FRESHWATER SPECIALIST STUDY:

Basic Assessment for the Proposed Development of the 325MW Kudusberg Wind Energy Facility and associated infrastructure, between Matjiesfontein and Sutherland in the Western and Northern Cape Provinces

Report prepared for:

CSIR – Environmental Management Services

P O Box 17001

Congella, Durban, 4013

South Africa

Report prepared by:

BlueScience (Pty) Ltd

P.O. Box 455

Somerset Mall, 7137

South Africa

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SPECIALIST EXPERTISE: ANTONIA BELCHER

Name:	Antonia (Toni) Belcher ***(Pr. Sci. Nat)***
Profession:	Aquatic scientist
Nationality:	South African
Years of experience:	27 years
Professional Registration:	Professional Environmental Scientist (Pr. Sci. Nat 400040/10) Professional Ecological Science (Pr. Sci. Nat 400040/10)
Accreditation:	SASS5 (Macro-invertebrate assessment method)
Academic Qualifications:	1998 - M.Sc. in Environmental Management, Potchefstroom University (*cum laude*) 1989 - B.Sc. (Hons) in Oceanography, University of Port Elizabeth 1987 - B.Sc. – Mathematics, Applied Mathematics, University of Port Elizabeth 1984 – Matriculation, Lawson Brown High School, Port Elizabeth
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
Countries Worked in:	South Africa, Namibia, Swaziland, Lesotho, Rwanda
Employment Record:	2013 - 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: 5 August 2018

EXECUTIVE SUMMARY

The proposed 325 MW Kudusberg Wind Energy Facility (WEF) is located on the Oliviersberg and Koedoesberg Mountains which form the watershed between the Tankwa, Ongeluks and Groot Rivers, all in the upper reaches of the Olifants/Doring River System, on the border of the Northern and Western Cape Provinces. The aquatic features within the study area consist of the upper reaches of the Doring River (Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and their lesser, unnamed tributaries, as well as some valley bottom wetlands associated with the larger watercourses and some small dams, vernal ponds and seeps on the hill tops).

The ecological habitat integrity of the rivers within the study area is still natural in the upper reaches with few modifications (some roads and very small dams). Downstream, in the middle reaches of the Windheuwels and Ongeluks Rivers, the rivers become largely natural to moderately modified. The riparian habitat is slightly more degraded as a result of direct habitat modification from the surrounding agricultural activities. The hillslope seeps and the vernal pool are in a natural ecological condition while the valley bottom wetlands 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 Brak River as well as portions of the Jakkalshok and Ongeluks Rivers (rivers in the valleys between the ridges on which the wind turbines are placed) are mapped as aquatic Critical Biodiversity Areas (CBAs) where they occur within terrestrial CBAs. The remainder of the watercourses is mapped as aquatic Ecological Support Areas (ESAs). Very limited aquatic ESAs occur where there is localised disturbance within the watercourses such as at the gravel road crossings. There is also a wetland at the source of the largest southwards flowing tributary of the Ongeluks River that is mapped as an aquatic CBA. Most of the terrestrial areas adjacent to the watercourses in the area are mapped as Other Natural Areas (ONAs).

Within the Northern Cape CBA mapping, most of the watercourses occur within ESAs, with reaches that are on the mid-slopes of the hillsides being mapped as ONAs. The width of the ESA corridor along the Windheuwels River (a tributary of the Tankwa River where the planned access to the WEF is located) within the site is 1000 m wide. There is a CBA located along the upper Windheuwels River that is avoided by the project activities.

The larger watercourses in the study area, Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers, have a high ecological importance and sensitivity while the smaller tributaries/drainage features have 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 wetland features within the study area are considered of moderate ecological importance and sensitivity. The hillslope seeps and 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. The vernal pools are small but contain a unique aquatic habitat and specific associated biota.

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 (turbines, crane pads, substations and construction camps) 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); Where access routes need to be constructed through the watercourses, the disturbance of the channels should be limited.
- 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
- The vernal pool and other wetland areas: at least 50m, measured from the top of bank of the delineated wetland edge.

In terms of the proposed project and its alternatives:

Access road: Alternative 1 would have the lesser freshwater impact as, with a slight realignment, it would not need to cross any watercourse and only an upgrade to the existing crossing over the river would be required. Alternative 2 would however still be acceptable, with mitigation;

Substation: Alternative 3 is located along a proposed internal access road and thus would not require an additional access road to be constructed. This alternative is likely to have the lowest potential freshwater impacts of the three alternatives proposed. Alternatives 1 and 2 would however still be acceptable, with mitigation.

Construction camp: Alternative 1 is located outside of any watercourses or their proposed buffers. The area is also relatively flat therefore runoff to the watercourses would be low. The camp will however need to be established in an area that comprises of natural vegetation cover and would need to be rehabilitated after the construction phase. Construction Camp Alternatives 2 and 3 are located adjacent to the larger Uriasgat River, on a small rise between the river and one of its larger tributaries. From a freshwater perspective these Construction Camp Alternatives 2 and 3 have a higher potential freshwater impact than Construction Camp Alternative 1 but these impacts could be mitigated such that the potential freshwater impacts associated with the use of either of these sites would be acceptable.

WEF turbines, crane pads, access roads and electrical transformers and cables: With these small alterations to the proposed layout plan, the potential impacts of the turbines and associated infrastructure would be very limited and of a low significance.

With mitigation, the potential freshwater impacts of the proposed Kudusberg 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 / river beds. 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. Road infrastructure and cable alignments should coincide as far as possible to minimise the impact.
- 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 in a suitable manner 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 storm water 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 Kudusberg 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.
Seeps	Occur on the hillslopes and valley heads and are often seasonal, mostly fed by groundwater, hillslope interflow and to a lesser degree precipitation. They are most numerous in the mountainous areas of the Western Cape.
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.
Vernal pools	Also called vernal ponds or ephemeral pools, are temporary pools of water that provide habitat for distinctive aquatic plants and animals that are adapted to the very short inundation periods of these pools.
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.

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Specialist Report page number**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	i-iii and x
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	iii
c) an indication of the scope of, and the purpose for which, the report was prepared;	4
(cA) an indication of the quality and age of base data used for the specialist report;	7
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	50
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	5
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	5
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	40-44
g) an identification of any areas to be avoided, including buffers;	38-42
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	39-42
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**Error! Bookmark not defined.**
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	24
k) any mitigation measures for inclusion in the EMPr;	65
l) any conditions for inclusion in the environmental authorisation;	65
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	65
n) a reasoned opinion- i. as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	71
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	23
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Comments will be included following the release of the Draft BAR for comment
q) any other information requested by the competent authority.	N/A

2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

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1 FRESHWATER SPECIALIST STUDY: BASIC ASSESSMENT FOR THE KUDUSBERG 325 MW WIND ENERGY FACILITY

1.1 INTRODUCTION AND METHODOLOGY

1.1.1 Scope and Objectives

This Aquatic Ecological (including wetlands) Impact Assessment is intended to inform the Basic Assessment (BA) process for the proposed 325 MW Kudusberg Wind Energy Facility (WEF) between Sutherland and Matjiesfontein in the Northern Cape and Western Cape provinces. The proposed WEF will be located within the Renewable Energy Development Zone 2 (REDZ 2) known as Komsberg, published in terms of Section 24(3) of the National Environmental Management Act, 1998 (NEMA) in Government Notice (GN) R114 of 16 February 2018.

1.1.2 Terms of Reference

Aquatic Ecology (including wetlands) Impact Assessment should include the following:

- A single site visit including field surveys for the proposed WEF.
- Screening of environmental sensitivities on the site based on the Strategic Environmental Assessment (SEA) data, site visit and other sources, to identify no-go areas for the WEF. Based on the screening, an environmental sensitivity map must be compiled by the specialist to identify the sensitive areas on site (low, medium and high or no-go areas). The proposed layout will then be informed by these no-go areas.
- A draft specialist assessment report (the input complying with content requirements of Appendix 6 of the EIA Regulations, 2014, as amended) to be included in the Draft BA Report; and
- A final specialist assessment report (the input complying with content requirements of Appendix 6 of the EIA Regulations, 2014, as amended) to be included in the Final BA Report. The final specialist report must address the review comments by the CSIR, the applicant and any relevant comments which may arise from the public participation process.

Specific issues to be addressed in the Aquatic Ecological Study:

- Describe the aquatic ecology features of the project area, with focus on features that are potentially impacted by the proposed project. The description should include the major habitat forms within the study site, giving due consideration to freshwater ecosystems, drainage lines and wetlands;
- Consider seasonal changes and long-term trends, such as due to climate change;
- Identify any Species of Special Concern or protected species on site relevant to the aquatic environment;
- Map the sensitive ecological features within the proposed project area, showing any "no-go" areas (i.e. "very high" sensitivity). Specify set-backs or buffers, and provide clear reasons for these recommendations. Also map the extent of disturbance and transformation of the site;
- Identify and delineate wetlands that may occur on the site, using the relevant protocols established by DWAF (2005);
- Determine if a Water Use License (WUL) or General Authorisation (GA) is required and if so, determine the requirements thereof;
- Identify and assess the potential impacts of the project (including all access roads) on the aquatic environment;
- Provide mitigation measures to include in the environmental management plan; and
- The assessment should be based on existing information, national and provincial databases, SANBI mapping, mapping in the Wind and Solar SEA (CSIR, 2015), professional experience and field work conducted.

1.1.3 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 in the rainy season for two days in July 2018 (21-22 July 2018), as well as in the spring for a single day (10 October 2018) to further verify an aquatic feature. 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 provide an indication of 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.

1.1.4 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.

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 ground-truthing of aquatic features was undertaken during winter when the use of vegetation as an indicator was possible. However, 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.

Cumulative impacts of the proposed project were assessed by reviewing all available documentation for the other wind energy facilities within a 50km radius of the site, particularly in terms of the aquatic features occurring on site; the proposed mitigation measures and the indicated potential impacts to these ecosystems as well as the association of these ecosystems with that within the study area.

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.

1.1.5 Source of Information

Information used in this freshwater impact assessment includes:

- The satellite image used as a background to all maps was obtained from PlanetGIS and Google Earth Professional, 2018;
- The SANBI Biodiversity GIS and CapeFarmMapper 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;
- The existing sensitivity mapping from the Strategic Environmental Assessment (SEA) conducted by CSIR from 2013-2015 (www.csir.co.za/national-wind-solar-sea) for the project area;
- 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;
- The State of Rivers Report for the Olifants Doorn Water Management Area (WMA) that was undertaken in 2006, the Olifants Doorn WMA Water Resources Classification Study in 2012 and the Resource Quality Objectives Study in 2014 were utilised to inform the PES and EI&ES, as well as the Recommended Ecological Condition (REC) of the aquatic features in the area;
- 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.

1.2 DESCRIPTION OF PROJECT ASPECTS RELEVANT TO THE AQUATIC ECOSYSTEM IMPACTS

The proposed 325 MW Kudusberg WEF is located on the Oliviersberg and Koedoesberg Mountains which form the watershed between the Tankwa, Ongeluks and Groot Rivers, all in the upper reaches of the Olifants/Doring River System on the West Coast of South Africa. Although the proposed development spans a portion of the Western Cape and Northern Cape provinces, the rivers within the area lie within the Olifants Doring Water Management Area which lies within the management area of the Western Cape Regional Office of the Department of Water and Sanitation (DWS).

Activities and infrastructure associated with the proposed Kudusberg WEF include (Figures 1a and 1b):

- A maximum of 56 wind turbines, each with a capacity of 3 MW to 6.5 MW. Turbine foundations will be up to 30 m in diameter and up to 5 m in depth where the hub height of each turbine will be up to 140 m and its rotor diameter of up to 180 m;
- Adjacent to the wind turbines are the permanently compacted, hardstanding crane pads areas of 90 m x 50 m (total footprint of 25.2 ha) that are required for the construction and maintenance of the turbines;
- Electrical transformers (690 V / 33 kV) adjacent to each turbine will also have a footprint of 2 m x 2 m, but can be up to 10 m x 10 m at certain locations;
- A temporary construction camp (approx. 12.6 ha), consisting of an on-site concrete batching plant for use during the construction phase, and offices, administration, operations and maintenance buildings during the operational phase;
- Two access road alternatives are proposed from the main access road (MN04469) in the north (within 200 m buffers). Upgrade to the public access roads (the tarred R354 connecting Matjiesfontein and Sutherland and the district gravel road DR02249 from this road) will need to be undertaken that may include upgrading the culvert structures over the watercourses.
- Internal roads of up to 12 m wide, including stormwater control structures will be constructed to access the turbines. Where feasible underground 33 kV cabling will be buried adjacent to the access roads between turbines, with overhead 33 kV lines grouping turbines to cross valleys and ridges outside the road footprints to get to the onsite 33/132 substation;
- One 33/132kV substation will be constructed onsite that will have a footprint of approximately 2.25ha. Three alternative locations have been identified for consideration; and
- Up to four 140 m high (depending of the final hub height) wind measuring lattice masts strategically placed within the wind farm development footprint to collect data on wind conditions during the operational phase, have been erected.

The above-mentioned structures would be in place for the operational phase of the project and could potentially impact on aquatic features over the longer term. No site or layout alternatives are being considered as part of the assessment however the proposed layout will be amended where necessary, based on specialist input.

Temporary infrastructure that will be required during the construction phase and that could have shorter term impacts on the aquatic features in the area comprises of a fenced construction camp of approximately 12.6 ha that will have a concrete batching plant. Offices at the construction camp could remain to be utilised in the operation phase. Three alternative sites have been proposed for consideration. A temporary water supply for construction will need to be installed that will make use of existing or new boreholes and will comprise of over-ground water pipelines and tanks to the construction camp. Approval for any additional water requirements will form part of a separate water use authorization approvals process.

Figure 1a shows the initial proposed layout for the WEF and Figure 1b the slight amendments that were made to accommodate specialist comment on the proposed layout. With regards to the aquatic ecosystem related recommendations, the following changes have been made:

- Moving Camp Alternatives 2 and 3 outside of the recommended buffer area of the adjacent watercourses;
- Minor changes to the road alignments to avoid watercourses and the recommended buffer areas, where possible; and
- Some of the locations of the turbines and associated crane pads were moved slightly to ensure that they are located outside of the aquatic features and their associated buffer areas.

