY:	VERY HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SERIOUS	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES	LOW
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	MODERATE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	HABITAT DIVERSITY CLASS	MODERATE	STREAM SIZE SENSITIVITY TO MODIFIED FLOW/WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG RATING BASED ON % NATURAL VEG IN 500m (100%=5)	VERY HIGH	HABITAT SIZE (LENGTH) CLASS	MODERATE	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	LOW
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	LOW	INSTREAM MIGRATION LINK CLASS	HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	HIGH		

SELECT SQ REACH	SQR NAME	LENGTH km	STREAM ORDER	PES ASSESSED BY XPERTS? (IF TRUE="Y")	REASONS NOT ASSESSED	PES CATEGORY DESCRIPTION	PES CATEGORY BASED ON MEDIAN OF METRICS
L22A-06724	Tierhoekspruit	39.08	1	Y		LARGELY NATURAL	B
MEAN EI CLASS	**MEAN ES CLASS**	**DEFAULT ECOLOGICAL CATEGORY (EC)**	**RECOMMENDED ECOLOGICAL CATEGORY (REC)**				
HIGH	MODERATE	B	#NUM!				

PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	MODERATE	FISH SPP/SQ	2.00	INVERT TAXA/SQ	24.00	FISH PHYS-CHEM SENS DESCRIPTION	MODERATE
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE	1.00	INVERT AVERAGE CONFIDENCE	1.42	FISH NO-FLOW SENSITIVITY DESCRIPTION	MODERATE
POTENTIAL INSTREAM HABITAT MOD ACT.	MODERATE	FISH REPRESENTIVITY PER SECONDARY: CLASS	HIGH	INVERT REPRESENTIVITY PER SECONDARY, CLASS	HIGH	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	SMALL	FISH REPRESENTIVITY PER SECONDARY: CLASS	HIGH	INVERT RARITY PER SECONDARY:	MODERATE	INVERTS VELOCITY SENSITIVITY	VERY HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS	HIGH	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES	LOW
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	LOW	HABITAT DIVERSITY CLASS	VERY HIGH	STREAM SIZE SENSITIVITY TO MODIFIED FLOW/WATER LEVEL CHANGES DESCRIPTION	HIGH
		RIPARIAN-WETLAND NATURAL VEG RATING BASED ON % NATURAL VEG IN 500m (100%=5)	VERY HIGH	HABITAT SIZE (LENGTH) CLASS	HIGH	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	LOW
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	LOW	INSTREAM MIGRATION LINK CLASS	HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	HIGH		

APPENDIX B: IMPACT ASSESSMENT METHODOLOGY

1. Definitions of terminology

ITEM	DEFINITION
EXTENT	
Local	Extending only as far as the boundaries of the activity, limited to the site and its immediate surroundings
Regional	Impact on the broader region
National	Will have an impact on a national scale or across international borders
DURATION	
Short-term	0-5 years
Medium-Term	5-15 years
Long-Term	>15 years, where the impact will cease after the operational life of the activity
Permanent	Where mitigation, either by natural process or human intervention, will not occur in such a way or in such a time span that the impact can be considered transient.
MAGNITUDE OR INTENSITY	
Low	Where the receiving natural, cultural or social function/environment is negligibly affected or where the impact is so low that remedial action is not required.
Medium	Where the affected environment is altered, but not severely and the impact can be mitigated successfully and natural, cultural or social functions and processes can continue, albeit in a modified way.
High	Where natural, cultural or social functions or processes are substantially altered to a very large degree. If a negative impact then this could lead to unacceptable consequences for the cultural and/or social functions and/or irreplaceable loss of biodiversity to the extent that natural, cultural or social functions could temporarily or permanently cease.
PROBABILITY	
Improbable	Where the possibility of the impact materialising is very low, either because of design or historic experience
Probable	Where there is a distinct possibility that the impact will occur
Highly Probable	Where it is most likely that the impact will occur
Definite	Where the impact will undoubtedly occur, regardless of any prevention measures
SIGNIFICANCE	
Low	Where a potential impact will have a negligible effect on natural, cultural or social environments and the effect on the decision is negligible. This will not require special design considerations for the project
Medium	Where it would have, or there would be a moderate risk to natural, cultural or social environments and should influence the decision. The project will require modification or mitigation measures to be included in the design
High	Where it would have, or there would be a high risk of, a large effect on natural, cultural or social environments. These impacts should have a major influence on decision making.
Very High	Where it would have, or there would be a high risk of, an irreversible negative impact on biodiversity and irreplaceable loss of natural capital that could result in the project being environmentally unacceptable, even with mitigation. Alternatively, it could lead to a major positive effect. Impacts of this nature must be a central factor in decision making.
STATUS OF IMPACT	
Whether the impact is positive (a benefit), negative (a cost) or neutral (status quo maintained)	
DEGREE OF CONFIDENCE IN PREDICTIONS	
The degree of confidence in the predictions is based on the availability of information and specialist knowledge (e.g. low, medium or high)	
MITIGATION	
Mechanisms used to control, minimise and or eliminate negative impacts on the environment and to enhance project benefits Mitigation measures should be considered in terms of the following hierarchy: (1) avoidance, (2) minimisation, (3) restoration and (4) off-sets.	

