Nkurenkuru
ECOLOGY & BIODIVERSITY

UMMBILA EMOYENI SOLAR ENERGY FACILITY FACILITY, MPUMALANGA PROVINCE

EIA PHASE:

TERRESTRIAL BIODIVERSITY AND ECOLOGICAL STUDY AND IMPACT ASSESSMENT

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Authors: Gerhard Botha

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Authors: Mr. Gerhard Botha

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Prepared for: Windlab (PTY) Ltd.
Unit 3, Demar Square, 45 Bell Crescent Road,
Westlake,
Cape Town,
7945
Cell:083 646 9696
Email: ben.brimble@windlab.com

Prepared by Nkurenkuru Ecology and Biodiversity
3 Jock Meiring Street
Park West
Bloemfontein
9301
Cell: 083 412 1705
Email: gabotha11@gmail.com

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I. DECLARATION OF CONSULTANT INDEPENDENCE

The consultants hereby declare that they:

- » act/ed as the independent specialists in this application;
- » regard the information contained in this report as it relates to specialist input/study to be true and correct at the time of publication;
- » do not, and will not, have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA Environmental Impact Assessment Regulations, 2014, and any specific environmental management Act;
- » do not, and will not, have any vested interest(s) in the proceedings of the proposed activities;
- » have disclosed, to the applicant, EAP, and competent authority(-ies), any information that have, or may have, the potential to influence the decision of the competent authority(-ies) or the objectivity of any report, plan, or document required in terms of the NEMA Environmental Impact Assessment Regulations 2014, and any specific environmental management Act;
- » are fully aware of, and meet, the responsibilities in terms of the NEMA Environmental Impact Assessment Regulations 2014 (specifically in terms of regulation 13 of GN No. R. 326), and any specific environmental management Act, and that failure to comply with these requirements may result in disqualification;
- » have provided the competent authority(-ies) with access to all necessary information at their disposal at the time of publication regarding the application, whether such information is favourable to the applicant or not; and
- » are aware that a false declaration is an offense in terms of regulation 48 of GN No. R. 326.

REPORT AUTHORS:

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)

Fields of Expertise: Fauna & Flora; Terrestrial Biodiversity; Wetland Ecology; Aquatic and Wetland; Aquatic Biomonitoring; and Wetland Habitat Evaluations.

BSc (Hons) Zoology and Botany; MSc Botany (Phytosociology) from 2011 to present.

October 2022

II. STATEMENT OF WORK

» This study has been executed in accordance with and meet the responsibilities in terms of:
  - NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326);
  - Procedures to be followed for the assessment and minimum criteria for reporting of identified environmental themes in terms of section 24(5)(a) and (h) of the National Environmental Management Act, 1998, when applying for Environmental Authorisation:
    - 3(c): Protocol for the assessment and reporting of environmental impacts on terrestrial animal species.
    - 3(d): Protocol for the assessment and reporting of environmental impacts on terrestrial plant species.

REPORT AUTHORS:

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)

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1. INTRODUCTION

1.1. Applicant

Emoyeni Renewable Energy Farm (Pty) Ltd

1.2. Project

The project will be known as Ummbila Emoyeni Solar Energy Facility (SEF), and the entire study area with its collection of sites will generally be referred to either as the "study area" or the "study site".

1.3. Proposed Activity

Emoyeni Renewable Energy Farm (Pty) Ltd is proposing the development of a commercial Solar Energy Facility and associated infrastructure on a site located ~6km south-east of Bethal and 1km east of Morgenzon, within the Mpumalanga Province. The project site is located across the Govan Mbeki, Lekwa, and Msukaligwa Local Municipalities within the Gert Sibande District on the following properties.

A preferred project focus area with an extent of 27 819 ha been identified by Emoyeni Renewable Energy Farm (Pty) Ltd as a technically suitable area for the development of the Ummbilla Emoyeni Renewable Energy Farm with a contracted capacity of up to 666 MW of wind energy and 150 MW of solar energy. This study and report focus solely on the proposed SEF. This layout, and project capacity, will be reduced as the EIA and scoping process identifies environmental constraints that exclude areas for development.

The project site comprises the following farm portions:

Parent Farm Number	Farm Portions
Farm 264 – Geluksplaats	0, 11
Farm 420 – Rietfontein	0 R/E, 1, 5 R/E, 22
Farm 423 – Bekkerust	8, 9, 10, 32

As mentioned the SEF will have a contracted capacity of up to 150MW and will be known as the Ummbila Emoyeni Solar Energy Facility. The grid connection infrastructure for both facilities (WEF and SEF) will include a 400/132kV Main Transmission Substation (MTS), to be located between Camden and SOL Substations, which will be looped in and out of the existing Camden-Sol 400kV transmission line; on-site switching stations (132kV in capacity) at each renewable energy facility (Eskom Portion); and 132kV power lines from the switching stations at each renewable energy facility to the new 400/132Kv MTS.

Infrastructure associated with the Ummbila Emoyeni SEF will include:

- » PV modules in the range of 330Wp to 450Wp mounted on either a fixed tilt or single axis tracker structure, dependent on optimisation, technology available and cost.
- » Inverters and transformers.
- » 33kV cabling to connect to the onsite collector substation, to be laid underground where practical.
- » 33kV/132kV onsite collector substation (IPP Portion).
- » Battery Energy Storage System (BESS).
- » Cabling between project components.
- » Laydown and O&M hub (approximately 300m x 300m):
  - Construction compound (temporary).
  - Maintenance office.
- » Access roads (up to 12m wide) and internal distribution roads (up to 12m wide).

A summary of the details and dimensions of the planned infrastructure associated with the project is provided below in Table 1.

» Table 1: Details or dimensions of typical infrastructure required for the 150MW Ummbila Emoyeni SEF.

Infrastructure	Footprint and dimensions
Number of Panels	To be determined
Panel Height	Up to 5m
Technology	Use of fixed-tilt, single-axis tracking, and/or double-axis tracking PV technology. Monofacial or bifacial panels are both considered.
Contracted Capacity	Up to 150MW
Area occupied by the solar array	To be determined in the EIA phase
Area occupied by the on-site facility substation (IPP Portion)	~5ha
Capacity of on-site facility substation (IPP Portion)	33kV/132kV
Underground cabling between the PV array and the onsite substation	Cabling will be installed underground where feasible at a depth of up to 1.5m to connect the PV panels to the on-site facility substation. Where not technically feasible to place cabling underground, this will be installed above-ground. The cabling will have a capacity of up to 33kV.
Laydown and Operations and Maintenance (O&M) hub	~ 300m x 300m, comprising: * Construction compound (temporary) of approximately 6 ha. * O&M office of approximately 1.5ha.
Area occupied by laydown area	~75m x 120m
Access and internal roads	Wherever possible, existing access roads will be utilised to access the project site and development area. It is unlikely that access roads will need to be upgraded as part of the proposed development. Internal roads of up to 12-13m in width will be required to access the PV panels and the on-site substation.
Grid connection	The grid connection infrastructure will include a 400/132kV Main Transmission Substation (MTS), to be located between Camden and SOL Substations, which will be looped in and out of the existing Camden-Sol 400kV transmission line; on-site switching stations (132kV in capacity) at each renewable energy facility (Eskom Portion); 132kV power lines from the switching stations at each renewable energy facility to the new 400/132kV MTS; and a collector substation with 2 x 132kV bus bars and 4 x 132kV IPP feeder bays to onsite IPP Substation The grid connection infrastructure will be assessed as part of a separate Environmental Impact

Infrastructure	Footprint and dimensions
	Assessment process in support of an application for Environmental Authorisation.
Temporary infrastructure	Temporary infrastructure, including laydown areas, hardstand areas and a concrete batching plant, will be required during the construction phase. All areas affected by temporary infrastructure will be rehabilitated following the completion of the construction phase, where it is not required for the operation phase.