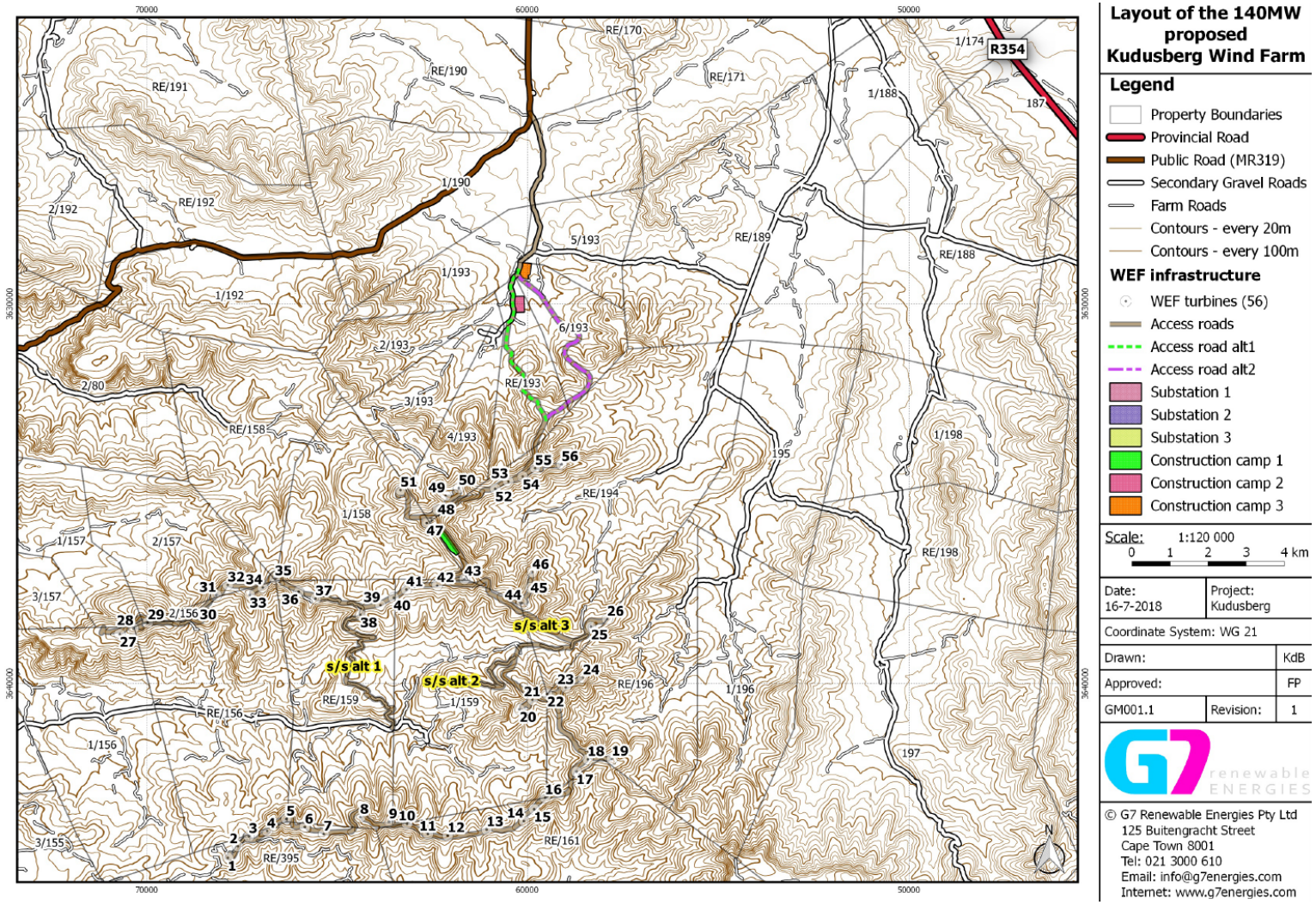


Figure 1a. The proposed layout for the Kudusberg WEF

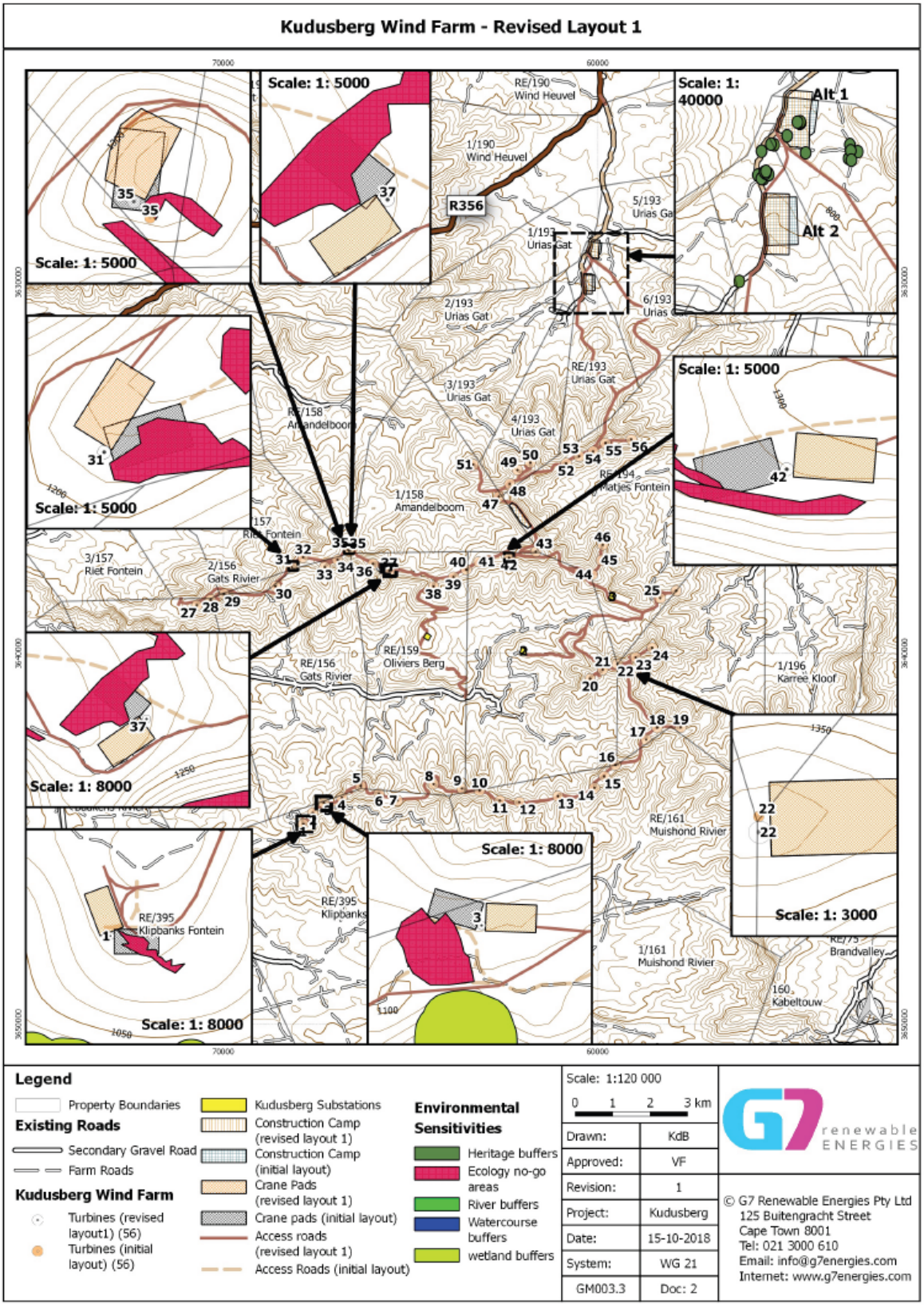


Figure 1b. Revised layout for the proposed Kudusberg WEF

1.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

1.3.1 Topography

The proposed WEF is located largely on the higher-lying Oliviersberg and Koedoesberg Mountains between Matjiesfontein and Sutherland. The proposed wind turbines are to be placed on mountain ridges that are mostly east-west orientated and form the watershed between several tributaries of the Doring River in the Olifants/Doring River System (Figure 2). The southern-most ridge extends between the Muishond and Ongeluks River, while central ridge lies between the Ongeluks and Jakkalshok Rivers. These rivers drain towards the west, with the Muishond River flowing into the Groot River that feeds the Doring River while the Jakkalshok River is a tributary of the Ongeluks River that drains into the Tankwa River.

The northern and eastern portions of the proposed WEF are located on the ridges that are drained by the Kleinpoort, Uriasgat and Brak Rivers, all smaller tributaries of the Tankwa River. The Tankwa River is a large tributary of the Doring River that has its confluence with the Doring River at Elandsvlei.

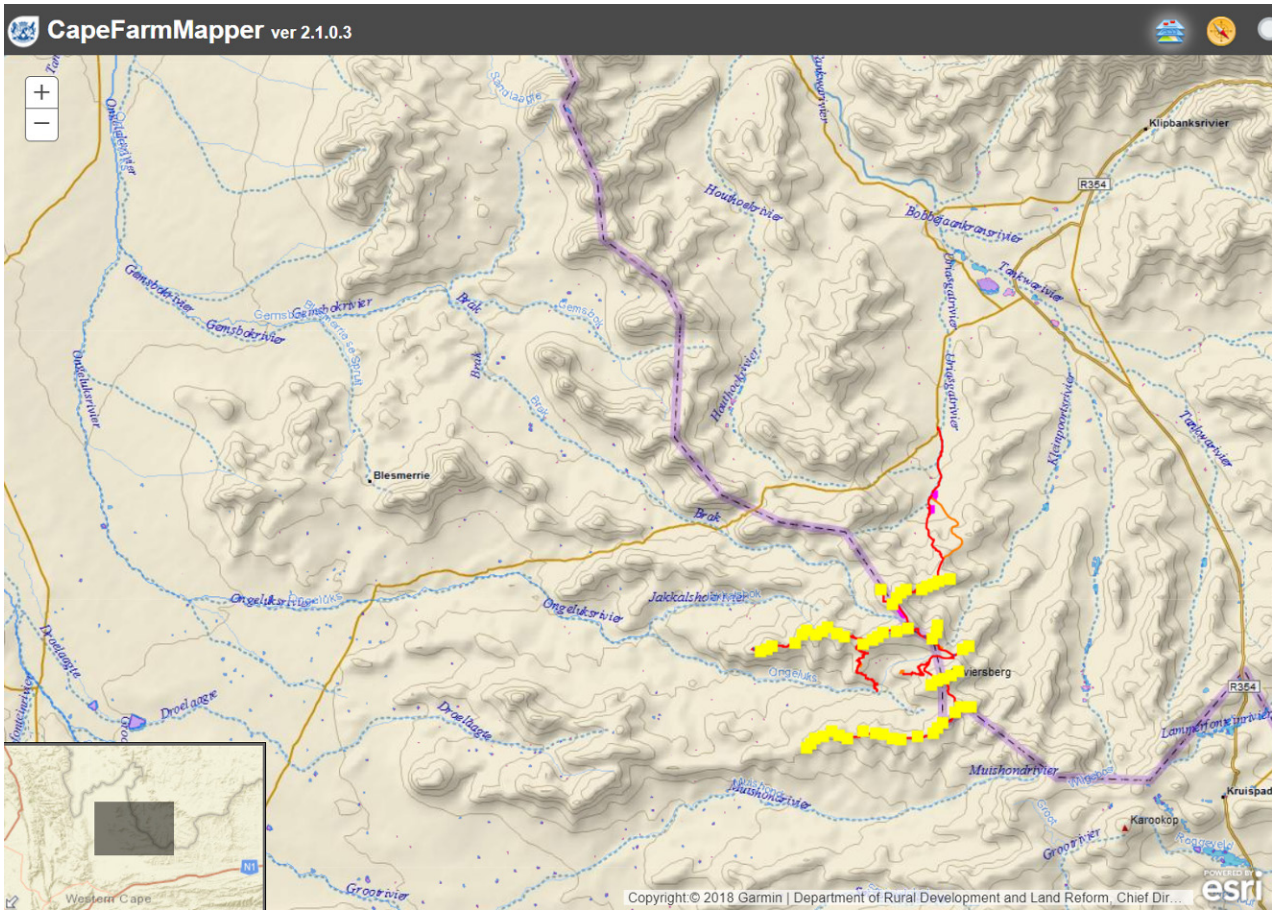


Figure 2. Relief map for the area, showing the main watercourses and the location of the WEF (CapeFarmMapper, 2018)

The access road into the site from the north is located along the Uriasgat River, following the existing road. Two of the construction camps are also placed adjacent to this access road and the river. 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	Berg Olifants WMA	
Catchment Area	Muishond River, a tributary of Groot River Kleinpoort; Uriasgat, Brak, Jakkalshok and Ongeluks Rivers, tributaries of the Tankwa River	Upper portion of the Doring Catchment in the larger Olifants Doring Catchment
Quaternary Catchment	E22B (Groot River) E23A (Kleinpoort River) E23B (Uriasgat River) E23G (Ongeluks River) E23H (Brak River)	
Present Ecological state	All the rivers–Natural (A)	DWS (2012)
Ecological Importance and Ecological Sensitivity	All the rivers- High EI and Very high ES with the exception of the Kleinpoorts/Wilgebos that has a High ES	
Type of water resources	Rivers, ephemeral streams and pans/pools	

1.3.2 Climate and Hydrology

The study area experiences a low rainfall of only 176mm per annum. Rainfall falls mostly in winter 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 3). Flow in the rivers tends to be episodic (Figure 4) with very little to no flow in the rivers for much of the river. Water flow typically only occurs for a short period of time following localised rainfall. These rainfall events tend to mostly occur in the higher rainfall month of June. 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, an essential mitigation.

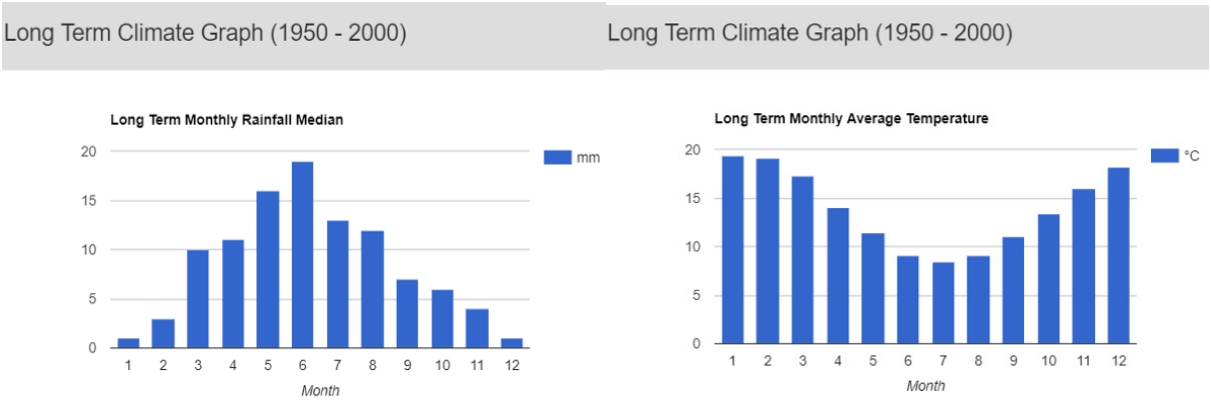


Figure 3. Average monthly rainfall (left) and temperatures (right) for the study area, collected between 1950 and 2000 (Schulze, 2009)

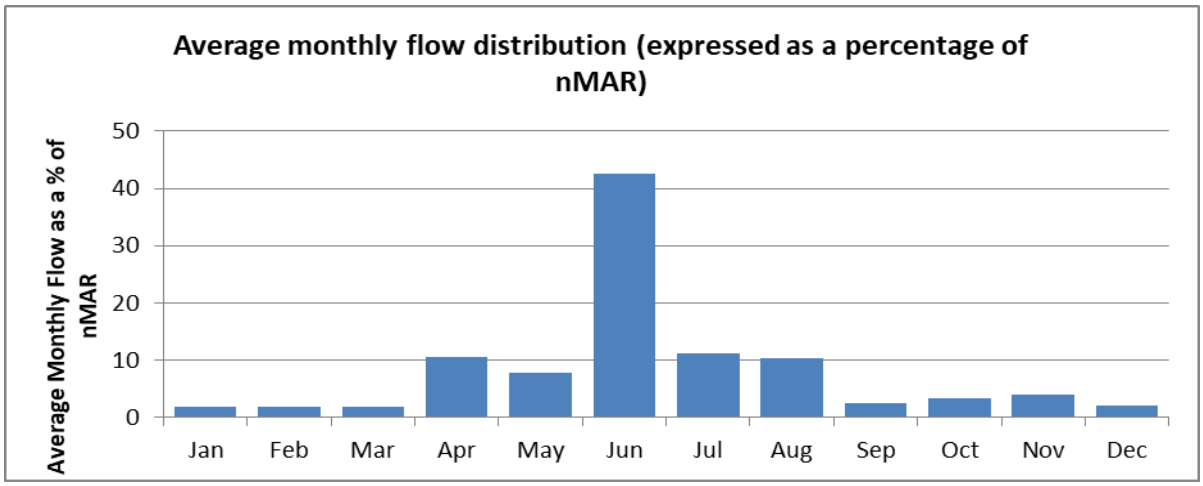


Figure 4. Monthly flow distribution within the rivers in the study area, with the month flow shown as a percentage of the natural mean annual runoff (nMAR) for the catchment

1.3.3 Geology and Soils

Mudstone, siltstone and sandstone of the Beaufort Group as well as sandstone, siltstone and shale of the Ecca Group; Karoo Sequence occur within the area.

The ridges are generally sandstone with very shallow, rocky soils. The lower-slopes and valley bottoms are largely underlain by shale, which may form loose gravel on the slopes or give rise to a heavier clay soil on the flat areas. Some of the lower slopes and plains contain coarse sands and gravels of a quartzitic nature. The soils are typically Glenrosa and / or Mispah forms and lime is generally present. Glenrosa has a low erodibility when occurring on flat or gentle slopes but increases on steeper slopes of ridges, hills and mountains. This is often ameliorated by stony deposits that reduce runoff intensity. Mispah soil is often found in association with Glenrosa and has a low erodibility.

1.3.4 Vegetation

Under unmodified conditions, two vegetation types occur across the wider study area; these are Koedoesberge-Moordenaars Karoo and Central Mountain Shale Renosterveld (Figure 5). Tanqua Wash Riviere vegetation occurs along the larger Tankwa River to the north of the site and the Groot River to the south. The vegetation reflects the varied topography and associated geology of the area with Central Mountain Shale Renosterveld occurring predominantly on the ridges where much of the project-related activities will occur, while Koedoesberge-Moordenaars Karoo dominates the lowlands. Central Mountain Shale Renosterveld comprises of a low, open to medium density shrubland with a medium dense matrix of short, divaricate shrubs, dominated by renosterbos. Koedoesberge-Moordenaars Karoo vegetation tends to be on the slopes and broad ridges of low mountains and comprises of tall shrubland dominated by renosterbos with non-succulent karoo shrubs and geophytes. Both these vegetation types are regarded as "least threatened".

The Tanqua Wash Riviere vegetation that occurs along the Tankwa River on the R356 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 of a mix of low trees and shrubs such as *Vachellia karroo*, *Searsia lancea, Buddleja saligna, Euclea undulata*, *Melianthus comosus, Sutherlandia frutescens, 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.

1.3.5 Biodiversity Conservation Value

There are three freshwater biodiversity conservation mapping initiatives of relevance to the study area due to the fact that the site is split over two provinces: the national Freshwater Ecosystem Priority Areas (FEPAs) and the 2017 Western Cape Biodiversity Spatial Plan (WCBSP) for the Witzenberg Local Municipality 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 6) that is associated with the larger downstream Doring River, a river of high ecological importance in terms of the endemic fish species that it supports. 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 Tankwa River System that have been mapped as FEPA

Wetlands (Rainshadow Valley Karoo channelled valley-bottom wetlands). These wetlands are however outside of the study area.

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 Witzenberg 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.