2. Scoring System for Impact Assessment Ratings

To comparatively rank the impacts, each impact has been assigned a score using the scoring system outlined in the Table below. This scoring system allows for a comparative, accountable assessment of the indicative cumulative positive or negative impacts of each aspect assessed.

IMPACT PARAMETER	SCORE	
Extent (A)	Rating	
Local	1	
Regional	2	
National	3	
Duration (B)	Rating	
Short term	1	
Medium Term	2	
Long Term	3	
Permanent	4	
Probability (C)	Rating	
Improbable	1	
Probable	2	
Highly Probable	3	
Definite	4	
IMPACT PARAMETER	NEGATIVE IMPACT SCORE	POSITIVE IMPACT SCORE
Magnitude/Intensity (D)	Rating	Rating
Low	-1	1
Medium	-2	2
High	-3	3
SIGNIFICANCE RATING (F) = (A*B*D)*C	Rating	Rating
Low	0 to - 40	0 to 40
Medium	- 41 to - 80	41 to 80
High	- 81 to - 120	81 to 120
Very High	> - 120	> 120

APPENDIX C: RISK MATRIX FOR THE PROPOSED PROJECT

ASPECTS AND IMPACT REGISTER/RISK ASSSESSMENT FOR WATERCOURSES INCLUDING RIVERS, PANS, WETLANDS, SPRINGS,DRAINAGE LINES:MODDERFONTEIN WEF
COMPILED BY: Toni Belcher, BlueScience (SACNASP 400040/10)

DATE: JULY 2021

					Severity																
Nr.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Control Measures	Confidence	Type Watercourse
1	Construction	Construction works associated with WEF	Soil and vegetation disturbance; potential for some water quality and flow impacts associated with constsruction activities	Loss of biodiversity & habitat, impeding flow & water quality impact	1	1.5	1.5	1	1.25	1	2	**4.25**	1	2	5	4	**12**	**51**	**L**	See freshwater report	High	Upper reaches of the Brak, Gabrielspruit, Tierhoekspruit and Kareespruit Rivers and their smaller tributaries, as well as some valley bottom wetlands associated with the larger watercourses (PES=A/B to B/C; EIS=Moderate to High)
2	Operation	Operational activities associated with WEF	Disturbance related to infrastructure maintenance; stormwater along roadss and developed area; resulting erosion and alien vegetation growth	Disturbance to aquatic habitat - Facilitation of erosion and invasion by alien plants	1	1	1	1	1	1	2	**4**	1	2	5	4	**12**	**48**	**L**			
3	Decommission	Removal of WEF infrastructure	Disturbance related to aquatic habitat disturbance onsite when removing infrastructure	Habitat disturbance and some flow and water quality impacts	1	1	1	1	1	1	2	**4**	1	2	5	4	**12**	**48**	**L**			