The Ummbila Emoyeni SEF is proposed in response to the identified objectives of national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to bid the Ummbila Emoyeni SEF under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme or a similar programme, with the aim of evacuating the generated power into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP), with the Ummbila SEF set to inject up to 150MW of electricity into the national grid. Similarly, the location of the new generation in the Mpumalanga Province is important in the context of the Just Energy Transition (JET). The Ummbila Emoyeni SEF will provide valuable jobs and socio-economic benefits that are required in an area where coal fired generation will be phased out over the next 10 years. This will be vitally important if the JET is to be successfully implemented and is a transition for everyone.

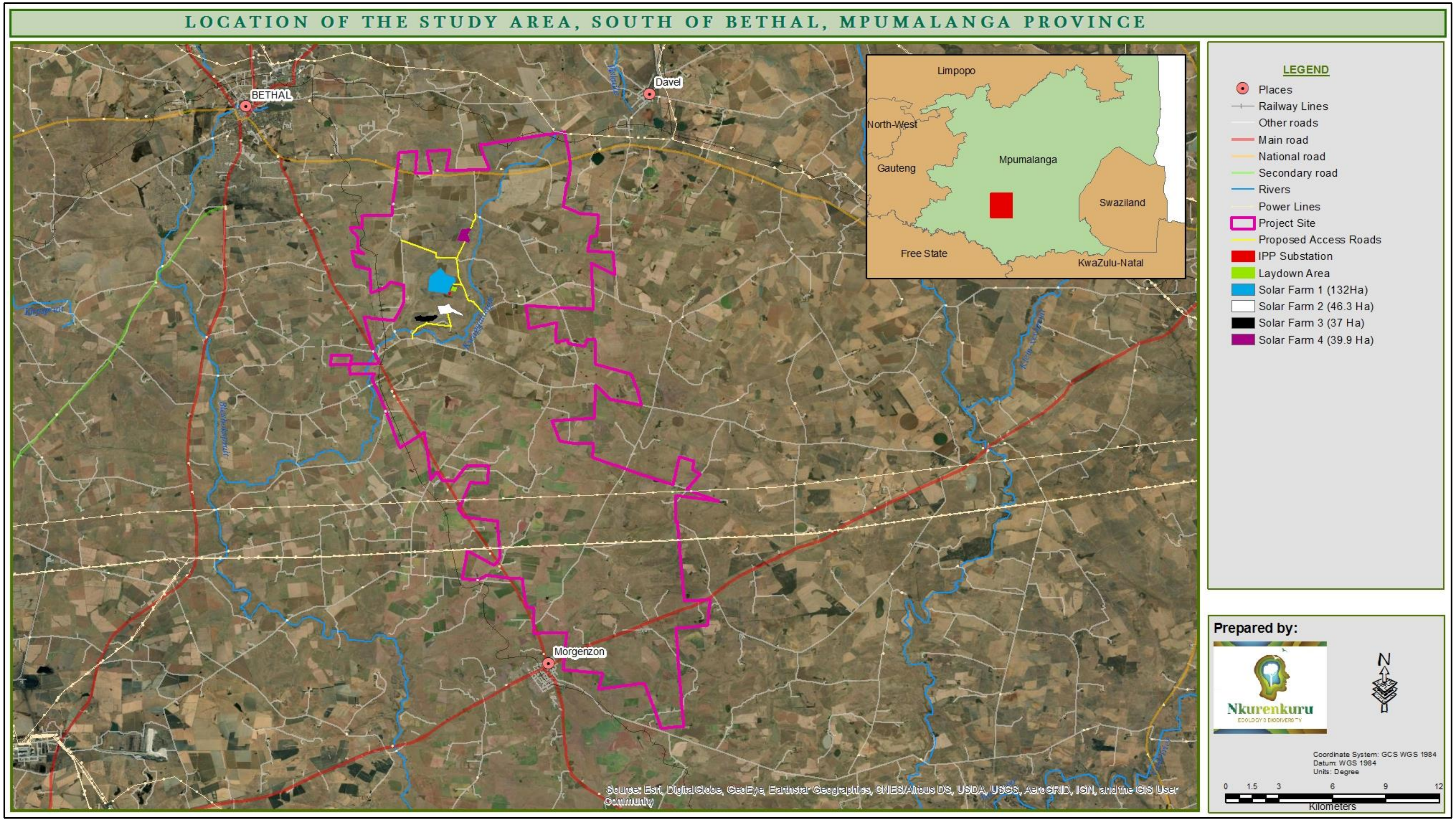

Figure 1: Locality of the study area, south of the town Bethal in the Mpumalanga Province. The inset map shows the main map extent (red square) within Mpumalanga, as well as the broader context of South Africa.

1.4. Terms of Reference (ToR)

The primary objective of the specialist freshwater resource assessment was to provide information to guide the proposed Wind Energy Facility development with respect to the potential impacts on the affected freshwater ecosystems within the project site. This main objected was done whilst adhering to the content requirements for specialist reports in accordance with the Specialist Assessment Protocol 20 March 2020. The focus of this study was solely on the specific Hydrogeomorphic Units (HGMs), within a radius of 500m of the proposed footprint and which will likely be impacted by the proposed development.

The focus of the work involved the undertaking of a specialist assessment of freshwater resource features, which included the following tasks:

» Desktop identification and delineation of potential freshwater resource areas affected by the proposed development, or occurring within a 500m radius of the proposed development using available imagery, contour information and spatial datasets in a Geographical Information System (GIS);
» Site-based (detailed in-field) delineation of the outer wetland boundary of wetland/watercourse areas within the project focal area and which were flagged during the desktop screening/risk assessment;
» Classification of wetlands and riparian areas and assessment of conservation significance based on available data sets;
» Description of the biophysical characteristics of the delineated freshwater habitats based on onsite observations and sampling (i.e. hydrology, soils, vegetation, existing impacts etc.);
» Baseline functional assessment of wetland habitats based on field investigations, involving the:

  - PES (Present Ecological State/Condition) of the delineated wetland units;
  - EIS (Ecological Importance and Sensitivity) of the delineated wetland units;
  - Direct and indirect ecosystem services (functions) importance of the delineated wetland units only.

» Impact assessment and identification of mitigation measures to reduce the significance of potential aquatic impacts for both the construction and operational phases of the pipeline project. For this section the same methodology and layout approach within the existing report was followed in order to maintain uniformity and coherence between the two reports.
» Compilation of a specialist wetland assessment report detailing the methodology and findings of the assessment, together with relevant maps and GIS information.

1.5. Conditions of this Report

Findings, recommendations, and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements, or conclusions drawn from or based on this report must clearly cite or refer to this report. Whenever such recommendations, statements or conclusions form part of the main report relating to the current investigation, this report must be included in its entirety.

1.6. Relevant Legislation

The link between ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore et al., 2007). In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection of freshwater resources in the country. Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been summarized below.

1.6.1. South African Constitution 108 of 1996

Section 24 of Chapter 2 of the Bill of Rights No. 108 of 1996 states that everyone has the right to:

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

1.6.2. National Environmental Management Act 107 of 1998

Wetlands and other watercourses defined in the NWA are also protected in the National Environmental Management Act (Act 107 of 1998), (NEMA). The act lists several activities that require authorisation before they can be implemented. NEMA lists various activities that require authorisation when located within 32 m or less from the edge of a wetland or other watercourse type.

1.6.3. National Water Act (Act No. 36 of 1998)

According to the National Water Act (Act No. 36 of 1998), a water resource is defined as: "a watercourse, surface water, estuary, or aquifer. A watercourse in turn refers to

(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 may, by notice in the Gazette, declare to be a watercourse. Reference to a watercourse includes, where relevant, its bed and banks."