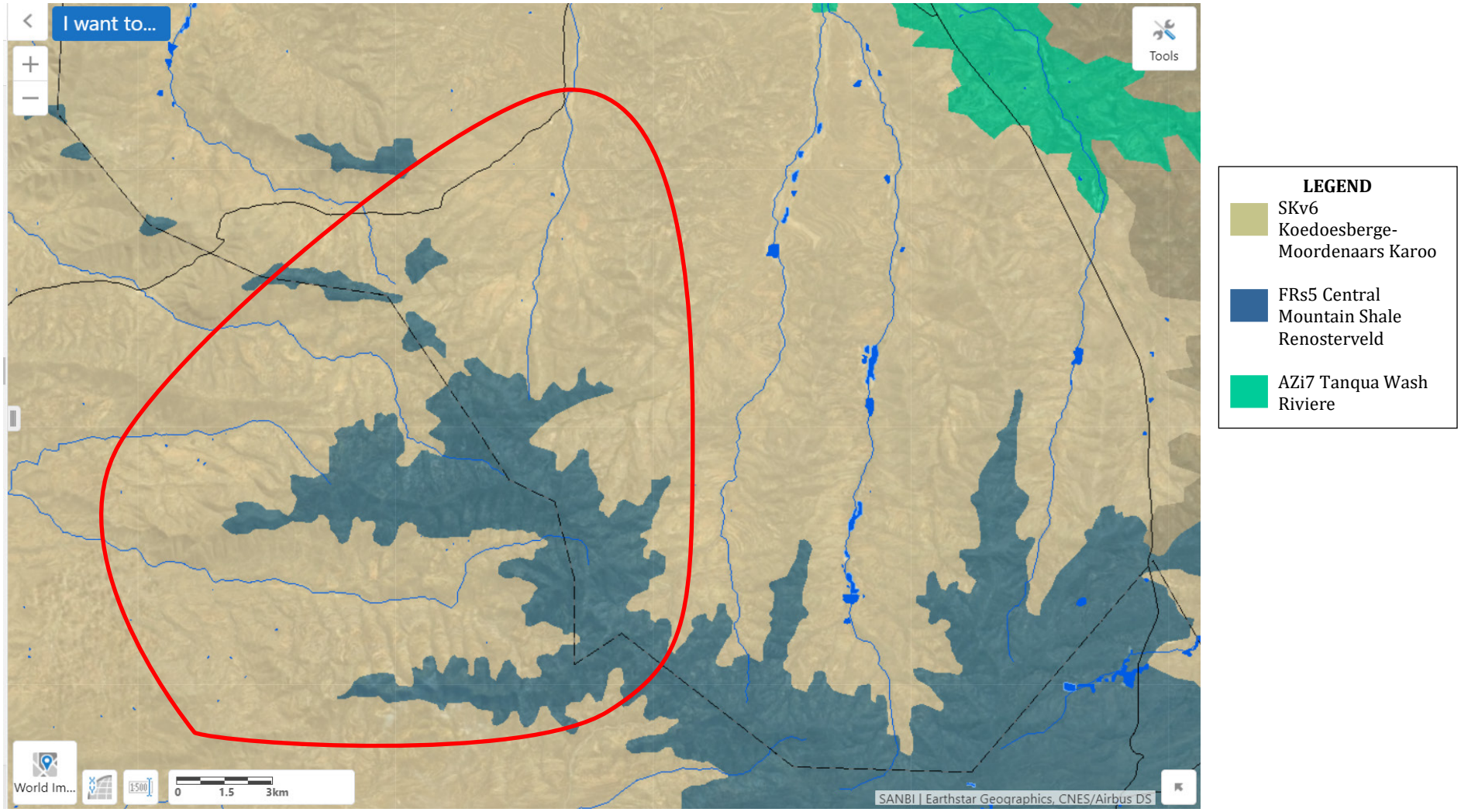


Figure 5. National Vegetation Map (SANBI, 2012) for the study area (red outlined area) (SANBI Biodiversity GIS, 2018)

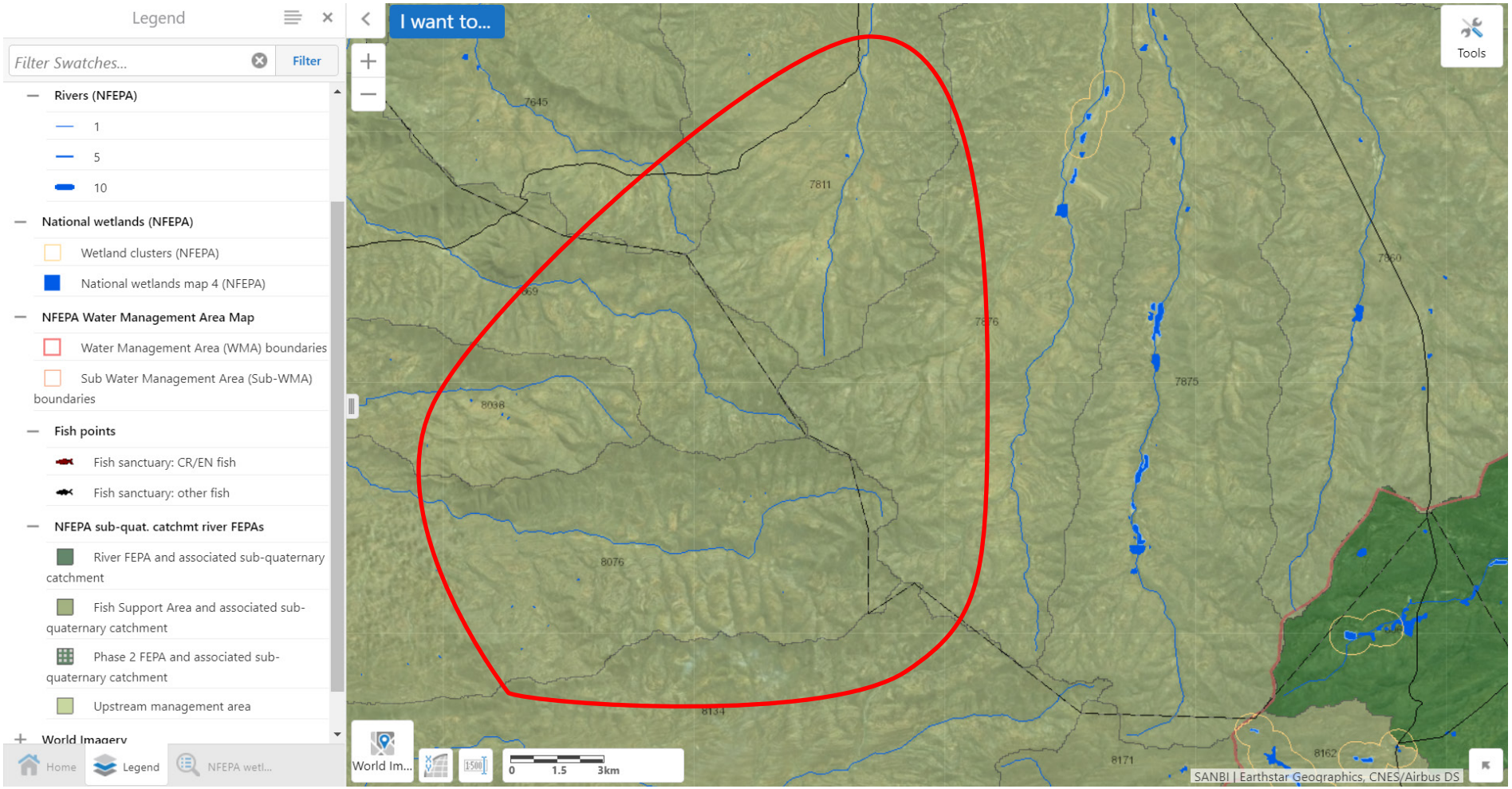


Figure 6. National Freshwater Ecosystem Priority Areas for the study area (red outline) (SANBI Biodiversity GIS, 2018)

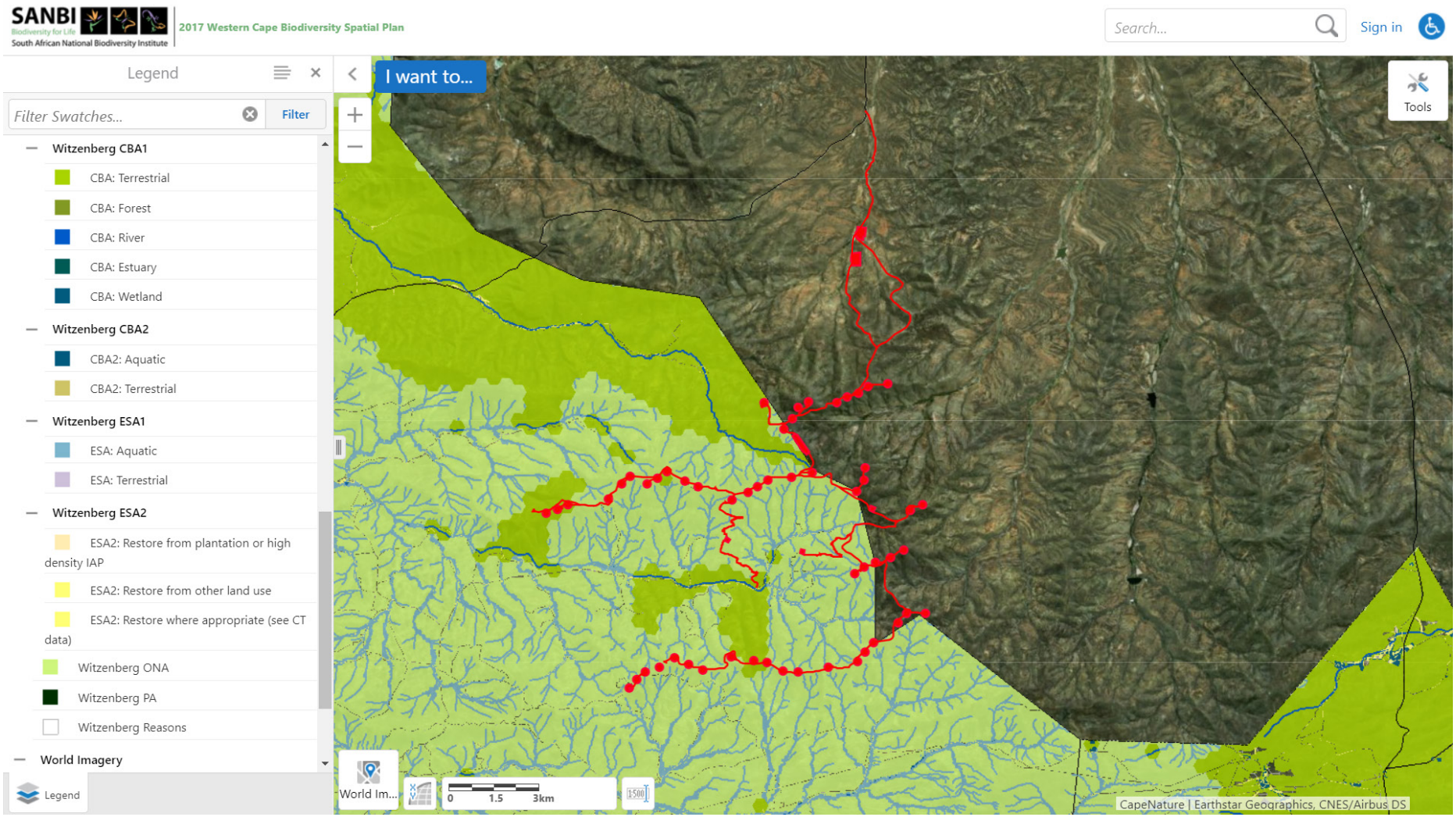


Figure 7. The 2017 Western Cape Biodiversity Spatial Plan for Witzenberg Municipality (SANBI Biodiversity GIS, 2018)

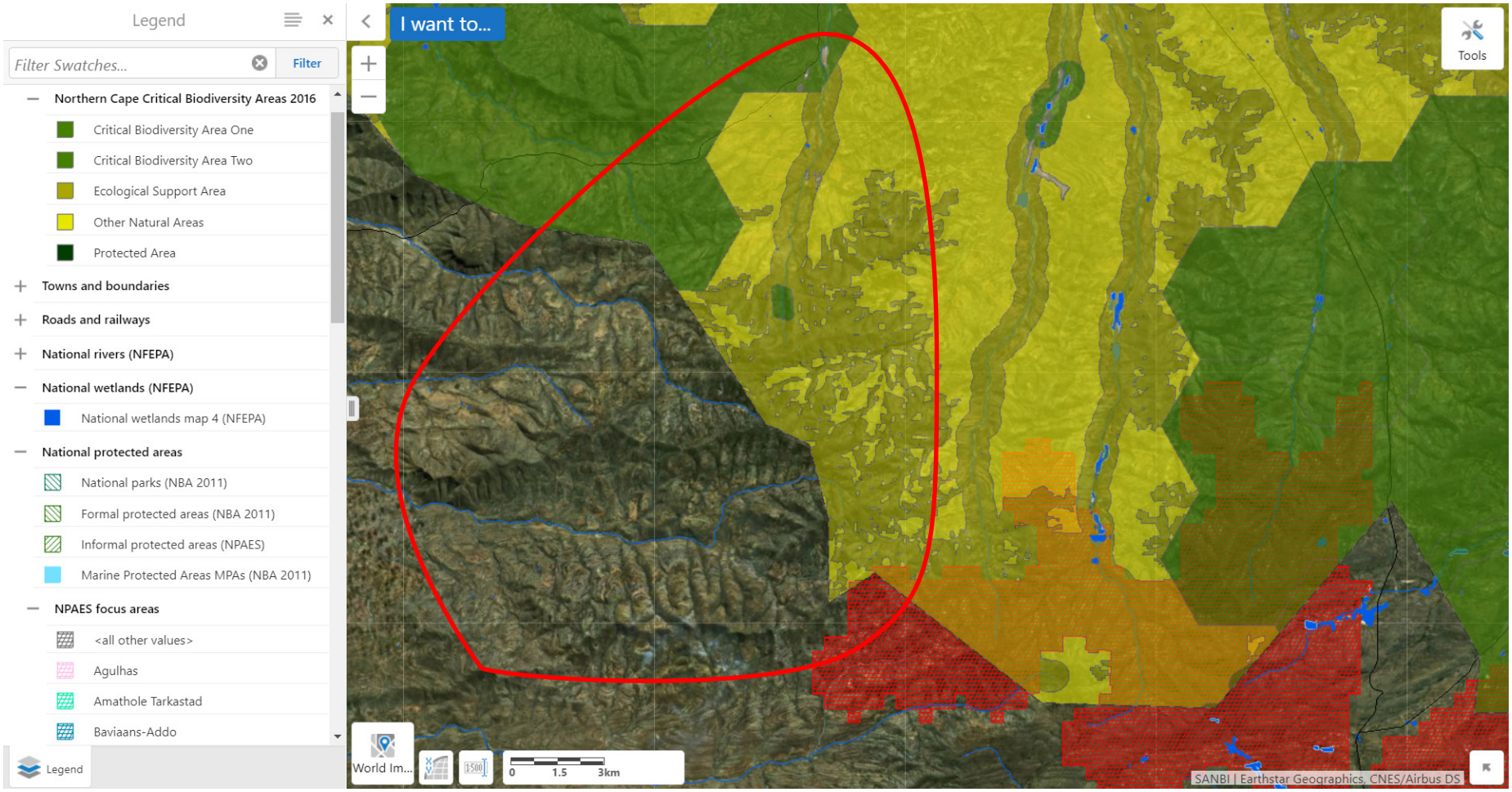


Figure 8. The 2016 Northern Cape Critical Biodiversity Areas for the study area (red outlined area), together with the Western Karoo Focus area for the 2010 National Protected Area Expansion Strategy Area (red hatched area) (SANBI Biodiversity GIS, 2018)

The Brak River as well as portions of the Jakkalshok and Ongeluks Rivers (rivers in the valleys between the ridges on which the wind turbines are placed) are mapped as aquatic CBA where they occur within terrestrial CBAs (CBA1). The remainder of the watercourses are 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. There is also a wetland at the source of the largest southwards flowing tributary of the Ongeluks River that is mapped as an aquatic CBA. Most of the terrestrial areas adjacent to the watercourses in the area are mapped as ONAs.

Within the Northern Cape CBA mapping of 2016, most of the watercourses occur within ESAs, with reaches that are on the mid-slopes of the hillsides being mapped as ONAs. The width of the ESA corridor along the Windheuwels River (a tributary of the Tankwa River where the access to the site is located) within the site is 1000m wide. There is a CBA located along the upper Windheuwels River that is avoided by the project infrastructure. There is also a CBA to the west of the study area in the upper Houthoek River (also a tributary of the Tankwa River but further to the west of the study area) that is outside of the study area. A cluster of wetlands in the Kleinpoorts River to the east of the site (and outside of the site) is also mapped as a CBA. The ecological integrity of the CBAs should be preserved while the ecological functionality of the watercourses within the ESAs needs to be retained.

1.3.5.1 Aquatic Habitat and Species of Concern

The rock-fields or pavements that occur on the higher-lying ridges in the study area offer a limited and unique habitat that is not found elsewhere. Vernal pools are associated with this shallow, temporarily inundated aquatic habitat that supports very specialised aquatic vegetation that is rooted in the mud but has floating stems and leaves such as *Romulea aquatica* (Listed as "Endangered" on the IUCN Red List of Threatened Species).

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".

One plant species of conservation concern, the candelabra lily (*Brunsvigia josephinae*) which is listed as "Vulnerable", is known to occur along the watercourses throughout the study area.

1.4 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).

1.4.1 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 in order 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."

1.4.2 NEMA Environmental Impact Assessment Regulations, 2014, as amended

NEMA provides for the identification of activities which 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.

1.4.3 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 on 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.

1.4.4 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.

1.4.5 GA 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 Kudusberg WEF and is discussed in this report, under Section 1.6.6.

1.5 IDENTIFICATION OF KEY ISSUES

1.5.1 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 a 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 has 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 the course of preparing this baseline freshwater specialist report. However, consultation will be undertaken if deemed necessary, to respond to relevant comments be received following the release of the Draft Basic Assessment Report.

1.5.2 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.

1.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The proposed WEF and associated infrastructure (substation, internal and access roads as well as the temporary construction camp) have the potential to impact on 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.

1.6.1 Ecological Assessment of the Aquatic Features within the Study area

This section comprises of 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 Doring River (Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and their lesser, unnamed tributaries, as well as some valley bottom wetlands associated with the larger watercourses and some small dams, vernal ponds and seeps on the hill tops). 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 wetland areas are closely associated with the rivers and thus have been included in the rivers' assessments.

1.6.1.1 Description of Aquatic Features

Muishond River

The Muishond River occurs to the south of the study area and flows westwards to drain into the Groot River, a tributary of the Doring River. A number of minor, southward flowing tributaries of the river originate on the southern-most ridge on which wind turbines are proposed. The river is still in a natural ecological condition with no disturbance except for gravel roads in its upper catchment. The river is mapped as an aquatic ESA and is an Upstream FEPA River.

Ongeluks River

The Ongeluks River is located within the two east-west ridges on which wind turbines are proposed. Two of the sub-station alternatives are placed within the river valley with access roads to these substation alternatives. The river also flows westwards but confluences with several other tributaries before draining into the Tankwa River in the north. The Gatsrivier Holiday Farm is located within the river valley and there are access roads, homesteads, guest accommodation and camping areas, as well as small dams in the valley. The river is however still in a largely natural ecological condition and is mapped as an aquatic CBA due to the large size of the river, with some of the more disturbed areas being mapped as aquatic ESAs. The river is also mapped as an Upstream FEPA River.

Jakkalshok River

The Jakkalshok River is a tributary of the Ongeluks Rivers that flows to the north of the ridge in the north-western portion of the study area where wind turbines are proposed on the north-western portion of the site. The river is approximately 13km in length and flows into the Ongeluks River to the south. The river, as well as three of its tributaries, drains from the northern slopes of the ridge. The river is still in a natural ecological condition with no disturbance except for a gravel road along the river. The river is mapped as an aquatic CBA with some more disturbed areas as aquatic ESAs and is an Upstream FEPA River.

Brak River

The Brak River originates in the north-western extent of the study area and flows in a north-westerly direction for approximately 40km before it joins the Gemsbok River, a tributary of the Ongeluks River. The river is still in a natural ecological condition with no disturbance present. The river is mapped as an aquatic CBA and is an Upstream FEPA River.

Windheuwels River, its tributary the Uriasgat and associated valley bottom wetlands

The Windheuwels River originates in the northern extent of the site and flows in a northerly direction for about 22km until joining the Tankwa River. Within the lower reaches of the river, it flows within a wide braided channel with an associated floodplain wetland area. The public access road R356 as well as the proposed access road follows the river for most of its length. Two of the alternative proposed laydown and construction areas for the WEF are located along the river. The river is in a largely natural ecological condition with some modification as a result of the road, homesteads and cultivation/farming activities along the river. The river corridor is mapped as an aquatic ESA with a small portion of the upper reach mapped as an aquatic CBA. The river is an Upstream FEPA River.

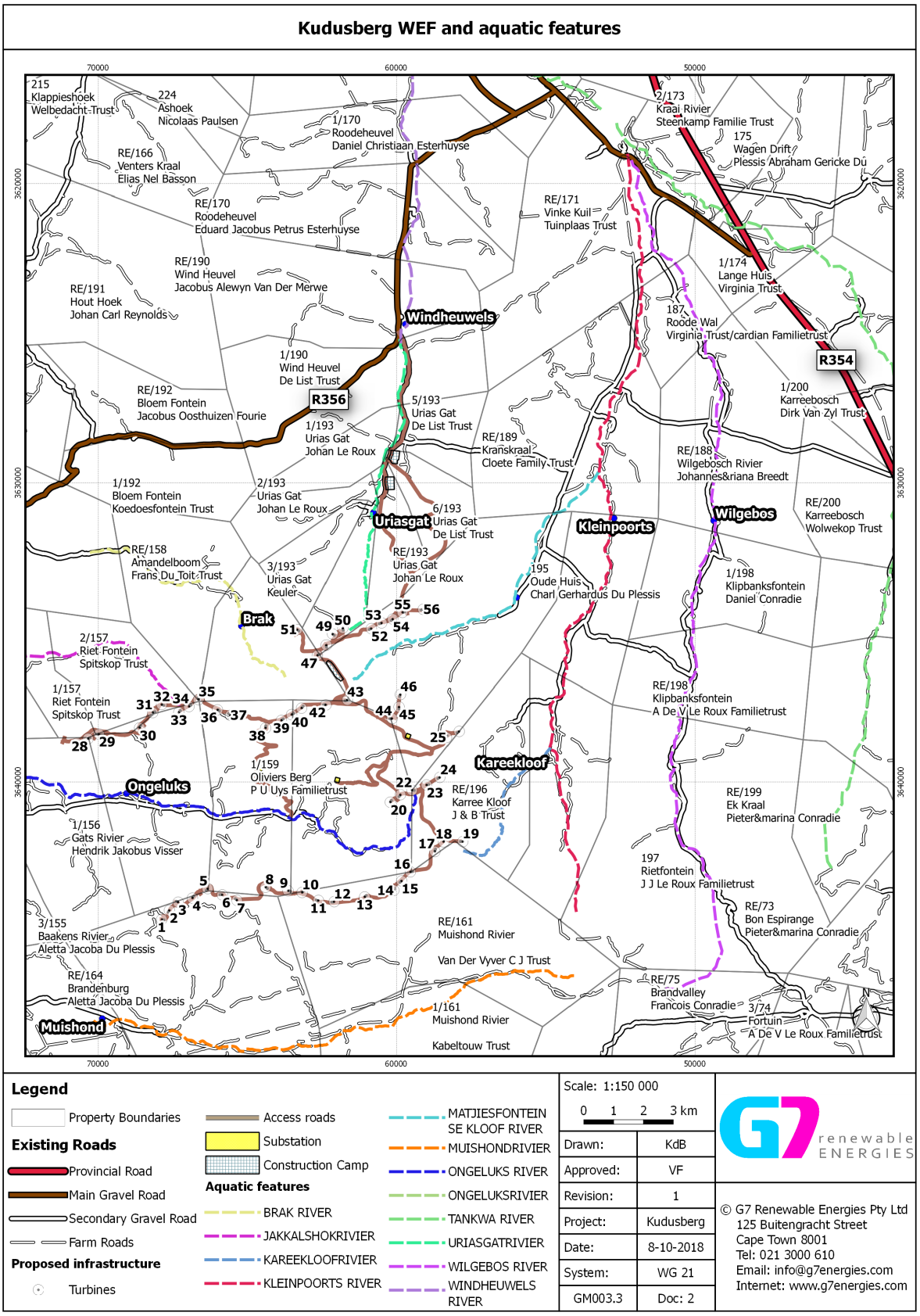


Figure 9. Map showing the location of the main aquatic features within the area

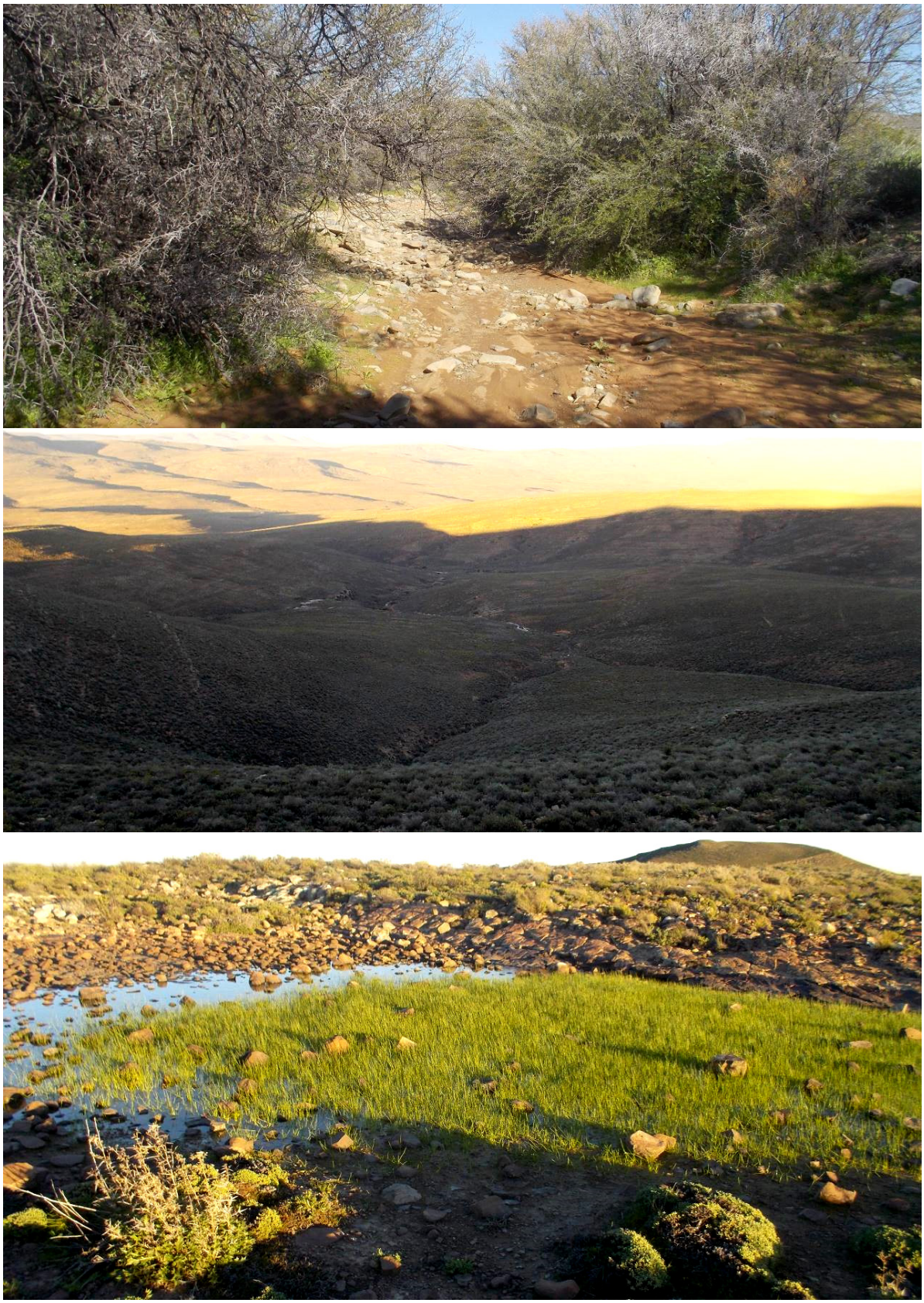


Figure 10. View of the larger rivers, smaller tributaries and a vernal pool within the study area

Kleinpoorts and Wilgebos Rivers

The Kleinpoorts and Wilgebos Rivers are two tributaries of the Tankwa River that flow northwards to the east of the study area and join just upstream of the confluence with the Tankwa River. Due to the fact that these rivers flow closely together in their lower reaches, they form a wider braided area with valley bottom wetland habitat. A FEPA wetland cluster is mapped in these lower reaches. This area is mapped as an aquatic CBA while the remainder of the river is mapped as an aquatic ESA. The river is mapped as an Upstream FEPA River. The existing public access road to the proposed WEF crosses the rivers downstream of where they confluence.

Unnamed tributaries and drainage features with some associated seeps on the hill tops

Many smaller tributaries and drainage features of the rivers described above arise on the northern and southern slopes of the hills where the wind turbines are proposed. These small watercourses are still in a natural condition, except for a few that have small dams constructed in them. Gravel tracks have also been constructed through some. At the source of a few of the larger tributaries, seep areas occur that feed these streams. These are very limited in extent and largely only occur on the southern steeper slopes below where ridges occur and are downslope from where the wind turbines are proposed.

Vernal pools

Along the southern ridge, vernal pools have formed on some of the rock surfaces where water is retained within small basins that have formed on the flat ridge surface. These pools have a rather unique ecosystem associated with them with very specialised biota that respond quickly to periods when the pools are inundated. An additional site visit was undertaken to confirm the presence/absence of certain vernal pools within proposed development areas.

1.6.1.2 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, in order 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 the purposes of 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:

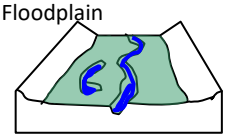
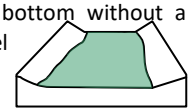
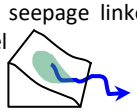
Table 3. Geomorphological and Physical features of the watercourses on site

River	Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers	Minor unnamed tributaries & drainage features
Geomorphological Zone	Lower Foothill Zone	Mountain streams and upper foothills zone
Lateral mobility	Semi-Confined	Largely 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	Gravel and alluvium	Bedrock, boulders and gravel
Channel modification	Channel is fairly natural with some direct habitat modification	Natural with some very small instream dams
Hydrological type	Seasonal to episodic	Seasonal to episodic
Ecoregion	Great Karoo	Great Karoo
DWA catchment	E22B; E23A; E23B; E23G; E23H	E22B; E23A; E23B; E23G; E23H
Vegetation type	Koedoesberge-Moordenaars Karoo, Central Mountain Shale Renosterveld	Central Mountain Shale Renosterveld
Rainfall region	Very late summer to winter	Very late summer to winter

1.6.1.3 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 Tankwa, Windheuwels, Wilgebos and Kleinpoorts Rivers (outside of the site but crossed by the existing public roads) are classified as valley bottom wetlands. In addition, in the upper reaches of the watercourses (particularly on the southern slopes of the hillslopes), there are some hillslope seeps associated with the river systems. The vernal pool and artificial wetlands associated with the dams are classified as depression wetland based on the wetland types described in Table 4. The dams and vernal pool only receive a small contribution of surface water runoff. 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 into groups 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 (oxbow depressions & natural levees) and alluvial transport and deposition of sediment, leads to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel 	Valley bottom areas with well-defined stream channel but lacking characteristic floodplain features. May be gently sloped, characterised by net accumulation of alluvial deposits or may have steeper slopes, characterised by net loss of sediment. Water inputs from main channel (overspill) 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 seepage linked to channel 	Slopes on hillsides, which are characterised by the colluvial movement of materials. 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 therefore this type is usually isolated from the stream channel network.	*/ ***	*/ ***

[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	Hillslope seeps	Vernal pool	Valley bottom wetlands
System	Inland		
Ecoregion	Great Karoo		
Landscape setting	Hill slope	Bench (hilltop)	Channeled Valley bottom
Longitudinal zonation	Headwaters	Depression	Lower foothill
Drainage	With channel outflow	Without channel in- and outflow	With channel in- and outflow
Seasonality	Seasonally inundated		
Modification	Largely natural to Moderately modified		
Geology	Sandstone of the Beaufort Group		Shale and siltstone of the Ecca Group; Karoo Sequence
Vegetation	Central Mountain Shale Renosterveld		Koedoesberge-Moordenaars Karoo
Substrate	Rock with limited fine sediment		Gravel/sand
Salinity	Fresh		Slightly brackish

Most of the dams have been constructed on the lower slopes of the hills within or adjacent to watercourses that are away from the proposed project activities. It would however appear that the smaller dams that have constructed on the ridge top may have been associated with vernal pools although the construction of the dams have modified any wetland feature that may have occurred at these sites such that they no longer contain aquatic ecosystems of significance. The dams have not been assessed further due to their artificial nature.

1.6.1.4 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 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 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 8).

The habitat integrity assessment was divided into the upper reaches of the watercourses that have few modifications and the lower, more modified middle 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 (some roads and very small dams). Downstream, in the middle reaches of the Windheuwels and Ongeluks Rivers, the rivers become largely natural to moderately modified. The riparian habitat is slightly more degraded as a result of direct habitat modification from the surrounding activities.

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

Instream Criteria	Upper Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and unnamed tributaries & drainage features	Middle reaches of the Windheuwels and the Ongeluks Rivers
Water Abstraction	2	6
Flow Modification	3	5
Bed Modification	3	8
Channel Modification	3	4
Water Quality	2	5
Inundation	3	4
Exotic Macrophytes	0	0
Exotic Fauna	0	0
Rubbish Dumping	0	2
Instream Integrity Class	A	A/B

Table 7. Riparian Habitat Integrity assessment for the watercourses within the study area

Riparian Category	Upper Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and unnamed tributaries & drainage features	Middle reaches of the Windheuwels and the Ongeluks Rivers
Vegetation Removal	2	4
Exotic Vegetation	2	4
Bank Erosion	3	5
Channel Modification	2	4
Water Abstraction	2	5
Inundation	3	4
Flow Modification	3	6
Water Quality	2	5
Riparian Integrity Category	A/B	B/C

Table 8. 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 9 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 9. Habitat integrity assessment criteria for palustrine wetlands (Dickens et al, 2003)

Criteria	Relevance
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.
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
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.
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.
Hydraulic/Geomorphic	
Canalisation	Desiccation or change to inundation of wetland and change in habitat
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities that reduce or change wetland habitat
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
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.
Invasive Plants	Affects habitat characteristics through changes in community structure and water quality changes
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over use of Biota	Overgrazing, over fishing, etc.

Table 10. Wetland habitat integrity assessment (score of 0=critically modified to 5=unmodified)

Criteria & Attributes	Hillslope seeps	Valley bottom wetlands	Vernal pools
Hydrological			
Flow Modification	4.9	3.9	4.8
Permanent Inundation	5	4.0	5
Water Quality			
Water Quality Modification	5	3.8	5
Sediment Load Modification	4.9	3.6	4.9
Hydraulic/Geomorphic			
Canalisation	5	4.8	5
Topographic Alteration	5	4.6	5
Biota			
Terrestrial Encroachment	4.9	4.0	4.9
Indigenous Vegetation Removal	5	3.9	5
Invasive Plant Encroachment	5	4.1	5
Alien Fauna	5	4.2	5
Over utilization of Biota	5	4.0	5
Total Mean	4.9	4.0	4.9
Category	A	B	A

The hillslope seeps and the vernal pool are in a natural ecological condition while the valley bottom wetlands have been modified but are still in a largely natural ecological condition.

Table 11. 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 that 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 12). Only the valley bottom wetlands were considered as the hillslope seeps and the vernal pools are still in a natural condition.

Table 12: 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 landuse activities and infrastructure (road) development (Table 12).

1.6.1.5 Ecological Importance and Sensitivity

The Ecological Importance and Ecological Sensitivity (EI&ES) assessment for both watercourses and wetlands considers 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 7). The median of the resultant score is calculated to derive the EI&ES category (Table 9). The results of the EIS assessment are shown in Table 8. The EI&ES have been determined for the larger water courses and for the smaller unnamed tributaries separately.