A wetland is defined as: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances support or would support vegetation typically adapted to life in saturated soil."

Chapter 4 of the Act deals with the regulation of the use of water and the requirements for controlled activities, general authorisations, and licenses. In general, a water use must be licensed unless: it is listed in Schedule 1 of the Act as an existing lawful water use, or is permissible under a general authorisation, or if a responsible authority waives the need for a license.

According to the Department of Water and Sanitation (DWS), any activity that falls within the temporary zone of a wetland or the 1:100 year floodline (whichever is greater) qualifies as a Section 21 water use activity (depending on the use) and will thus require either a general authorization or Water Use License (WUL). According to the NWA, an application for a WUL should be submitted to the DWS if any of the above activities are to be undertaken.

Section 21 of the National Water Act (NWA Act No. 36 of 1998) covers the following activities, which might be applicable to the proposed project. According to Section 21 of the NWA and in relation to the river ecosystem, the following activity is considered a use, and therefore requires a water use license:

» 21 (c) impeding or diverting the flow of water in a watercourse;
» 21 (i) altering the bed, banks, course or characteristics of a watercourse;

In terms of Section 22 (1), a person may only undertake the abovementioned water uses if it is appropriately authorised:

22(1) A person may only use water

(a) without a licence
    (i) if that water use is permissible under Schedule 1;
    (ii) if that water use is permissible as a continuation of an existing lawful use; or
    (iii) if that water use is permissible in terms of a general authorisation issued under section 39;
(b) if the water use is authorised by a licence under this Act; or

(c) if the responsible authority has dispensed with a licence requirement under subsection (3).

1.6.4. National Water Act (Act No. 36 of 1998)

- The National Forests Act No. 84 of 1998;
- The Natural Heritage Resources Act No. 25 of 1999;
- The National Environmental Management: Protected Areas Act No. 57 of 2003;
- Minerals and Petroleum Resources Development Act No. 28 of 2002;

2. METHODOLOGY

2.1. Assessment Approach and Philosophy

2.1.1. Aquatic Biodiversity

The delineation and classification of freshwater resources were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009).

In addition to these guidelines, the general approach to freshwater habitat assessment was furthermore based on the proposed framework for wetland assessment as proposed within the Water Research Commission's (WRC) report titled: "Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition" (Ollis et. al., 2014). A schematic illustration of the proposed decision-support framework for wetland assessment in South Africa is provided in Figure 2 below.

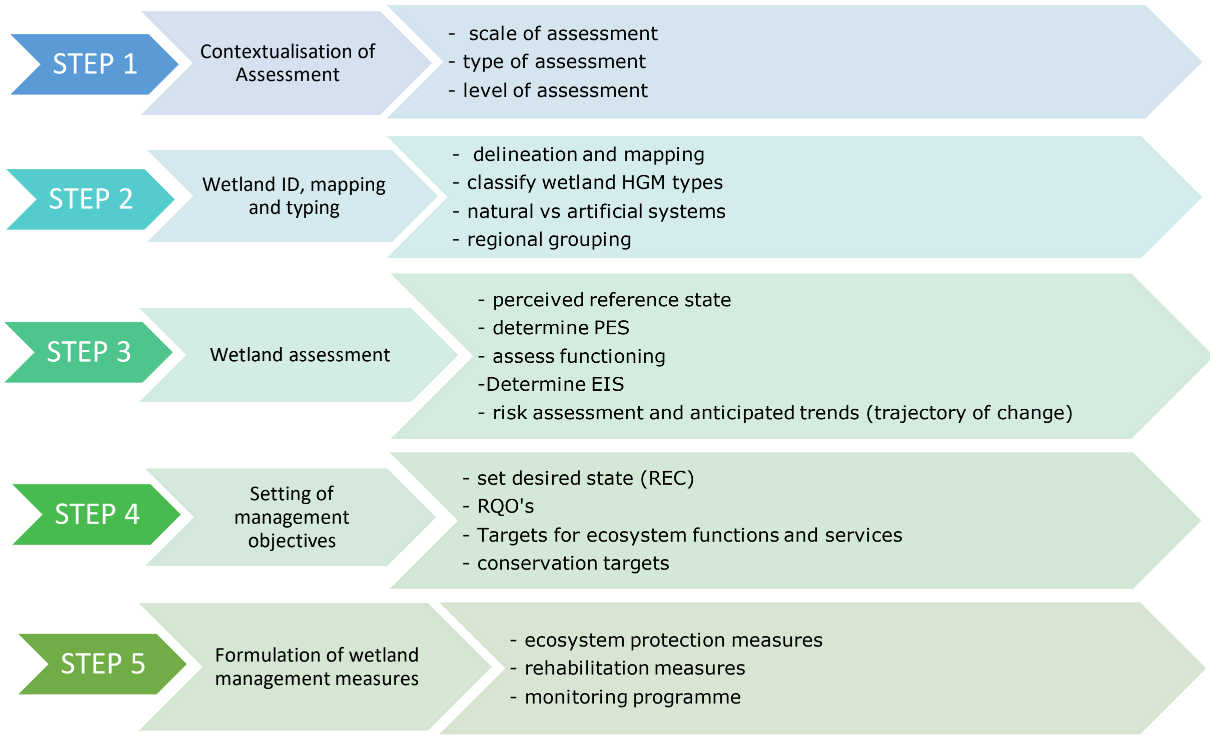

Figure 2: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

2.2. Data Exploration and Review

The assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region (Table 2). The desktop delineation of all freshwater resources (rivers / streams and wetlands) within 500m (DWS regulated area) of the proposed project site was undertaken by analysing available 5m contour lines and colour aerial photography supplemented by Google EarthTM imagery where more up to date imagery was needed. Digitization and mapping were undertaken using ArcGis software. All of the mapped freshwater resources were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems / habitat). This was undertaken based on aerial photographic analysis and professional experience in working in the region.

Following the desktop identification and mapping exercise, freshwater resource features where confirmed and their boundaries refined in-field

Data sources from the literature and GIS spatial information was consulted and used where necessary in the study and include the following (also refer to Table 2: Information and data coverages used to inform the ecological assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**Colour Aerial Photography**	Desktop mapping of habitat/ecological features	National Geo-Spatial Information (NGI)
	Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
	1:50 000 Relief Line (5m Elevation Contours GIS Coverage)	Desktop mapping of terrain and habitat features as well as drainage network.	Surveyor General
	1:50 000 River Line (GIS Coverage)	Highlight potential on-site and local rivers and wetlands and map local drainage network.	CSIR (2011)
	South African Vegetation Map (GIS Coverage)	Classify vegetation types and determination of reference primary vegetation	Mucina & Rutherford (2012; 2018); Dayaram et al., 2018
	NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	CSIR (2011)
Conservation and Distribution Context	**National Biodiversity Assessment – Threatened Ecosystems** (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2018)
	Mpumalanga Biodiversity Sector Plan: Critical Biodiversity Areas (GIS Coverage)	Determination of provincial /freshwater conservation priorities and biodiversity buffers	SANBI (2016)
	NFEPA: River, wetland and estuarine FEPAs (GIS Coverage)	Shows location of national aquatic ecosystems conservation priorities	CSIR (2011)
	Red Data Books (Red Data Lists of Plants)	Determination of endangered and threatened plants,	Red List of South African Plants (2011); http://redlist.sanbi.org/

for a summary):

Vegetation:

- South African National Vegetation Map (SANBI, 2018); (Mucina & Rutherford, 2006) and National List of Threatened Ecosystems (NEM:BA, 2011): vegetation types and their respective conservation statuses. The latest version of the National Vegetation Map was also consulted to check for any updates of the respective regions (Dayaram, et al., 2019); (SANBI, 2018).
- Botanical Database of Southern Africa (BODATSA), hosted by the South African National Biodiversity Institute (SANBI; https://posa.sanbi.org; also referred as POSA: Plants of Southern Africa): information on plant species recorded for the Quarter Degree Squares 2919BA, 2919BB, 2919BD and 2920AA. This is a larger area than required and is a conservative approach that ensures all species possibly occurring within the site have been represented. It also accounts for the fact that the site itself might not be well represented in national databases.