Table 13. 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

Table 14. Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General description	Range of median
Very high	Quaternaries/delineations unique on a national and international level based on unique biodiversity. These rivers are usually very sensitive to flow modifications 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

Ecological Importance and Sensitivity of the Watercourses

Table 15. Results of the EI&ES assessment of the watercourses in the study area

Biotic and Aquatic Habitat Determinants	Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts 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, Natural Heritage sites, Natural areas, PNEs	1.5	1.5
EIS CATEGORY	High	Moderate

The larger watercourses in the study area, Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers, 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.

Ecological Importance and Sensitivity of the Wetlands

The EIS Assessment for the wetland areas utilise a similar methodology to that for rivers. The results from the wetland EIS assessment are provided in Table 16 below. The assessment of the ecosystem services supplied by the wetland areas (divided into Hydrological Functional Importance and Direct Human Benefits) was conducted according to the guidelines as described by Kotze et al (2005).

Table 16: Results of the EIS assessment for the wetland areas

Ecological Importance	Hillslope seeps	Valley bottom wetlands	Vernal pools
Biodiversity support	1.83	2.17	2.33
Presence of Red Data species	2	1	3
Populations of unique species	2	2	3
Migration/breeding/feeding sites	1.5	3.5	1
Landscape scale	2.10	1.40	1.60
Protection status of the wetland	3	1	1
Protection status of the vegetation type	1	1	1
Regional context of the ecological integrity	2	2	2
Size and rarity of the wetland type/s present	2	1	2
Diversity of habitat types	2.5	2	2
Sensitivity of the wetland	1.33	1.93	1.67
Sensitivity to changes in floods	1	2.8	1
Sensitivity to changes in low flows/dry season	1	2	1
Sensitivity to changes in water quality	2	1	3
ECOLOGICAL IMPORTANCE & SENSITIVITY	2.10	2.17	2.33
Flood attenuation	1	3	0
Streamflow regulation	2	1	0
Sediment trapping	1.5	2.5	0.5
Phosphate assimilation	1	1	1
Nitrate assimilation	1	1.5	0
Toxicant assimilation	0	1	0
Erosion control	2.5	2	0
Carbon storage	1.5	1	0.5
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.31	1.63	0.25
Water for human use	1	1.5	0
Harvestable resources	1	1.5	0
Cultivated foods	1	0	0
Cultural heritage	1	0	0
Tourism and recreation	1	2	0
Education and research	1	1	1
IMPORTANCE OF DIRECT HUMAN BENEFITS	1.00	1.00	0.17
OVERALL IMPORTANCE (highest score of ecological, hydrological and direct human benefits)	2.10	2.17	2.33

The wetland features within the study area are considered of moderate ecological importance and sensitivity. The hillslope seeps and 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. The vernal pools are small but contain a unique aquatic habitat and specific associated biota.

1.6.1.6 Recommended Ecological Condition of Aquatic Ecosystems

Considering the natural to 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 with the exception of the the middle reaches of the Windheuwels and Ongeluks Rivers that are in a 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.

1.6.1.7 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 (turbines, crane pads, substations and construction camps (please note this excludes roads) 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
- The vernal pool and other wetland areas: at least 50m, measured from the top of bank of the river channels or the delineated wetland edge.

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.

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.

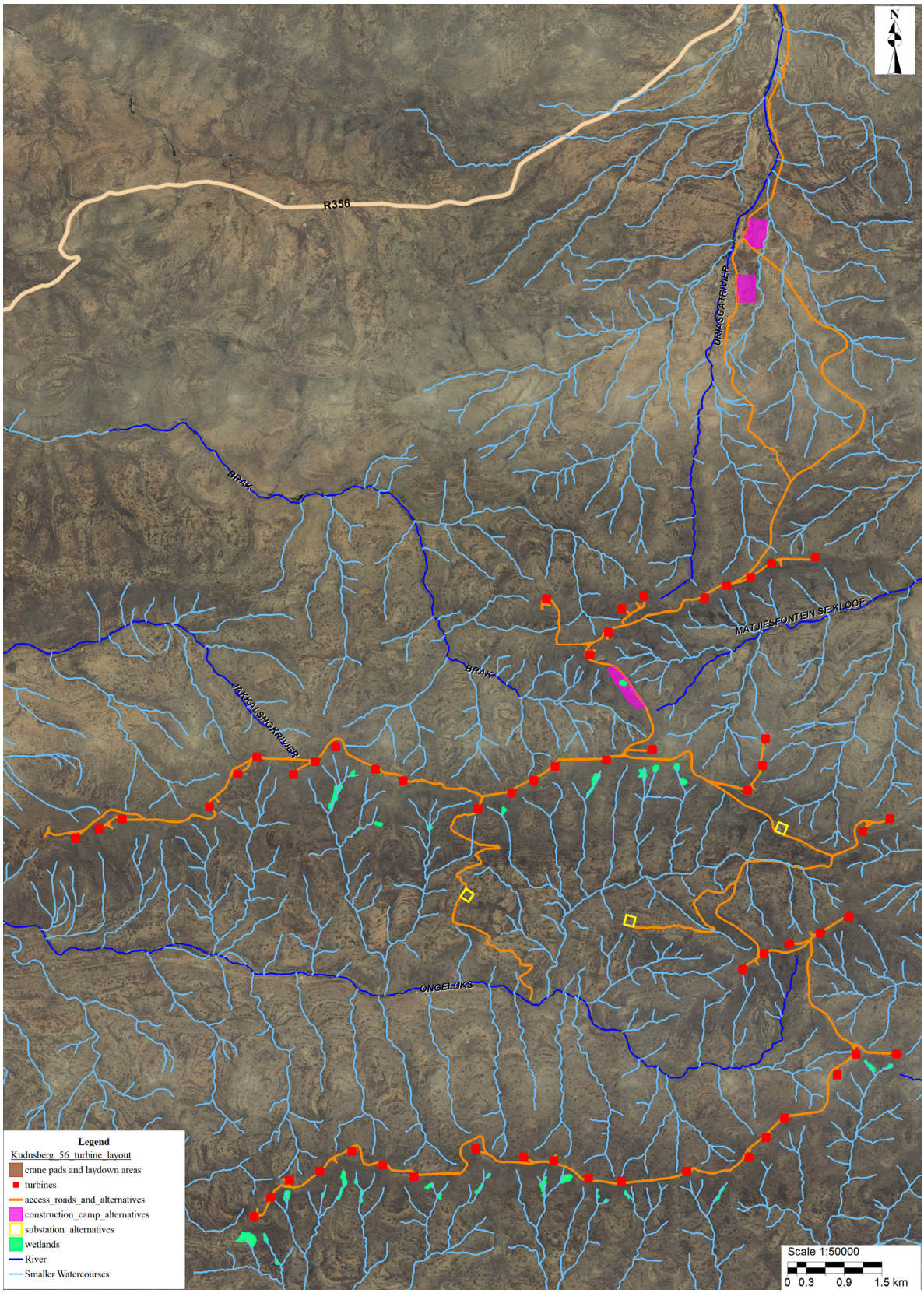
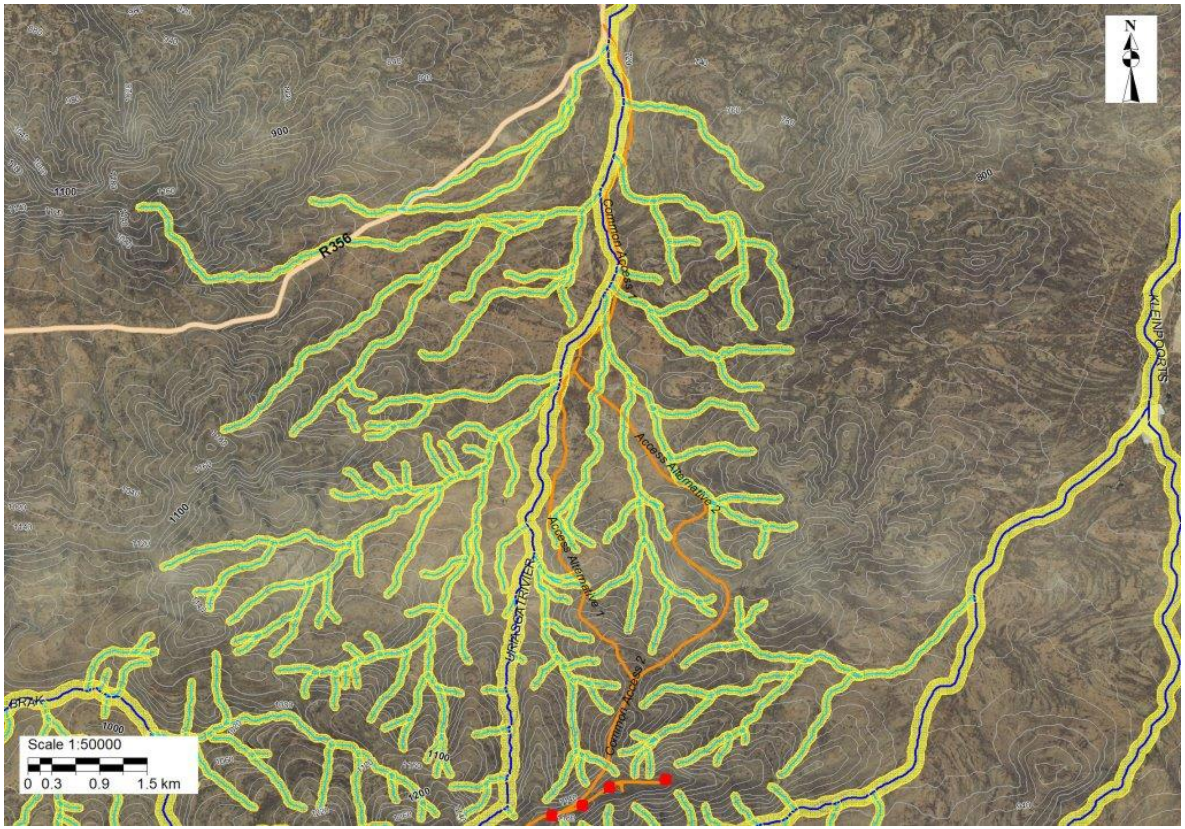
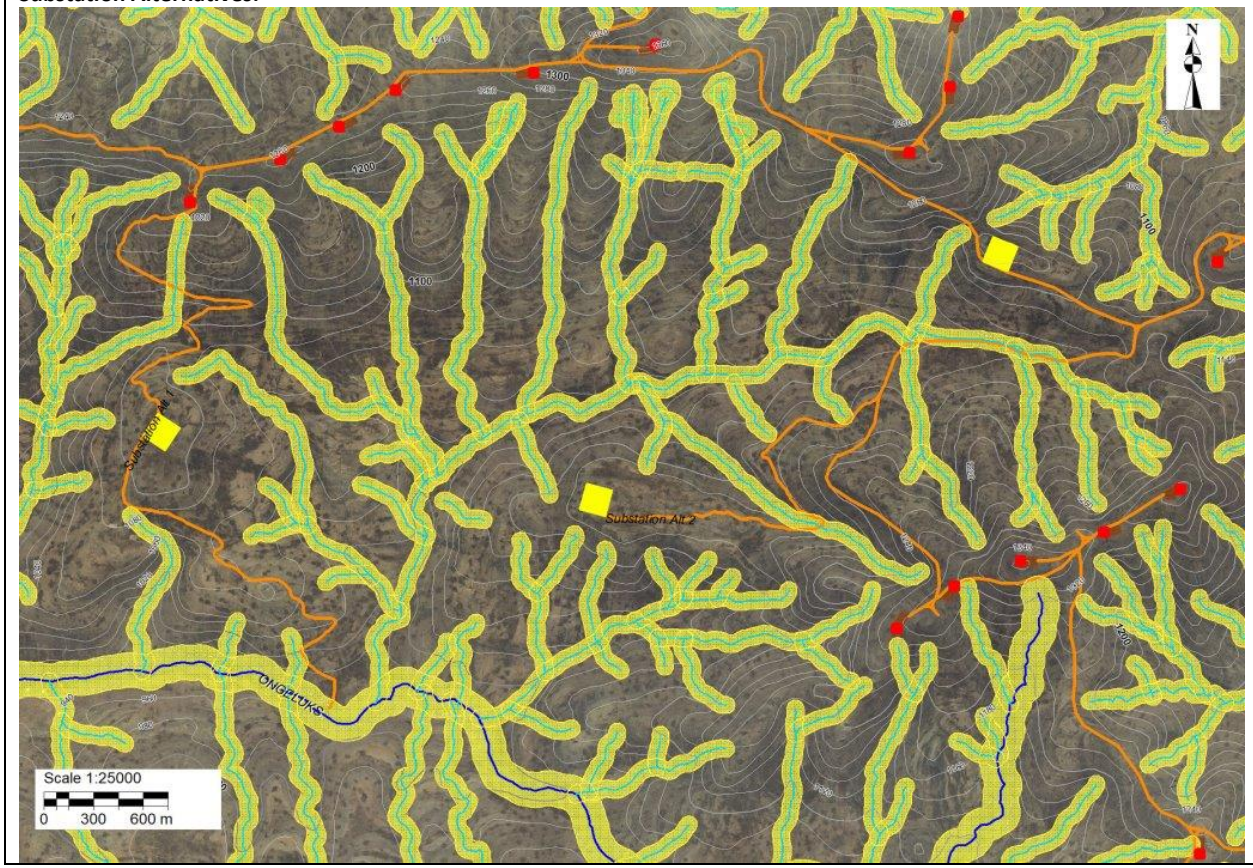
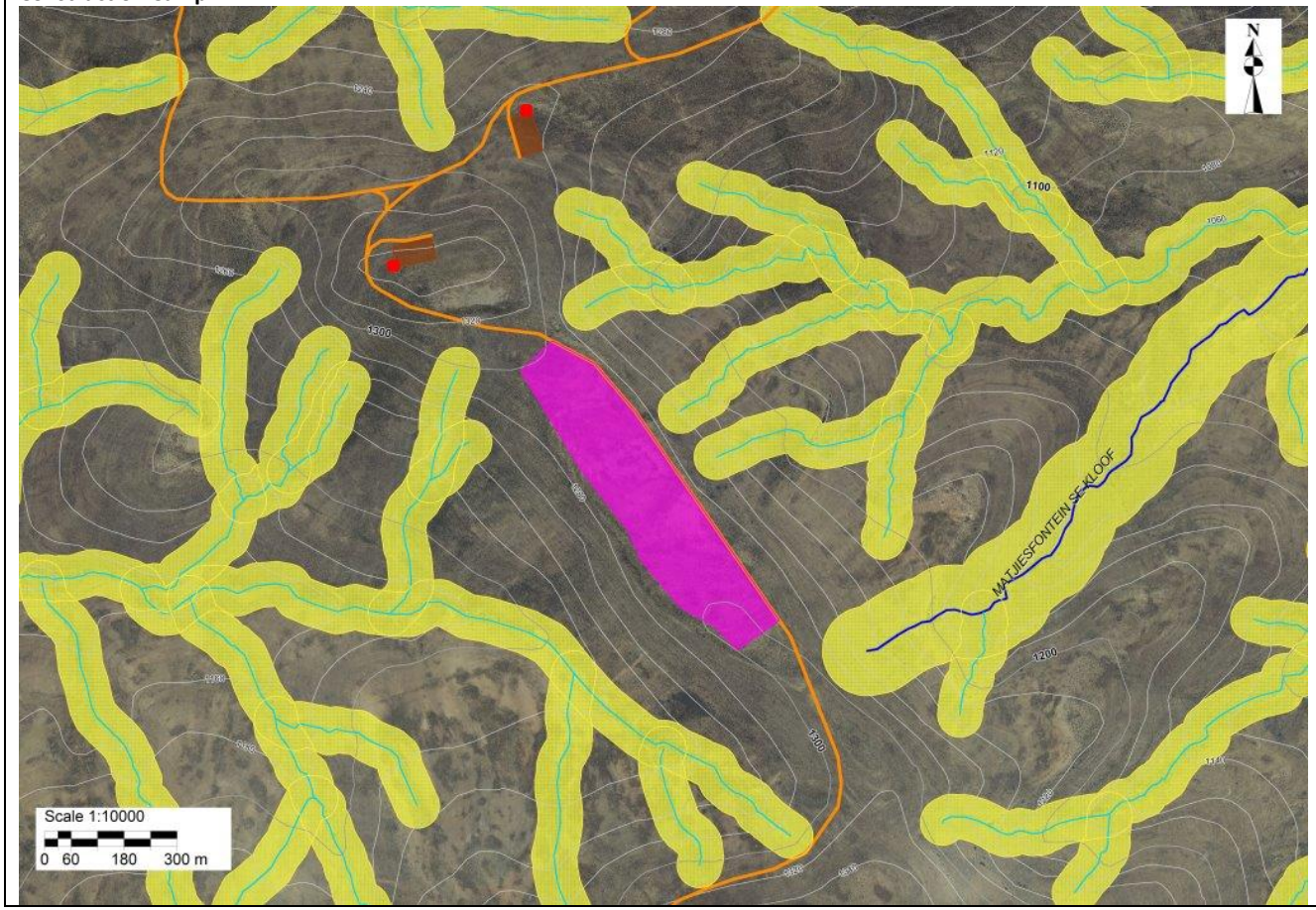