» Threatened Species Programme, Red List of South African Plants (SANBI, 2021): The IUCN conservation statuses of all listed species were extracted from this database.

Ecosystem:

» Freshwater and wetland information was extracted from the National Freshwater Ecosystem Priority Areas assessment (Nel, et al., 2011). This includes rivers, wetlands, and catchments defined in the study area.
» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (Government of South Africa, 2008).
» Critical Biodiversity Areas for the site and surroundings (CBA Map for Northern Cape; obtained from SANBI Biodiversity GIS (BGIS), specifically http://bgis.sanbi.org/Projects/Detail/203.

Table 2: Information and data coverages used to inform the ecological assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**Colour Aerial Photography**	Desktop mapping of habitat/ecological features	National Geo-Spatial Information (NGI)
	Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
	1:50 000 Relief Line (5m Elevation Contours GIS Coverage)	Desktop mapping of terrain and habitat features as well as drainage network.	Surveyor General
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	Red Data Books (Red Data Lists of Plants)	Determination of endangered and threatened plants,	Red List of South African Plants (2011); http://redlist.sanbi.org/

2.3. Baseline Freshwater Resource Assessment

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section.

The on-site / in-field assessment of the freshwater resource indicators was conducted on the 24th to 27th April 2022 (autumn). The area was, prior to the time of the survey, experiencing an above average rainfall season, and during the inspection, the conditions were regarded as optimal to access all wetland indicators. All of the dam features and natural freshwater features were inundated (70% - 95% capacity) during the inspection. However, the presence of inundation is not a prerequisite for the accurate delineation of freshwater resource features as other indicators were used as described below.

The assessments undertaken as part of this study are listed in Table 3 below along with the relevant published guidelines and assessment tools / methods / protocols utilised. A more comprehensive description of the methods listed below is included in Appendix 1.

Table 3: Summary of methods used in the assessment of delineated freshwater resources.

Method/Technique	Reference for Methods / Tools Used
Freshwater Resource Delineation	A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).
Freshwater Resource Classification	National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2013)
Freshwater Resource Condition/PES	Wetland Index of Habitat Integrity (DWAF, 2007): Modified to include additional criteria in order to include additional wetland types (seepages, depressions and unchanneled valley-bottom wetlands).
Freshwater Ecological Importance and Sensitivity (EIS)	EIS (Ecological Importance and Sensitivity) assessment tool (DWAF 1999c; Rountree & Malan, 2013): Slightly modified as follows: » Where the freshwater resource features comprised/provided the following features/functions or a combination of these features/functions, • Contained any faunal or floral Species of Conservation Concern (SCC); • Comprised of unique habitats; • Highly connected to other important habitats/features forming important ecological corridors; and • Provide unique and valuable ecosystems services (social and ecological); and the freshwater resource features were in natural to largely natural condition (PES: A/B); their EIS were upgraded to Very High. Likewise, should the freshwater resource feature be in a slightly to moderately modified condition (PES: C), the EIS will be upgraded to High.
Buffers for rivers and watercourses	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. Recommendations are made based on the wetlands functioning and site characteristics

2.4. Impact Assessment Methodology

The impact assessment methodology is in accordance with the recently revised 2014 EIA regulations. The significance of environmental impacts is a function of: the present environmental aspects that are to be impacted on, the probability of an impact occurring, and the consequence of such an impact occurring before, and after, implementation of proposed mitigation measures.

The significance of environmental impacts is to be assessed by means of the criteria of nature (descriptive), extent (scale), duration, magnitude (severity), probability (certainty), and direction (negative, neutral, or positive) (Figure 3). Summarized briefly:

» **Nature**: a description of what causes the effect, what will be affected, and how it will be affected.

- **Extent**: whether the impact will be site specific (limited to the immediate area or development site), local, or regional/provincial. A value between 1 and 5 is assigned as appropriate (with 1 being low and 5 being high).
- **Duration**:
  - the lifetime of the impact will be of a very short duration (0 – 1 year) — assigned a score of 1;
  - the lifetime of the impact will be of short duration (1 – 5 years) — assigned a score of 2;
  - medium-term (5 – 15 years) — assigned a score of 3;
  - long term (15 – 30 years) — assigned a score of 4; or
  - permanent (> 30 years) — assigned a score of 5.
- **Magnitude**: quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high and processes are altered to the extent that they temporarily cease, and 10 is very high and results in complete destruction of patterns, and permanent cessation of processes.
- **Probability** (of occurrence): the likelihood of the impact actually occurring. Probability is estimated on a scale of 1 – 5, where 1 is highly improbable (will likely not happen), 2 is improbable (possible, but likelihood still low), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will definitely occur regardless of any prevention measures).
- **Significance**: determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM**, or **HIGH**.
- Direction: either positive, negative, or neutral.

Also implicitly considered is the degree to which the impact:

- can be reversed;
- may cause irreplaceable loss of resources; and
- can be mitigated.

Impact significance is calculated by combining the criteria as follows:

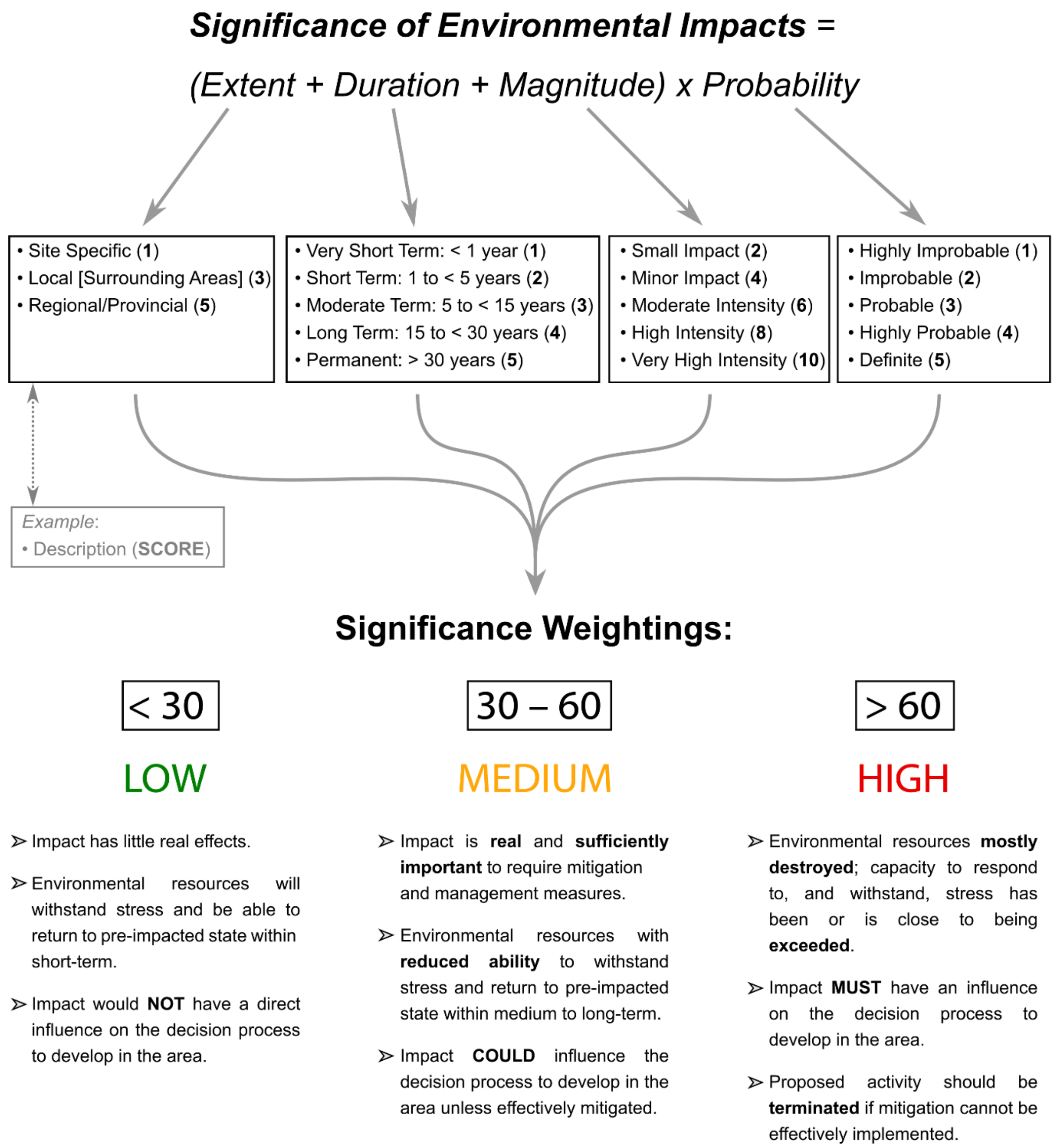

Figure 3: Calculation, description, and summary of Significance Weightings that result from calculating the Significance of Environmental Impacts.

2.5. Assumptions and Limitations

2.5.1. General Assumptions and Limitations

» This report deals exclusively within a defined area as well as downstream freshwater/aquatic resources that may potentially be impacted and which fall within the Regulated Areas (500 m) as defined by DWS.

- All relevant project information provided by the applicant and engineering design team to the specialist was correct and valid at the time that it was provided.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the Northern Cape Province at the time of the assessment.

2.5.2. Sampling Limitations and Assumptions

- While disturbance and transformation of habitats can lead to shifts in the type and extent of ecosystems, it is important to note that the current extent and classification are reported on here.
- The delineation of the outer boundary of riparian/wetland areas is based on several indicators, including topography, the presence of alluvial deposits and/or soil wetness, soil forms and vegetation indicators. The boundaries mapped in this specialist report, therefore, represent the approximate boundary of riparian/wetland habitat as evaluated by an assessor familiar and well-practiced in the delineation technique.
- The accuracy of the delineation is based solely on the recording of the relevant onsite indicators using a GPS. GPS accuracy will, therefore, influence the accuracy of the mapped sampling points and therefore resource boundaries and an error of 3 – 5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin etrex Touch 35 Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Any freshwater resources that fall outside of the affected catchment (but still within the 500m DWS regulated area) and are not at risk of being impacted by the specific activity were not delineated or assessed. Such features were flagged during a baseline desktop assessment before the site visit.
- Sampling by its nature means that generally not all aspects of ecosystems can be assessed and identified.
- While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that that is possible. The nature of the vegetation, seasonality, human intervention etc. limit the veracity of the material presented.
- No water sampling and analysis was undertaken.
- The vegetation information provided is based on onsite/ infield observations and not formal vegetation plots. As such, the species list provided only gives an indication of the dominant and/or indicator wetland/riparian species and thus only provides a general indication of the composition of the vegetation communities.
- No faunal sampling and/or faunal searches were conducted and the assessment was purely wetland and riverine habitat based.
- Probably the most significant potential limitation associated with such a sampling approach is the narrow temporal window of sampling.
    - Ideally, a site should be visited several times, during different seasons to ensure that the full complement of plant and animal species present is captured.

- However, this is rarely possible due to time constraints and therefore, the representation of the species sampled at the time of the site visit should be critically evaluated.
- The site was sampled on both occasions (site visits), following the wet season; however, the Spring season is regarded as a preferred season for such studies.
- The footprint was covered in detail and results are considered highly reliable and it is unlikely that there are any significant species or features present that were not recorded.

2.5.3. Baseline Assessment – Limitations and Assumptions

» All assessment tools utilised within this study were applied only to the resources and habitats located within the development footprint as well as the 500m DWS "regulated area" around the footprint area, and which are at risk of being impacted by the proposed development. Any resource located outside of the DWS "regulated area" and which is not a risk of being impacted was not assessed.
» It should be noted that the most appropriate assessment tools were selected for the analysis of the specific features and resources that may potentially be impacted by the proposed development. The selection was based on the specialist's knowledge and experience of these tools and their attributes and shortcomings.
» Furthermore, it should be noted that these assessment techniques and tools are currently the most appropriate available tools and techniques to undertake assessments of freshwater resources, there are however rapid assessment tools that rely on qualitative information and expert judgment. While these tools have been subjected to peer review processes, the methodology for these tools is ever-evolving and will likely be further refined in the near future. For the purposes of this assessment, the assessments were undertaken at rapid levels with somewhat limited field verification. It, therefore, provides an indication of the PES of the portions of the affected systems rather than providing a definitive measure.
» The PES, EIS and functional assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
» The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
» The impact descriptions and assessment are based on the author's understanding of the proposed development based on the site visit and information provided.
» Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures to be included in the Environmental Management Programme (EMPr).

3. CONSERVATION AND FUNCTIONAL IMPORTANCE OF AQUATIC ECOSYSTEMS

Water affects every activity and aspiration of human society and sustains all ecosystems. “Freshwater ecosystems” refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters, and estuaries (Driver et al., 2011). South Africa’s freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage and are often referred to as the “kidneys” and “arteries” of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel et al., 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa’s most scarce natural resource) and are important in providing additional biophysical, social, cultural, economic, and aesthetic services (Nel et al., 2013). The health of our rivers and wetlands is measured by the diversity and health of the species we share these resources with. Healthy river ecosystems can increase resilience to the impacts of climate change, by allowing ecosystems and species to adapt as naturally as possible to the changes and by buffering human settlements and activities from the impacts of extreme weather events (Nel et al., 2013). Freshwater ecosystems are likely to be particularly hard hit by rising temperatures and shifting rainfall patterns, and yet healthy, intact freshwater ecosystems are vital for maintaining resilience to climate change and mitigating its impact on human wellbeing by helping to maintain a consistent supply of water and for reducing flood risk and mitigating the impact of flash floods. We, therefore, need to be mindful of the fact that without the integrity of our natural river systems, there will be no sustained long-term economic growth or life (DEA et al., 2013).

Freshwater ecosystems, including rivers and wetlands, are also particularly vulnerable to anthropogenic or human activities, which can often lead to irreversible damage or longer-term, gradual/cumulative changes to freshwater resources and associated aquatic ecosystems. Since channelled systems such as rivers, streams, and drainage lines are generally located at the lowest point in the landscape; they are often the “receivers” of wastes, sediment, and pollutants transported via surface water runoff as well as subsurface water movement (Driver et al., 2011). This combined with the strong connectivity of freshwater ecosystems means that they are highly susceptible to upstream, downstream, and upland impacts, including changes to water quality and quantity as well as changes to aquatic habitat & biota (Driver et al., 2011). South Africa’s freshwater ecosystems have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work shows that 60% of our river ecosystems are threatened and 23% are critically endangered. The situation for wetlands is even worse: 65% of our wetland types are threatened, and 48% are critically endangered (Driver et al., 2011). Recent studies reveal that less than one-third of South Africa’s main rivers are considered to be in an ecologically ‘natural’ state, with the principal threat to freshwater systems being human activities, including river regulation, followed by catchment transformation (Rivers-Moore & Goodman, 2009). South Africa’s freshwater fauna also display high levels of threat: at least one-third of freshwater fish indigenous to South Africa are reported as threatened, and a recent southern African study on the conservation status of major freshwater-dependent taxonomic groups (fishes, molluscs, dragonflies, crabs, and vascular plants) reported far higher levels of threat in South Africa than in the rest of the region (Darwall et al., 2009). Clearly, urgent attention is required to ensure that representative natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations to come. The degradation of South African rivers and wetlands is a concern now recognized by Government as requiring urgent action and the protection of freshwater resources, including rivers and wetlands, is considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

4. DESKTOP ANALYSIS

4.1. Regional/Local Biophysical Setting

The project/study site is located primarily (>95% of project site) within one Quaternary Drainage Region/Catchment (QDR) namely C11H QDR (Blesbokspruit River). Small portions of the project site extend into QDRs C11G and C11J. All of the above mentioned QDRs are located within the Upper Vaal Water Management Area. These QDRs are drained by numerous wetlands and watercourses with the larger drainage features being perennial, lower and upper foothill freshwater resource features. The smaller tributaries are typically non-perennial/seasonal, transitional and headwater freshwater resource features. The larger perennial freshwater resource features tend to drain in a south-western direction, whilst the smaller tributaries tend to drain perpendicular to the larger features (north-western, south-eastern).