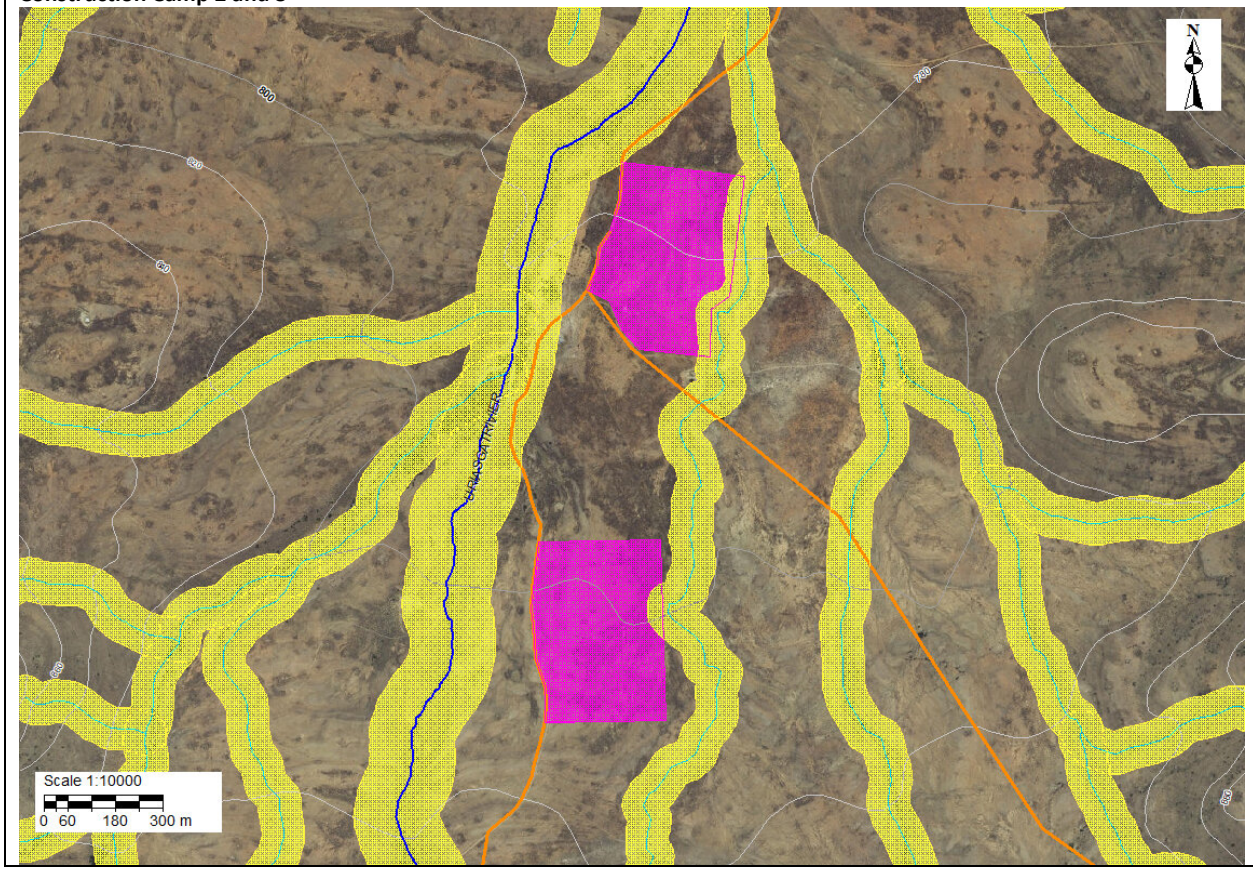
Figure 11. Orthophotograph (taken in 2014) of the entire study area with the mapped aquatic features within the site

Table 17. Freshwater constraints associated with the project components and alternatives

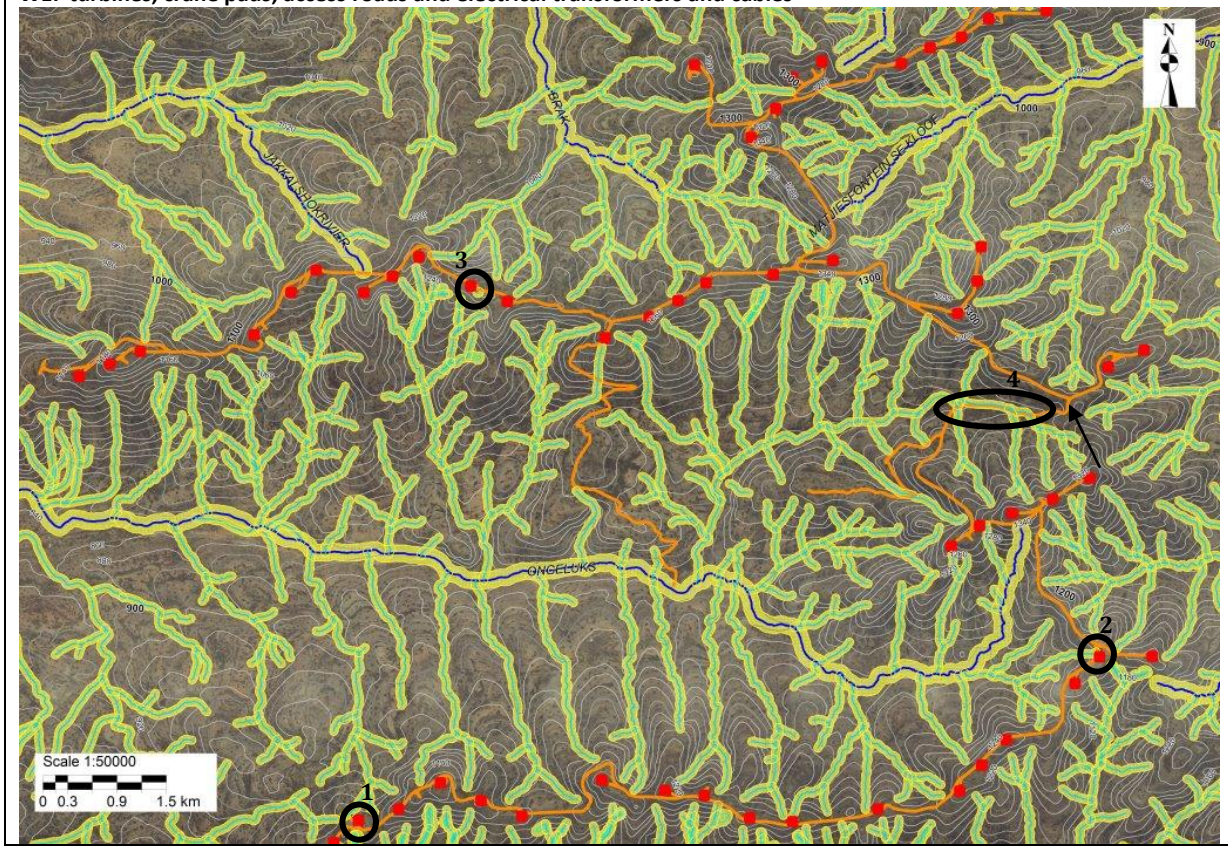
Mapped Freshwater Constraints	Comments and Recommendations
Access road Alternatives: 	The northern portion of the common access road is an existing road that will need to be upgraded. It is located adjacent to the larger Uriasgat River and crosses the river at the entrance to the property. It is likely that the existing low water crossing would need to be upgraded. Considering the volume of sediment, the river is still in a largely natural to moderately modified ecological condition. The main river of the channel flows within a wide braided channel. The existing road is largely located along the edge of the recommended 100m buffer. Access Alternative 1 route continues along the existing internal farm road within the site and along Uriasgat River. The extension of the road up the slope (the existing road crosses the Uriasgat River) and crosses some smaller drainage channels that could potentially be avoided with a slight realignment of the road. Access Alternative 2 would be located near an existing internal road but follows a more direct route that would need to be established. In addition, it will need to cross two larger streams and will thus have the greater potential impact on the aquatic habitat and flow in the watercourses. The remainder of the common access road follows the hilltop and could be slightly realigned to avoid crossing the top of the drainage features in that area. Thus, should the Access Alternative 1 route be selected, with a slight realignment there should no need to have any watercourse crossings, only an upgrade to the existing crossing over the river. The potential upgrades required to the existing public road crossings over the rivers are also likely to have a very limited impact due to the fact that there are already existing structures in place. The opportunity exists to improve on the current hydraulic capacity of these structures. The structures should be designed so that they do not require significant maintenance (cleaning of blockages) and should not constrict or change the channel shape or direction.

Substation Alternatives: 	Three substation alternatives are proposed that are all located on hilltops or ridges. The substation alternatives are thus not located within the watercourses or the recommended buffers. The access roads to two of the substation alternatives will however need to cross watercourses. Substation Alternative 1 is located along the existing track to the lookout point at Gatrivier. This road will however need to be upgraded and is on relatively steep hillslopes that have a high erosion potential. Appropriate erosion control measures will need to be put in place to prevent the road from forming a preferential flow path and resulting in erosion of the hillslope, especially where it intercepts the drainage feature. Substation Alternative 2 would result in additional disturbance of natural terrestrial vegetation cover as well as cross a smaller drainage feature. It can thus be expected that this alternative would have the highest potential freshwater impacts of all the substation alternatives. Substation Alternative 3 is located along a proposed internal access road and thus would not require an additional access road to be constructed. This alternative is likely to have the lowest potential freshwater impacts of the three alternatives proposed.

Construction Camp 1 	Construction Camp Alternative 1 is located on a ridge and along a proposed internal access road. The campsite is placed outside of any watercourses or their proposed buffers. The closest drainage feature is approximately 90m away from the edge of the camp. The area is also relatively flat therefore runoff to the watercourses would be low. The camp will however need to be established in an area that comprises of natural vegetation cover and would need to be rehabilitated after the construction phase is completed.

Construction Camp 2 and 3 	Construction Camp Alternatives 2 and 3 are located adjacent to the larger Uriasgat River, on a small rise between the river and one of its larger tributaries. Both areas extend into the recommended buffer areas and would need to be set back further. *In the revised layout these areas have been altered to accommodate the recommended buffers.* These areas have both been previously disturbed but have some minor drainage features crossing them. Should either of these areas be utilised for the construction camp, adequate stormwater management measures will need to be put in place to ensure there is no contaminated runoff to the adjacent tributary to the east. From a freshwater perspective these construction camp alternatives have a lower potential freshwater impact than Construction Camp Alternative 1. In addition, the potential impacts can easily be mitigated as mentioned above to reduce the potential impact.

WEF turbines, crane pads, access roads and electrical transformers and cables



The proposed WEF turbines, crane pads, access roads and electrical transformers and cables are located along the hill tops and ridges of the study area where there are largely no aquatic features. A slight shift of the internal access roads may in cases be necessary to allow for more than 50m between the road and watercourses. Locations where a crane pad and WEF turbine need to be shifted are indicated in the adjacent image by ovals numbered 1 to 3. The WEF turbine and crane pad at number 3 in particular should be moved further west and away from the vernal pool. The oval number 4 is an internal road that is located in and adjacent to a watercourse on a slope with an average gradient of approximately 4%, increasing to about 7.5%. It is recommended that this route be moved slightly upslope and away from the watercourse or an alternative route be sought such as where the arrow is located.

With these small alterations to the proposed layout plan, the potential impacts of the turbines and associated infrastructure would be very limited and of a low significance.

In the revised layout plan, the locations of the WEF turbines and crane pads at numbers 1 to 3 have been moved further away from the aquatic features as indicated. The road by number 4 in the image is an existing road along the watercourse that could not be moved due to the adjacent slope. Use of the existing road would have a low potential impact however any widening of the road should not take place closer to the watercourse.

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

Construction Phase: WEF require 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. The internal substation would also need to be constructed within the site. A construction camp with a temporary laydown area and concrete batching plant would need to be placed within the site for the construction works. All three of the construction camp alternatives are located closer than 100m from watercourses with the two northern alternatives being of greater concern as they are also adjacent to valley bottom wetland areas. This concern has been addressed in the revised layout for the WEF and therefore is no longer of concern.

Activities during the construction phase of the project could thus be expected to result in some disturbance of vegetation cover for clearing and preparation of the turbine and substation 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. Only a limited amount of water is utilised during construction for the batching of cement for wind turbines and other construction activities.

According to the layout plan for the proposed 56 turbines, as discussed in the previous section, some of the proposed turbines and the associated infrastructure have been moved to ensure that they are all placed outside of the recommended buffer areas of 100m from the delineated edge of the watercourses and valley bottom wetland areas and seeps as well as the 50m buffer from the vernal pool and other wetland areas. The substation alternatives are all located more than 100m away from the aquatic features.

A localised short-term impact of low intensity could be expected that has a low to very low 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 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 of lubricating oils and hydraulic and insulating fluids. Therefore, contamination of surface or

ground water 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 valley bottom wetlands occur as well as at least 50m buffer adjacent to the vernal pool and other wetland areas (as measured from the outer edge of the wetland area).

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 in a suitable manner 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.

Storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water 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.

Nature:
Direct impacts: Disturbance of aquatic habitat; modification to flow and water quality due to the proposed activities in or adjacent to aquatic ecosystems.
Indirect impacts: Invasive alien plant growth in riparian zones and wetland areas and potential for erosion of watercourses due to the disturbance of aquatic habitat and modification of runoff characteristics.

	Without mitigation	With mitigation
Extent	Local	Site only
Duration	Long term	Short term
Magnitude	Low	Minor
Probability	Likely	Unlikely
Status	Negative	Negative
Reversibility	Moderate to low	Moderate to Low
Irreplaceable loss of resources	Moderate	Low
Can impact be mitigated	Yes	Yes
Consequence	Moderate	Slight
Significance	Low	Low to very low

Mitigation:
As provided above

Cumulative impacts:
The aquatic ecosystems are mostly still in a natural ecological condition. The proposed WEF would however not be expected to significantly alter the current ecological status of the watercourses and wetland areas in the area provided that the recommended buffers are adhered to.

Residual risks:
Residual risks are associated with the indirect impacts of the proposed activities, that is, the potential for erosion of the watercourses and invasion of the aquatic habitats with alien plant species. It is important that these aspects be monitored and management on an ongoing and long-term basis.

Confidence: High

1.6.3 Impact of the 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 and underground 33 kV cabling will need to cross some watercourses, some of which will be on existing gravel roads. The major impacts associated with the internal roads relate to loss of habitat within the rivers, riparian areas and wetland habitats, loss of indigenous vegetation within the riparian zones and potential invasive alien plant growth as well as the potential for 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 identified aquatic ecosystems in the area at the points at which the infrastructure will need to cross of rivers/drainage lines or wetland areas, 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 at least 100 m outside of the drainage / river beds. 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. Road infrastructure and cable alignments should coincide as far as possible to minimise the impact. 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.

Nature: Direct impacts: Disturbance of aquatic habitat; modification to flow and water quality due to proposed activities in or adjacent to aquatic ecosystems. Indirect impacts: Invasive alien plant growth in riparian zones and wetland areas and potential for erosion of watercourses due to disturbance of aquatic habitat and modification of runoff characteristics.		
	Without mitigation	With mitigation
Extent	Local	Site only
Duration	Long term	Long term
Magnitude	Moderate	Minor to Low
Probability	Very likely	Unlikely
Status	Negative	Negative
Reversibility	Moderate to low	Moderate to Low
Irreplaceable loss of resources	Moderate	Low
Can impact be mitigated	Yes	Yes
Consequence	Moderate	Slight
Significance	Low	Low
Mitigation: As provided above		
Cumulative impacts: The aquatic ecosystems are mostly still in a natural ecological condition. The proposed WEF associated infrastructure is not expected to significantly alter the current ecological status of the watercourses and wetland areas in the area provided that the roads are placed outside of the recommended buffers and the number of and road crossings minimised as far as possible.		
Residual risks: Residual risks are associated with the indirect impacts of the proposed activities, that is, the potential for further erosion of the watercourses and invasion of the aquatic habitats with alien plant species. It is important that these aspects be monitored and managed on an ongoing and long-term basis.		
Confidence: High		

1.6.4 Cumulative impact of the Proposed projects on freshwater ecosystems

Existing WEF projects that were considered in terms of their potential cumulative freshwater impacts that are in an approximate 50 km radius of the Kudusberg WEF between Matjiesfontein and Sutherland (Figure 11) are listed in Table X below:

Table 18: Other Renewable Energy Projects within a radius of 50 km from the proposed Kudusberg WEF site

DEA REFERENCE NUMBER	EIA PROCESS	APPLICANT	PROJECT TITLE	EAP	TECHNO-LOGY	MW	STATUS
WIND PROJECTS							
14/12/16/3/3/2/967	Scoping and EIA	Biotherm Energy (Pty) Ltd	Proposed 140 MW Esizayo Wind Energy Facility and its associated infrastructure near Laingsburg within the Laingsburg Local Municipality in the Western Cape	WSP/Parsons Brinckerhoff	Wind	140 MW	Approved
East -14/12/16/3/3/2/962 West- 14/12/16/3/3/2/693	Scoping and EIA	Biotherm Energy (Pty) Ltd	East: Proposed 140 MW Maralla East Wind Energy Facility on the remainder of the farm Welgemoed 268, the remainder of the farm Schalkwykskraal 204 and the remainder of the farm Drie Roode Heuvels 180 north of the town of Laingsburg within the Laingsburg and Karoo Hoodland Local Municipalities in the Western and Northern Cape Provinces West: Proposed 140 MW Maralla West Wind Energy Facility on the remainder of the Farm Drie Roode Heuvels 180, the remainder of the farm Annex Drie Roode Heuvels 181, portion 1 of the farm Wolven Hoek 182 and portion 2 of the farm Wolven Hoek 182 north of the town of Laingsburg within the Karoo Hoodland Local Municipality in the Northern Cape Province	WSP/Parsons Brinckerhoff	Wind	140 MW	Approved
12/12/20/1966/AM5	Amendment	Witberg Wind Power (Pty) Ltd	Proposed establishment of the Witberg Wind Energy Facility, Laingsburg Local Municipality, Western Cape Province	Environmental Resource Management (Pty) Ltd /	Wind	140 MW	Approved