All infrastructure for the proposed development is located entirely within the C11H QDR.

The main drainage features within the region are the Blesbokspruit- Kwaggaslaagte- and Osspruit River. Both the Kwaggaslaagte- and Osspruit Rivers drain in south-western directions to feed into the Blessbokspruit River, which is regarded as an important upper tributary of the Vaal River (CSIR, 2018) (Van Deventer, et al., 2018) ((DWAF), 2006). The proposed development site is located within the catchment of the Kwaggaslaagte River.

The Blesbokspruit River, itself is located approximately 12.24km west of the development site.

The Kwaggaslaagte River, is classified as lower and upper foothill river, with the lower foothill section characterised by floodplains confined on one side (V2), whilst the upper foothill section is characterised by confined valley flood plains and wetlands (V4) (Rowntree & Wadeson, 1999). The smaller tributary freshwater resource features are typically characterised by confined valley floodplains (V4) and v-shaped valleys (V6).

The Kwaggaslaagte Rive and its tributaries have been classified as being Moderately Modified (PESS: C) by DWS in 1999, however according to a more recent survey (NBA, 2018), using different methods and techniques[1], the Present Ecological State/Ecological Importance/Ecological Sensitivity of freshwater resource features as well as their mainstems and tributaries (at a sub-quaternary level), were classified as:

» C11H1584 and C11H1609 (PES/EIS: B) - Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged (DWS, 2014).

According to the PES/EIS assessment all of the freshwater resource features as well as their mainstems and tributaries are of moderate ecological importance (EI) and Ecological Sensitivity (ES)

The Hydrological Characteristics of the project site are summarised as follows:

» Mean Annual Precipitation = 676 mm (min: 629 mm; max: 723 mm);
» Mean Annual Runoff = 74 mm;
» Mean Annual Evaporation = 1400 - 1600 mm; and

The proposed SEF project is located within the Highveld ecoregion (11.05 level 2 ecoregion) (Kleynhans, et al., 2005). Numerous prominent and important rivers have their sources within this region namely the; Vet, Modder, Riet, Vaal, Olifants, Steelport, Maric, Crocodiver (west), Crocodile (east) and the Great Usutu. The project site falls within the Vaal River catchment. The characteristics of the ecoregion are:

» Topography can be described as plains with a moderate to low relief, as well as various grassland vegetation types (with moist types present towards the east and drier types towards the west and south);
» Rainfall varies from low to moderately high, with an increase from west to east. Coefficient of variation of annual precipitation are moderately high in the west, decreasing to low in the east;
» Drainage density is mostly low, but medium in some areas;
» Stream frequency varies between low to medium
» Median annual simulated runoff is moderately low to moderate, and
» Mean annual temperature is hot in the west and moderate in the east.

[1] The methods used for assessing the ecological condition of the river ecosystem types differed from the NBA 2011 in that Present Ecological State (PES) categories were not modelled in the NBA 2018. The river condition data was determined by using (DWS, 2014) Present Ecological State/Ecological Importance/Ecological Sensitivity (PES/EI/ES) (also referred to as PES/EIS) data, which included mainstems and tributaries at a sub-quaternary level. These desktop data were updated with data that became available between 2011 and 2017. The ecological category was either updated or remained unchanged depending on which assessment was most recent (Van Deventer, et al., 2019)

The proposed development area is situated within the Highveld Geomorphic Province, and the Northwestern Highveld Sub-province (Partridge, et al., 2010) and is drained by the north-bank Vaal River tributaries. The Blesbokspruit River flow in a valley with a broad and wide cross-sectional profile and flat to medium slope so that the sediment storage surrogate descriptors for this river and its tributaries are predominantly BF (broad valley widths and flat slopes) and WM (wide valley width and medium slopes). The potential for sediment storage within these surrogate descriptors is regarded as high. Furthermore, the Bleskbokspruit River and its tributaries are mainly characterised as having concave longitudinal profiles and linear BFCs (Best Fit Curves).

In terms of wetland features, characterising the entire project site, numerous wetland features have been identified within NBA's 2018 National Wetland MAP 5 (157 wetland features have been mapped within the entire project area) (refer to Table 4 below). Of these 157 wetland features, 14 wetlands fall within the PV solar development's 500 m regulated area, with two of these wetland features likely being directly impacted by the development (access road crossings).

Furthermore, four hydrogeomorphic units have been identified within the project site namely, channelled valley-bottom wetlands, floodplain wetlands, seepage wetlands and depression wetlands. Wetlands within the project site were predominantly seepages (67% of all wetlands) and combined, covered the second largest area within the project site (648.9 ha) (Table 4 and **Error! Reference source not found.**). Second to the seepages were the channelled valley-bottom wetlands with 39 units identified within the project site (25%). However, even though these wetlands were fewer, they collectively covered a significantly larger area (1886.3 ha). Even though only three floodplain units were identified within the project site, these three units collectively covered just a few hectares less than the seeps (612.8 ha). Nine depression wetlands were identified within the project site and only covered a combined area of 4 ha.

Within the PV solar development's 500m regulated area one flood plain has been mapped by SANBI (2018), and cover approximately 162.81 ha (largest area of all wetland features). This floodplain wetland covers approximately 7% of the regulated area. Three channelled valley-bottom wetlands have been mapped and cover approximately 75.2 ha (second largest area of all wetland features). These channelled valley-bottom wetlands cover 3% of the regulated area. Most of the hydrogeomorphic units mapped within the regulated area, are seepage wetlands, however these features are fairly small and collectively cover only 38.45 ha (2% of the regulated area). Only two small depression wetland features have been mapped within the regulated area, collectively covering an area of approximately 1.36 ha (less than 1% of the regulated area).

In terms of the conditions of the wetlands (PES) located within the regulated area, the majority of the wetlands were moderately to significantly (heavily to severely/critically) modified, with 5 wetlands having a C PES valley and 5 wetlands having a D/E/F PES value.

Only 4 wetlands are regarded as being natural to near-natural (Table 4**Error! Reference source not found.**).

Furthermore, all channelled valley bottom wetlands, floodplains and seeps are regarded as Critically Threatened Aquatic Ecosystems, whilst depression wetlands are regarded as Least Concerned Aquatic Ecosystems. Additionally, all channelled valley-bottom and floodplain wetlands are not protected whilst seepage and depression wetlands are poorly protected (Table 4).

Table 4: Summary of the wetlands identified within the 500m regulated area according to the NBA 2018 Wetland Map 5.