DEA REFERENCE NUMBER	EIA PROCESS	APPLICANT	PROJECT TITLE	EAP	TECHNO-LOGY	MW	STATUS
				Savannah Environmental Consultants (Pty) Ltd			
12/12/20/1783/2/AM1	Scoping and EIA	South Africa Mainstream Renewable Power Perdekraal West (Pty) Ltd	Proposed development of a Renewable Energy Facility (Wind) at the Perdekraal Site 2, Western Cape Province	Environmental Resource Management (Pty) Ltd	Wind	110 MW	Under construction
12/12/20/1783/1	Scoping and EIA	South Africa Mainstream Renewable Power Perdekraal East (Pty) Ltd	Proposed development of a Renewable Energy Facility (Wind) at the Perdekraal Site 2, Western Cape Province	Savannah Environmental Consultants (Pty) Ltd	Wind	150 MW	Approved
14/12/16/3/3/2/899	Scoping and EIA	Rietkloof Wind Farm (Pty) Ltd	Proposed Rietkloof Wind Energy (36 MW) Facility within the Laingsburg Local Municipality in the Western Cape Province	EOH Coastal & Environmental Services	Wind	36 MW	Approved
TBC	BA		Proposed Rietkloof Wind Energy Facility, Western Cape, South Africa	WSP	Wind	140 MW	In progress
14/12/16/3/3/2/826	Scoping and EIA	Gunstfontein Wind Farm (Pty) Ltd	Proposed 200 MW Gunstfontein Wind Energy Facility on the Remainder of Farm Gunstfontein 131 south of the town of Sutherland within the Karoo Hooglands Local Municipality in the Northern Cape Province, south of Sutherland.	Savannah Environmental Consultants (Pty) Ltd	Wind	200 W	Approved
12/12/20/1782/AM2	Scoping and EIA	Mainstream Power Sutherland	Proposed development of 140 MW Sutherland Wind Energy Facility, Sutherland, Northern and Western Cape Provinces	CSIR	Wind	140 MW	Approved

DEA REFERENCE NUMBER	EIA PROCESS	APPLICANT	PROJECT TITLE	EAP	TECHNO-LOGY	MW	STATUS
Karusa - 12/12/20/2370/1 Soetwater -12/12/20/2370/2	Scoping and EIA	African Clean Energy Developments Renewables Hidden Valley (Pty) Ltd	Proposed Hidden Valley Wind Energy Facility on a site south of Sutherland, Northern Cape Provinces (Karusa & Soetwater)	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW each	Preferred bidders. Construction to commence in 2019
12/12/20/2370/3	Scoping and EIA	African Clean Energy Developments Renewables Hidden Valley (Pty) Ltd	Proposed Hidden Valley Wind Energy Facility on a site south of Sutherland, Northern Cape Provinces (Greater Karoo)	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW	Approved
West -14/12/16/3/3/2/856 East - 14/12/16/3/3/2/857	Scoping and EIA	Komsberg Wind Farm (Pty) Ltd	Proposed 275 MW Komsberg West Wind Energy Facility near Sutherland within the Northern and Western Cape Provinces Proposed 275 MW Komsberg East Wind Energy Facility near Sutherland within the Northern and Western Cape Provinces	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW each	Approved
12/12/20/1988/1/AM1	Amendment	Roggeveld Wind Power (Pty) Ltd	Proposed Construction of the 140 MW Roggeveld Wind Farm within the Karoo Hoogland Local Municipality and the Laingsburg Local Municipality in the Western and Northern Cape Provinces	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW	Preferred bidders. Construction to commence in 2019.
14/12/16/3/3/2/807/AM1	Scoping and EIA Amendment	Karreebosch Wind Farm (Pty) Ltd	Proposed Karreebosch Wind Farm (Roggeveld Phase 2) and its associated infrastructure within the Karoo Hoogland and Laingsburg Local Municipalities in the Northern and Western Cape Provinces	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW	Approved
14/12/16/3/3/2/900	Scoping and EIA	Brandvalley Wind	Proposed 147 MW Brandvalley Wind Energy	EOH Coastal &	Wind	140 MW	Approved

DEA REFERENCE NUMBER	EIA PROCESS	APPLICANT	PROJECT TITLE	EAP	TECHNO-LOGY	MW	STATUS
		Farm (Pty) Ltd	Facility North of the Town of Matjiesfontein within the Karoo Hoogland, Witzenberg and Laingsburg Local Municipalities in the Northern and Western Cape Provinces	Environmental Services			
TBA	Scoping and EIA	Rondekop Wind Farm (Pty) Ltd	Proposed establishment of the Rondekop WEF, south-west of Sutherland in the Northern Cape	SiVEST SA (Pty) Ltd	Wind	325 MW	In process
West 14/12/16/3/3/2/856 East 14/12/16/3/3/2/857	Scoping and EIA	Komsberg Wind Farms (Pty) Ltd	Komsberg East and West WEF	Arcus Consulting Services (Pty) Ltd	Wind	140 MW each	
TBC	BA	ENERTRAG SA (Pty) Ltd	Proposed Development of the Tooverberg Wind Energy Facility and the associated grid connection near Touws River, Western Cape Province)	SiVEST SA (Pty) Ltd	Wind	140 MW	In process
SOLAR PROJECTS							
12/12/20/2235	BA	Inca Sutherland Solar (Pty) Ltd	Proposed Photovoltaic (PV) Solar Energy Facility on A Site South of Sutherland, Within The Karoo Hoogland Municipality Of The Namakwa District Municipality, Northern Cape Province	CSIR	Solar	10 MW	Approved

The Brandvalley; Gunstfontein; Hidden Valley; Karreebosch; Perdekraal; Rietkloof; Roggeveld; and Sutherland WEFs were selected as the only ones that lie within the same catchments (Upper Doring and Tankwa Rivers in the Olifants Doring River System). The other WEFs all occur in the upper Touws and Dwyka Rivers in the Gouritz River System. Of the above-mentioned WEFs within a 50 km radius of the Kudusberg WEF, Gunstfontein, Sutherland and Hidden Valley are the only ones likely to have a cumulative impacts on the upper Tankwa and Doring Rivers. However, these WEF only contain relatively small portions of their properties within the very upper reaches of the Tankwa River that are unlikely to have cumulative impacts of any significance on the river system. For this reason, only the Brandvalley; Karreebosch; Perdekraal; Rietkloof and Roggeveld WEFs are considered further.

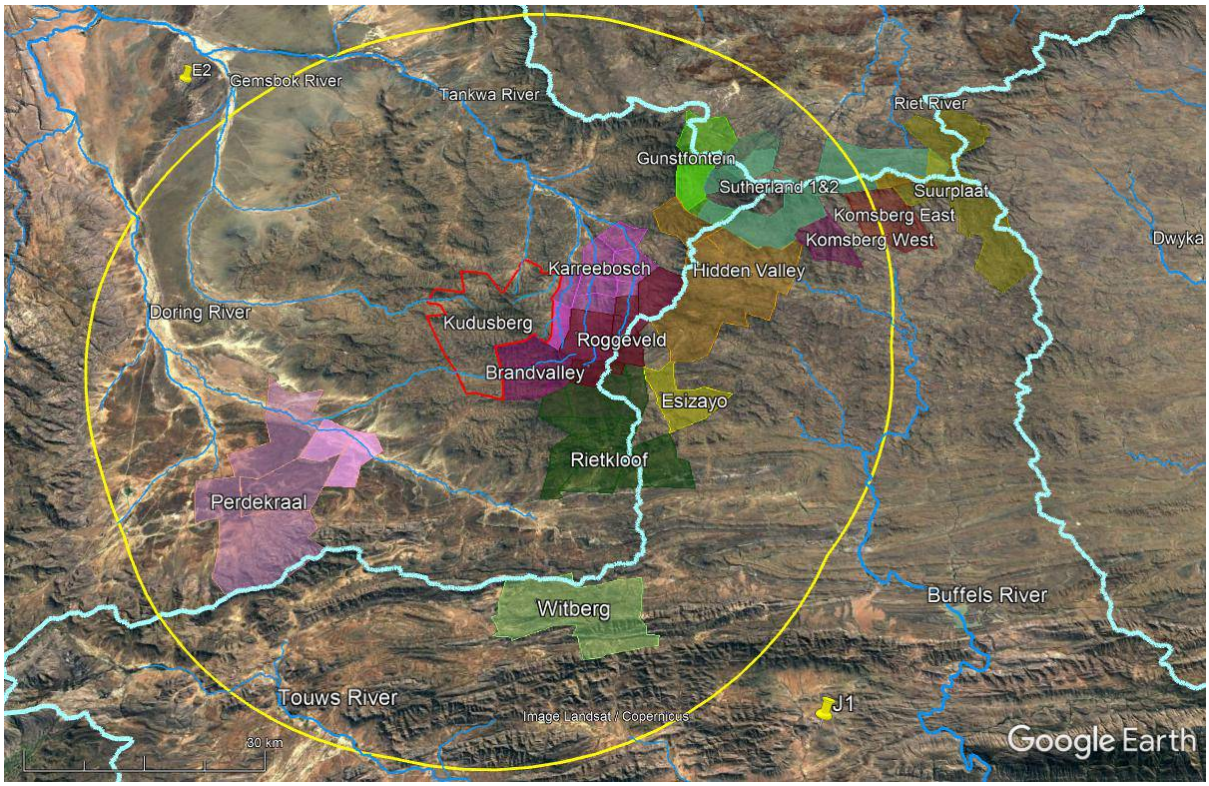


Figure 12. Map indicating the Wind Farms within 50km (yellow oval) of the proposed project. The catchment boundaries are indicated by the light blue lines (Note: The cumulative assessment only considered the WEFs located within the same catchments as Kudusberg and thus the ones most likely to have a cumulative impact on the watercourses in the catchments associated with the Kudusberg WEF).

Freshwater impact assessments were undertaken for the **Brandvalley, Karreebosch and Rietkloof WEFs** by Scherman Colloty & Associates. The Brandvalley WEF is located in the upper reaches of the Wilgebos / Kleinpoorts Tributaries (E23A) of the Tankwa River; Groot River (E22A) and Muishond River (E22B), tributaries of the Doring River and the Roggeveld River (J11D) a tributary of the Touws River. Karreebosch WEF largely occurs within the Kleinpoorts and Wilgepoorts Tributaries (E23A) of the Tankwa River. Rietkloof WEF lies largely within the Groot (E22A) in the Doring River with its

eastern extents in the upper Buffels (J11D and J11E) in the Gouritz River System. The recommended river buffers for these WEFs are 50 m for the upper reaches of the rivers, 100 m for the lower reaches and 32 m for all other drainage channels.

The freshwater impact assessment for both projects was very similar and stated that "*The proposed layout for the facility would seem to have limited impact on the aquatic environment as the proposed structures for the most part have either avoided the delineated watercourses and wetlands with the exception of a number of water course crossings by the proposed access roads. Use of any existing roads will further support this conclusion, particularly with regard the two wetland crossings (Figure 6), although the wetlands concerned are already impacted by the surrounding roads, dams and farming activities. Thus, based on the findings of this study no objection to the authorisation of any of the proposed activities inclusive of the alternatives is made.*"

The Freshwater impact assessment for the **Perdekraal WEFs (East and West)** was undertaken by BlueScience. The WEF project area is in the Groot River and its tributary the Adamskraal River in the upper Doring River (E22B). Buffers are proposed for the rivers, streams and drainage lines that vary from 100m on each side of the two rivers, measured from top of bank, and 50m on each side of the ephemeral streams and drainage lines. The layouts for the proposed WEFs were altered to minimise the disturbance within the recommended buffers such that there were only two new road crossings through the watercourses. The impact of the WEFs on the aquatic features would thus be very limited.

A fauna and flora specialist report was undertaken by Simon Todd for the **Roggeveld WEF.** The WEF lies in the upper reaches of the Wilgebos Tributary and the Tankwa River (E23A); and Muishond Tributary (E22B) of the Doring River. The southern extent lies within the very upper reaches of tributaries of the Buffels River (J11D) in the Gouritz River System. The aquatic ecosystems within the project area were not specifically assessed nor were buffers recommended. From an ecological perspective, the potential cumulative impact of the numerous WEF projects in the area that was raised as a concern was the impact on broad-scale ecological processes such as disruption of movement and migration pathways and fragmentation of habitats which supports the need to preserve viable river corridors.

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 Doring and Tankwa Rivers within the larger study area is therefore 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 so as to not impact on 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 projects concerned, the road layouts have been revised in such a manner that all of the important wetland areas / rivers were avoided and where possible existing roads have been used. This further reduced the impacts on the aquatic ecosystems, but also provided 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. All of the projects have indicated that this is also their intention with regard to mitigation, i.e. selecting the best possible routes to minimise the local and regional impacts and improving the drainage or hydrological conditions with these rivers the cumulative impact could be seen as a net benefit.

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 however a limiting factor on the further development of this area, although the water requirements during the operation phase will be low.

The assessment of the potential cumulative impacts is provided below:

Nature:
Direct impacts: Disturbance of aquatic habitat; modification to flow and water quality as a result of proposed activities in or adjacent to aquatic ecosystems.
Indirect impacts: Invasive alien plant growth in riparian zones and wetland areas and potential for erosion of watercourses as a result of disturbance of aquatic habitat and modification of runoff characteristics.

	Overall impact of the proposed project considered in isolation	Cumulative impact of the project and other projects in the area
Extent	Site only	At WEF Sites only
Duration	Long term	Long term
Magnitude	Minor	Minor
Probability	Unlikely	Unlikely
Status	Negative	Negative
Reversibility	Moderate to low	Moderate to Low
Irreplaceable loss of resources	No	No
Can impact be mitigated	Yes	Yes
Consequence	Moderate	Slight
Significance	Low	Low

Mitigation:
Placement of turbines and associated WEF infrastructure to minimise disturbance of aquatic features within the site and allow for adequate buffers to ensure protection of the aquatic features. The potential stormwater impacts of the proposed developments areas should be mitigated on-site to address any erosion or water quality impacts. Good housekeeping measures as stipulated in the EMPr for the project should be in place where construction activities take place to prevent contamination of any freshwater features. Where possible, infrastructure should coincide with existing infrastructure or areas of disturbance (such as existing roads). Disturbed areas should be rehabilitated through reshaping of the surface to resemble that prior to the disturbance and vegetated with suitable local indigenous vegetation. Any new road crossings through the watercourses should cross perpendicular to the channels and should not impede or concentrate flow in the channels. Undertake ongoing and long-term monitoring and management of aquatic features to prevent the impacts of erosion and invasive alien vegetation growth.

Cumulative impacts:
The aquatic ecosystems have been moderately modified by the surrounding agricultural activities. The cumulative impacts of the proposed WEFs and their associated infrastructure are not expected to alter the current ecological status of the watercourses and wetland areas in the larger area. The recommended mitigation measures should be implemented.

Residual risks:
Residual risks are associated with the indirect impacts of the proposed activities, that is, the potential for further erosion of the watercourses and invasion of the aquatic habitats with alien plant species. It is important that these aspects be monitored and managed on an ongoing and long-term basis.

Confidence: High

1.6.5 Consideration of the No-Go Alternative

The No-go Alternative implies that no WEF would be established within the area and that low-level agricultural practices would continue. The existing agricultural practices within the study area have had a very low impact on the freshwater features in the area. Should the WEF not be developed, it is likely that the aquatic features would remain in a natural to largely natural ecological condition. Water is however a limiting factor on the future development of the area. Invasive alien plant growth within the riparian areas of the rivers, as well as erosion of the watercourses within the area should be continually managed to reduce any impacts on the freshwater features.

1.6.6 Risk Assessment

A preliminary risk assessment was carried out for the proposed Kudusberg Wind Farm 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 19. These risk rating classes can be seen in Table 20.

Table 19: 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 20: 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 development of the Kudusberg 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 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.

1.7 IMPACT ASSESSMENT SUMMARY

The assessment of the potential aquatic ecosystem impacts for the proposed Kudusberg WEF and recommendation of mitigation measures as discussed above and collated in Table 21, Table 22 and Table 23 for the Construction, Operation and Decommissioning Phases of the project.