Hydrogeomorphic Type	Number of Features	Coverage (ha)	Coverage (%)	Total Coverage of Project Site (%)	Wetland Conditions (PES)			Ecosystem Threat Status	Ecosystems Protection Level
					A/B	C	D/E/F		
Channelled Valley-Bottom	3	75.2	27	3	1	0	2	Critically Threatened	Not Protected
Floodplain	1	162.81	59	7			1	Critically Threatened	Not Protected
Seep	8	38.45	14	2	2	4	2	Critically Threatened	Poorly Protected
Depression	2	1.36	0.5	0.1	1	1	0	Least Concerned	Poorly Protected
Total	**14**	**277.81**	**100**	**11.1**	**4**	**5**	**5**		

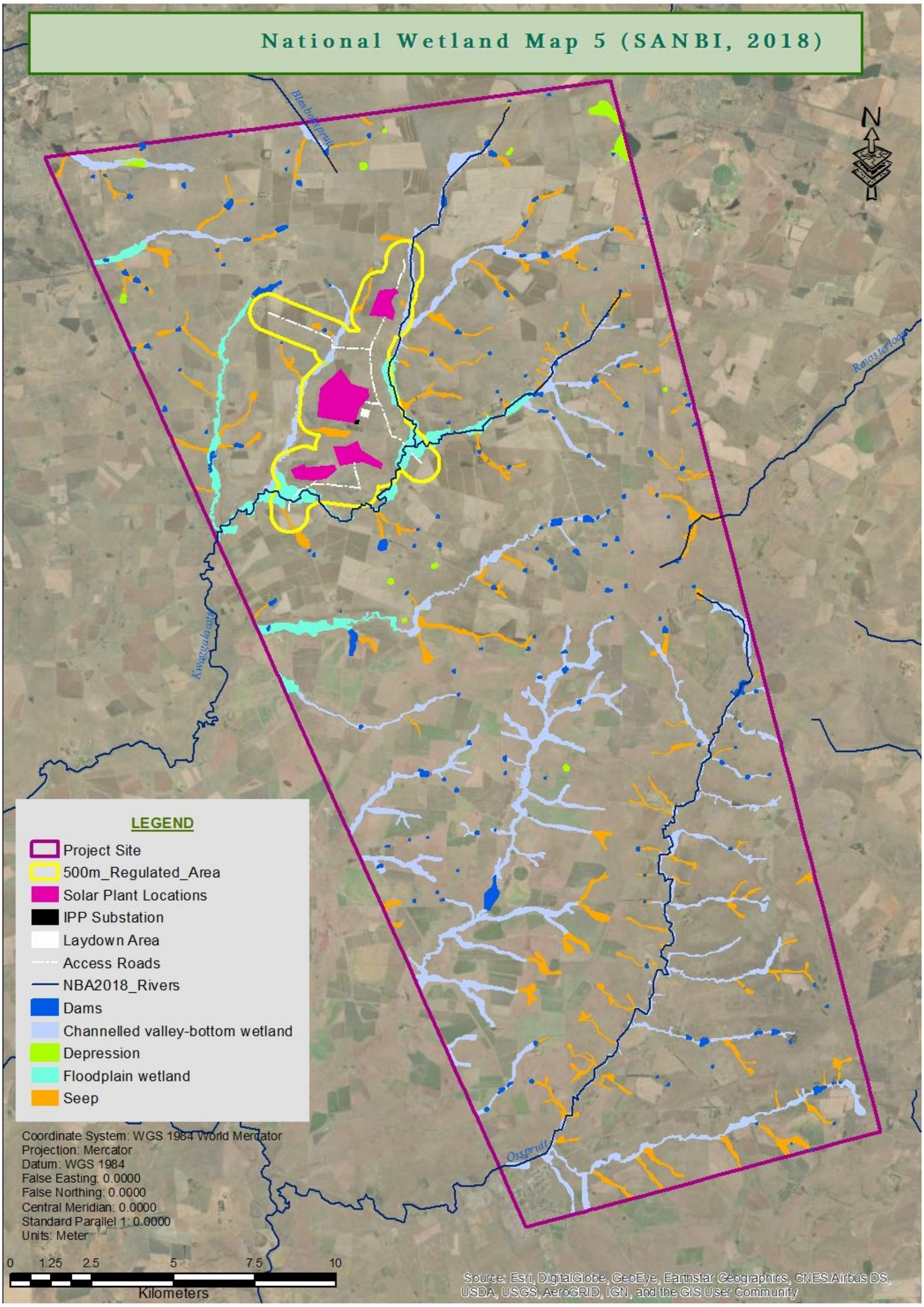

Figure 4: Regional drainage setting (Entire project/study site).

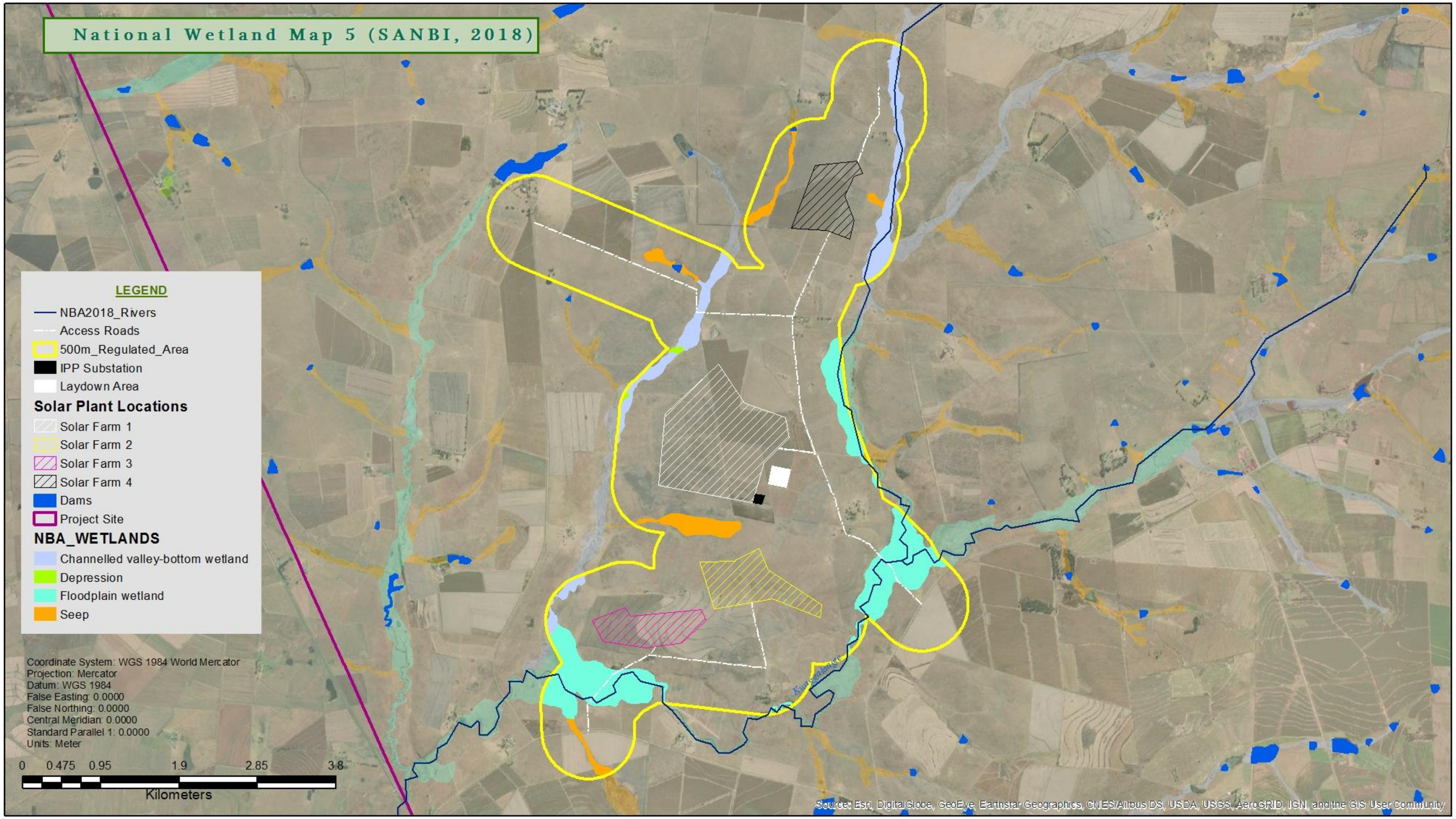

Figure 5: Regional drainage setting (Proposed development site and 500m regulated area).