Table 21. Impact assessment summary table for the Construction Phase: Freshwater Ecosystems

Impact pathway	Nature of potential impact/risk	Status[1]	Extent[2]	Duration[3]	Consequence	Proba-bility	Reversibility of impact	Irreplaceability of receiving environment/ resource	Significance of impact/risk = consequence x probability (before mitigation)	Can impact be avoided?	Can impact be managed or mitigated ?	Potential mitigation measures	Significance of residual risk/ impact (after mitigation)	Ranking of impact/ risk	Confidence level
FRESHWATER															
CONSTRUCTION PHASE															
Direct Impacts															
Construction activities in or adjacent to aquatic features	Disturbance of aquatic habitat	Negative	Local	Short term	Moderate	Likely	Moderate	Moderate	Moderate	Yes	Yes	Limit disturbance of watercourses through avoiding recommended buffers and utilising existing disturbed areas	Low	4	High
Indirect Impacts															
Altered runoff characteristics as a result of construction activities	Modification to flow and water quality due to the proposed activities in or adjacent to aquatic ecosystems	Negative	Local	Short-term	Slight	Likely	High	Moderate	Moderate to low	Yes	Yes	Stormwater planning and management; design of crossings	Low to very low	4 to 5	High

[1] Status: Positive (+) ; Negative (-)
[2] Site; Local (<10 km); Regional (<100); National; International
[3] Very short-term (instantaneous); Short-term (<1yr); Medium-term (1-10 years); Long-term (project duration); Permanent (beyond project decommissioning)

Table 22. Impact assessment summary table for the Operational Phase: Freshwater Ecosystems

Impact pathway	Nature of potential impact/risk	Status	Extent	Duration	Conse-quence	Proba-bility	Reversibility of impact	Irreplaceability of receiving environment/ resource	Significance of impact/risk = consequence x probability (before mitigation)	Can impact be avoided?	Can impact be managed or mitigated ?	Potential mitigation measures	Significance of residual risk/ impact (after mitigation)	Ranking of impact/ risk	Confidence level
FRESHWATER															
OPERATIONAL PHASE															
Direct Impacts															
Operation activities in or adjacent to aquatic features	Disturbance of aquatic habitat; modification to flow and water quality due to the proposed activities in or adjacent to aquatic ecosystems.	Negative	Local	Long-term	Moderate to low	Likely	Medium to low	Moderate	Moderate	Yes	Yes	Limit disturbance to project areas that are outside of watercourses and buffers	Low	4	High
Indirect Impacts															
Secondary impacts as a result of disturbance and removal of riparian vegetation	Invasive alien plant growth in riparian zones and wetland areas and potential for erosion of watercourses due to the disturbance of aquatic habitat and modification of runoff characteristics.	Negative	Local	Long-term	Moderate to low	Likely	Medium to low	Moderate	Moderate	Yes	Yes	Monitoring and clearing alien vegetation; mitigation of erosion on steeper slopes	Low	4	High

Table 23. Impact assessment summary table for the Decommissioning Phase: Freshwater Ecosystems

Impact pathway	Nature of potential impact/risk	Status[4]	Extent[5]	Duration[6]	Conse-quence	Proba-bility	Reversibility of impact	Irreplaceability of receiving environment/ resource	Significance of impact/risk = consequence x probability (before mitigation)	Can impact be avoided?	Can impact be managed or mitigated ?	Potential mitigation measures	Significance of residual risk/ impact (after mitigation)	Ranking of impact/ risk	Confidence level
FRESHWATER															
DECOMMISSIONING PHASE															
Direct Impacts															
Decommission activities in or adjacent to aquatic features	Disturbance of aquatic habitat	Negative	Local	Short term	Slight	Likely to unlikely	Moderate	Moderate	Moderate to low	Yes	Yes	Limit disturbance of watercourses through avoiding recommended buffers and utilising existing disturbed areas	Low to very low	4 to 5	High
Indirect Impacts															
Altered runoff characteristics as a result of decommission activities	Modification to flow and water quality due to the disturbance activities in or adjacent to aquatic ecosystems	Negative	Local	Short-term	Slight	Likely to unlikely	High	Moderate	Moderate to low	Yes	Yes	Stormwater planning and management; design of crossings	Low to very low	4 to 5	High
Secondary impacts as a result of disturbance	Invasive alien plant growth and potential	Negative	Local	Medium-term	Moderate	Likely to unlikely	Moderate to low	Moderate	Moderate to low	Yes	Yes	Monitoring and clearing alien vegetation;	Low to very low	4 to 5	High

[4] Status: Positive (+) ; Negative (-)
[5] Site; Local (<10 km); Regional (<100); National; International
[6] Very short-term (instantaneous); Short-term (<1yr); Medium-term (1-10 years); Long-term (project duration); Permanent (beyond project decommissioning)

Impact pathway	Nature of potential impact/risk	Status[4]	Extent[5]	Duration[6]	Conse-quence	Proba-bility	Reversibility of impact	Irreplaceability of receiving environment/ resource	Significance of impact/risk = consequence x probability (before mitigation)	Can impact be avoided?	Can impact be managed or mitigated ?	Potential mitigation measures	Significance of residual risk/ impact (after mitigation)	Ranking of impact/ risk	Confidence level
and removal of riparian vegetation	for erosion of watercourses due to the disturbance of aquatic vegetation.											mitigation of erosion on steeper slopes			

Table 24. Cumulative impact assessment summary table

Impact pathway	Nature of potential impact/risk	Status	Extent	Duration	Conse-quence	Proba-bility	Reversibility of impact	Irreplaceability of receiving environment/ resource	Significance of impact/risk = consequence x probability (before mitigation)	Can impact be avoided?	Can impact be managed or mitigated ?	Potential mitigation measures	Significance of residual risk/ impact (after mitigation)	Ranking of impact/ risk	Confidence level
FRESHWATER															
CUMULATIVE IMPACTS															
Cumulative disturbance activities within watercourses of the area; use of water and possible modification and contamination of runoff	Disturbance of aquatic habitat; modification to flow and water quality as a result of proposed activities in or adjacent to aquatic ecosystems. Invasive alien plant growth in riparian zones and wetland areas and potential for erosion of watercourses as a result of disturbance of aquatic habitat and modification of runoff characteristics	Negative	Local	Short and longer term	Moderate	Likely	Moderate	Moderate	Low	Yes	Yes	Allow for adequate buffers; mitigate stormwater impacts on-site; Good housekeeping measures as stipulated in the EMPr; infrastructure should coincide with existing infrastructure as far as possible; disturbed areas should be rehabilitated and vegetated with suitable local indigenous vegetation; new road crossings through the watercourses should cross perpendicular to the channels and should not impede or concentrate flow in the channels; Undertake ongoing and long term monitoring and management of aquatic features to prevent the impacts of erosion and invasive alien vegetation growth	Low	4	High

1.8 INPUT TO THE ENVIRONMENTAL MANAGEMENT PROGRAM

The following mitigation measures are recommended to minimise the potential impacts of the proposed activities on the aquatic features within the site. These measures should be addressed in the EMPr for the Construction and Operation Phases of the Project. It is also recommended that a Maintenance Management Plan be drawn up for the project to guide the longer-term activities that would need to take place within the aquatic features in the site.

Impact	Mitigation/Management Objectives	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
DESIGN PHASE					
FRESHWATER ECOLOGY IMPACTS					
Potential impact on freshwater ecology as a result of the proposed Kudusberg WEF and associated infrastructure.	Limit the disturbance of aquatic habitat. Minimise potential to modify flow / hydraulics related impacts and increase the potential for erosion	• Ensure final layout of WEF avoids watercourses and recommended buffers as far as possible; utilisation should be made of existing disturbed areas where possible; • A comprehensive stormwater management plan should be compiled for the compacted surfaces within the site by the project engineer with input from the freshwater specialist. The plan should aim to reduce the intensity of runoff particularly on the steeper slopes and reduce the intensity of the discharge into the adjacent drainage lines. Where necessary measures to dissipate flow intensity or protect erosion should be included in the plan. Adjacent to wetland areas, the plan should encourage infiltration rather than runoff and should prevent the impedance of surface or sub-surface flows. The plan should also mitigate any contaminated runoff from the construction and operation activities from being discharged into any of the aquatic features within the site;	Ensure that this is taken into consideration during the planning and design phase.	During design cycle and before construction commences.	Holder of the EA

Impact	Mitigation/Management Objectives	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***

		• Adequate and erosion mitigation measures should be incorporated into designs;
		• For any new infrastructure placed within the watercourses:
		  ○ The structure should not impede or concentrate the flow in the watercourse.
		  ○ The structure should also be placed at the base level of the channel and be orientated in line with the channel. and
		  ○ Any rubble or waste associated with the construction works within the aquatic features should be removed once construction is complete;
		• Water consumption requirements for the site for the construction and operation of the site if not obtained from an authorised water user within the area, must be authorised by the DWS; and
		• No liquid waste should be discharged into any of the aquatic features within the site without the approval of the DWS. Wastewater should be properly contained on-site and removed to a licensed wastewater treatment facility that is able to treat the wastewater.			

CONSTRUCTION PHASE					
FRESHWATER ECOLOGY IMPACTS					
Potential impact on freshwater ecology as a result of the proposed Kudusberg WEF and associated infrastructure.	Limit the disturbance of aquatic habitat. Limit potential for contamination/pollution of aquatic ecosystems	• For all project related components within the site, the aquatic features of high sensitivity (wetland areas and vernal pools) should be demarcated by the appointed ECO prior to commencement of the construction activities and treated as no-go areas during the construction phase. • Any activities that require construction within the delineated aquatic features and the recommended buffers should be described in method statements that are approved by the ECO. • Rehabilitation of any the disturbed areas within the aquatic features and the recommended buffer areas should be undertaken immediately following completion of the disturbance activity according to rehabilitation measures as included in a method statement for that specific activity as described above; • Ablution facilities should not be placed within 100m of any of the aquatic features delineated within the site; • Liquid dispensing receptacles (e.g. lubricants, diesel, shutter oil etc.) must have drip trays beneath them/beneath the nozzle fixtures. Material safety data sheets (MSDS) must be available on site (if required) where products are stored, so that in the event of an incident, the correct action can be taken. Depending	Monitoring that no-go areas are adhered to should be undertaken on an ongoing basis for the duration of the construction phase. Ongoing monitoring of implementation of method statements and rehabilitation measures should be undertaken in the construction phase. Weekly monitoring of basic water quality constituents (Dissolved oxygen, electrical conductivity, suspended solids, and pH) should be undertaken upstream and downstream of sites where construction activities will need to take place within aquatic features. This should be accompanied with ongoing visual inspections.	Ongoing during construction	Proponent/contractor and ECO

		on the types of materials stored on site during the maintenance activities, suitable product recovery materials (such as Spillsorb or Drizit products) must be readily available. Vehicles should ideally be washed at their storage yard as opposed to on site. • Proper waste management should be undertaken within the site with facilities provided for the on-site disposal of waste and the removal of stored waste to the nearest registered solid waste disposal facility			

OPERATION PHASE					
FRESHWATER ECOLOGY IMPACTS					
Potential impact on freshwater ecology as a result of the proposed Kudusberg WEF and associated infrastructure.	Limit the disturbance of aquatic habitat; Minimise potential to modify flow / hydraulics related impacts and increase the potential for erosion; Control of invasive alien plants in riparian zones and wetland areas; Limit potential for contamination/pollution of aquatic ecosystems	• Ongoing control of invasive alien plants within the site should be undertaken according to an approved plan. The plan should make use of alien clearing methods as provided by the Working for Water Programme. Monitoring and control measures should take place at least biannually for the first 3 years of the project • Invasive alien plant material that has been cleared should be removed from the riparian zones and not left on the river banks or burnt within the riparian zone and buffer area; • Ongoing monitoring of the structures, in particular prior to the rainfall period, should be undertaken to ensure that the integrity of the structures is intact and that they are not block with sediment or debris. Ongoing monitoring post large rainfall events should also be undertaken to identify and address any erosion occurring within the watercourses	Ongoing monitoring of invasive alien plants within the site should be undertaken according to an approved plan Once the construction activities have ceased, the frequency of the monitoring can be reduced.	Ongoing during operation	Proponent/contractor

DECOMMISSION PHASE					
FRESHWATER ECOLOGY IMPACTS					
Potential impact on freshwater ecology as a result of the proposed Kudusberg WEF and associated infrastructure.	Limit the disturbance of aquatic habitat.	• For all project related components within the site, the aquatic features of high sensitivity should be demarcated by the appointed ECO prior to commencement of the decommission activities and treated as no-go areas during the decommission phase. • Any activities that require decommission activities within the delineated aquatic features and the recommended buffers should be described in method statements that are approved by the ECO • Rehabilitation of any the disturbed areas within the aquatic features and the recommended buffer areas should be undertaken immediately following completion of the disturbance activity according to rehabilitation measures as included in a method statement for that specific activity as described above • Control of invasive alien plants within the site should be undertaken according to the approved plan	Monitoring that no-go areas are adhered to should be undertaken on an ongoing basis for the duration of the decommission phase. Ongoing monitoring of implementation of method statements and rehabilitation measures should be undertaken in the decommission phase. Ongoing monitoring of invasive alien plants within the site should be undertaken according to an approved plan	Ongoing during decommission	Proponent/contractor and ECO

1.8.1 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 biannually (every six months) for the construction phase and the first three operational years of the project. That monitoring should preferably take place prior to the winter rainfall period and following high rainfall events.

1.9 CONCLUSION AND RECOMMENDATIONS

The aquatic features within the study area consist of the upper reaches of the Doring River (Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and their lesser, unnamed tributaries, as well as some valley bottom wetlands associated with the larger watercourses and some small dams, vernal ponds and seeps on the hill tops).

The ecological habitat integrity of the rivers within the study area is still natural in the upper reaches with few modifications (some roads and very small dams). Downstream, in the middle reaches of the Windheuwels and Ongeluks Rivers, the rivers become largely natural to moderately modified. The riparian habitat is slightly more degraded as a result of direct habitat modification from the surrounding agricultural activities. The hillslope seeps and the vernal pool are in a natural ecological condition while the valley bottom wetlands 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 Brak River as well as portions of the Jakkalshok and Ongeluks Rivers (rivers in the valleys between the ridges on which the wind turbines are placed) is mapped as aquatic CBAs where they occur within terrestrial CBAs. The remainder of the watercourses are mapped as aquatic ESAs. Very limited aquatic ESAs occur where there is localised disturbance within the watercourses such as at the gravel road crossings. There is also a wetland at the source of the largest southwards flowing tributary of the Ongeluks River that is mapped as an aquatic CBA. Most of the terrestrial areas adjacent to the watercourses in the area are mapped as ONAs.

Within the Northern Cape CBA mapping, most of the watercourses occur within ESAs, with reaches that are on the mid-slopes of the hillsides being mapped as ONAs. The width of the ESA corridor along the Windheuwels River (a tributary of the Tankwa River where the proposed access to the WEF is located) within the site is 1000 m wide. There is a CBA located along the upper Windheuwels River that is avoided by the project activities.

The larger watercourses in the study area, Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers, 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 wetland features within the study area are considered of moderate ecological importance and sensitivity. The hillslope seeps and 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. The vernal pools are small but contain a unique aquatic habitat and specific associated biota.

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 (turbines, crane pads, substations and construction camps) 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 or the delineated wetland edge (whichever is the furthest);
- 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 (whichever is the furthest); and
- The vernal pool and other wetland areas: at least 50m, measured from the top of bank of the delineated wetland edge.

In terms of the proposed project and its alternatives:

Access road: Alternative 1 would have the lesser freshwater impact as, with a slight realignment, it would not need to cross any watercourse and only an upgrade to the existing crossing over the river would be required. Alternative 2 would however still be acceptable, with mitigation;

Substation: Alternative 3 is located along a proposed internal access road and thus would not require an additional access road to be constructed. This alternative is likely to have the lowest potential freshwater impacts of the three alternatives proposed. Alternatives 1 and 2 would however still be acceptable, with mitigation

Construction camp: Alternative 1 is located outside of any watercourses or their proposed buffers. The area is also relatively flat therefore runoff to the watercourses would be low. The camp will however

need to be established in an area that comprises of natural vegetation cover and would need to be rehabilitated after the construction phase. Construction Camp Alternatives 2 and 3 are located adjacent to the larger Uriasgat River, on a small rise between the river and one of its larger tributaries. From a freshwater perspective these Construction Camp Alternatives 2 and 3 have a higher potential freshwater impact than Construction Camp Alternative 1 but these impacts could be mitigated such that the potential freshwater impacts associated with the use of either of these sites would be acceptable.

WEF turbines, crane pads, access roads and electrical transformers and cables: With these small alterations to the proposed layout plan, the potential impacts of the turbines and associated infrastructure would be very limited and of a low significance.

With mitigation, the potential freshwater impacts of the proposed Kudusberg 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 / river beds. 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. Road infrastructure and cable alignments should coincide as far as possible to minimise the impact.
- 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 in a suitable manner 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 storm water 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 Kudusberg 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 and thereby has improved the acceptability of the proposed WEF from an aquatic ecosystem point of view.

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1.11 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
E22B-08134	Muishond	44.03	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	VERY HIGH	A	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	28.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	1.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	VERY HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY 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	VERY HIGH	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23A-07876	Kleinpoorts	27.68	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	HIGH	B	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	HABITAT DIVERSITY CLASS	LOW	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	MODERATE	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23A-07853	Wilgebos	2.05	2	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	HIGH	B	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	HABITAT DIVERSITY CLASS	VERY LOW	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	VERY LOW	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23B-07811	Windheuwels	22.07	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	VERY HIGH	A	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	HABITAT DIVERSITY CLASS	LOW	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	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23G-08038	Jakkalshok	12.85	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	VERY HIGH	A	#NUM!				

PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	HABITAT DIVERSITY CLASS	LOW	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	LOW	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23G-08076	Ongeluks	22.32	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	VERY HIGH	A	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	HABITAT DIVERSITY CLASS	LOW	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	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY 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
E23H-07869	Brak	39.38	1	Y		NATURAL/CLOSE TO NATURAL	A
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY (REC)				
HIGH	VERY HIGH	A	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	NONE	FISH SPP/SQ		INVERT TAXA/SQ	25.00	FISH PHYS-CHEM SENS DESCRIPTION	
RIP/WETLAND ZONE CONTINUITY	SMALL	FISH: AVERAGE CONFIDENCE		INVERT AVERAGE CONFIDENCE	3.00	FISH NO-FLOW SENSITIVITY DESCRIPTION	
POTENTIAL INSTREAM HABITAT MOD ACT.	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT REPRESENTIVITY PER SECONDARY, CLASS	MODERATE	INVERT PHYS-CHEM SENS DESCRIPTION	MODERATE
RIPARIAN-WETLAND ZONE MOD	NONE	FISH REPRESENTIVITY PER SECONDARY: CLASS		INVERT RARITY PER SECONDARY: CLASS	HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	SMALL	FISH RARITY PER SECONDARY: CLASS		ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY LOW	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	NONE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	VERY 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	HIGH	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	INSTREAM MIGRATION LINK CLASS	VERY HIGH		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	VERY HIGH		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	VERY HIGH		
				INSTREAM HABITAT INTEGRITY CLASS	VERY HIGH		

Appendix B: Risk Matrix for the Proposed Project

ASPECTS AND IMPACT REGISTER/RISK ASSSESSMENT FOR WATERCOURSES INCLUDING RIVERS, PANS, WETLANDS, SPRINGS,DRAINAGE LINES:Kudusberg WEF
COMPILED BY: Toni Belcher, BlueScience
Date:October 2018

					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 Doring River (Muishond, Ongeluks, Jakkalshok, Brak, Windheuwels, Wilgebos and Kleinpoorts Rivers and their lesser, unnamed tributaries, as well as some valley bottom wetlands associated with the larger watercourses and some small dams, vernal ponds and seeps on the hill tops (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**			