4.2. Land Use

Land use within the project site is mostly for farming. The study area consists of a mosaic of buildings/structures, active farmland ("agriculture"), fallow land (abandoned farmlands which consist of secondary vegetation; "fallow"), natural grasslands, and freshwater resource features or drainage areas (which is comprised of small streams, wetlands, shallow pans and depressions, and artificial dams).

Farming practices consist a mixture of cultivation (mainly maize with some soya bean cultivation), livestock farming (predominantly cattle on natural to near-natural grasslands and planted pastures), and to lesser extent, game farming.

4.3. Conservation Planning / Context

Understanding the conservation context and importance of the study area and surroundings is important to inform decision making regarding the management of the aquatic resources in the area. In this regard, national, provincial, and regional conservation planning information available and was used to obtain an overview of the study site (

Table 5).

Table 5: Information and data coverages used to inform the freshwater resource assessment.

Relevant Conservation Feature		Location in Relationship to Project Site		Conservation Planning Status
NATIONAL LEVEL CONSERVATION PLANNING	**Strategic Water Source Areas for groundwater and surface water.**	Areas with high groundwater availability and of national importance	The entire development site.	Upper Vaal (SWSA_sw)
	National Freshwater Ecosystem Priority Area	River FEPAs (priority sub quaternary catchment areas)	No FEPA priority sub-quaternary catchments will be impacted » The entire development site is located within Upstream Sub-Quaternary Catchments (two SQCs) associated with the Kwaggalaagte River.	2X Upstream FEPA Catchments
		Kwaggalaagte River (FEPA ID: 1609) – Upstream FEPA River	» The Kwaggalaagte River flows in a southern to south-western direction across the northern half of the project area.	1X Upstream FEPA Rivers
		NFEPA Wetlands	» Approximately 4 wetlands within the project site is classified as FEPA priority wetlands. » The remaining 7 natural wetlands within the project site is not regarded as FEPA priority wetlands. » Two artificial wetlands (dams) occur within the project site	4 FEPA Priority Wetlands
CONSERVATION AND DISTRIBUTION CONTEXT	**MPBSP: Freshwater Critical Biodiversity Areas**	Ecological Support Areas (ESA)	» Wetlands: ± 159.83 ha (6%) of 500m regulated area;	Freshwater ESA
		Critical Biodiversity Areas (CBA)	» Wetlands: ± 0.54 ha (0.02%) of project site	Freshwater CBA

4.3.1. Strategic Water Source Areas (SWSAs)

Strategic Water Source Areas (SWSAs) are defined as areas of land that either:

- » supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important;
- » have high groundwater recharge and where the groundwater forms a nationally important resource;
- » areas that meet both criteria mentioned above.

They include transboundary Water Source Areas that extend into Lesotho and Swaziland.

The project site is located outside of any SWSA for groundwater water but is located within a SWSA for surface water; namely the Upper Vaal SWSA-sw (Figure 6).

Due to the nature of PV solar energy developments (limited use of chemicals, hazardous and toxic materials as well as the fact that the only likely direct impact on freshwater resources will be road crossings), there is a low probability that such developments will have a significant impact on important freshwater resource features. The most likely/significant impact will be a local change in runoff and infiltration patterns within the affected catchments, due to a local modification of roughage (vegetation cover) and natural geomorphology within and around the construction and infrastructure areas.

These impacts associated with the SEF development can however, be successfully mitigated through careful planning and with effective mitigation measures in place.

4.3.2. National Freshwater Ecosystem Priority Areas (2011) Database

The National Freshwater Ecosystems Priority Areas (NFEPA) (2011) database provides strategic spatial priorities for conserving South Africa's freshwater ecosystems and supports the sustainable use of water resources. The spatial priority areas are known as Freshwater Ecosystem Priority Areas (FEPAs).

FEPAs were identified based on:

» Representation of ecosystem types and flagship free-flowing rivers.
» Maintenance of water supply areas in areas with high water yield.
» Identification of connected ecosystems.
» Preferential identification of FEPAs that overlapped with"

- Any free-flowing river
- Priority estuaries identified in the National Biodiversity Assessment 2011.
- Existing protected areas and focus areas for protected area expansion identified in the National Protected Area Expansion Strategy.

FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas (FSAs) and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas (UMAs).

4.3.2.1. NFEPA: River and Sub-Quaternary Catchments

A review of the NFEPA coverage for the study area (Figure 6) revealed that no FEPA1 priority sub-quaternary catchment will be impacted by the proposed development.

Furthermore, the 500m regulated area falls across two Upstream sub-quaternary catchments with the bulk of the regulated area located within Upstream sub-quaternary catchment 1584 (covering 76.18% of the regulated area). These sub-quaternary catchments are fairly small to moderate in size. Both of these sub-quaternary catchments are drained by the Kwaggaslaagte River.

These UMAs represent sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas but do not include management areas for wetland FEPAs, which need to be determined at a finer scale (Nel, *et al*., 2011).

The 500m regulated area is located within the Kwaggaslaagte River's catchment and is drained by the this river as well as a few maller drainage networks/tributaries. This river is perennial in nature and predominantly flow in a western to south-western direction, along the eastern portion of the regulated area. The Kwaggaslaagte River is regarded as an important tributary of the upper reaches of the Blesbok River. The higher lying portion of the Kwaggaslaagte River as well as the higher lying tributaries are classified as Upper Foothill reaches whilst the lower lying portion of the Kwaggaslaagter River and associated tributaries are classified as Lower Foothill reaches (according to geomorphological zonation). The valley form of the Kwaggaslaagte River and associated tributaries are predominantly V4 (confined valley floodplain), and to a lesser extent, V2 (flood plain confined to one side) (Nel, et al., 2011). The Present Ecological State (DWAF, 1999) of the Kwaggaslaagte River and its associated tributaries are classified as Moderately Modified (Class C) (Kleynhans, 2000).

Refer to Section 4.3.1, for a description of the potential impacts, associated with the SEF, development, on freshwater resource features and their associated catchments.

With meticulous planning, especially in terms of the layout design and location of infrastructure, as well as the implementation of effective mitigation measures, the significance of these impacts can be significantly reduced to acceptable levels. It is furthermore recommended that where watercourses/wetlands are to be crossed by the access routes, existing crossings should be used/upgraded.

4.3.2.2. NFEPA: Wetlands

A review of the NFEPA coverage for the study area (Figure 6) revealed that a large amount of wetland features occur within the larger project site (332 wetland features) (Nel, et al., 2011). Of these wetland features, most (188 features) are classified as Non-FEPA, artificial wetland features, and represent the numerous dams/reservoirs (mainly instream), that characterize the project site. Most of these artificial dam features are fairly small in size (average size of dam features; 0.85 ha). Of the 144 natural wetlands, only 20 wetlands have been listed as FEPA priority wetland features (Nel, et al., 2011).

Within the 500m regulated area, a total of eleven wetland features have been mapped (Nel, et al., 2011). Of these wetland features, most (7 features) are classified as Non-FEPA wetlands with two of these wetland features being artificial (representing instream dams/reservoirs). These artificial dam features are fairly small in size. Of the nine natural wetlands, only four wetlands have been listed as FEPA priority wetland features (Nel, et al., 2011).

A summary of the natural wetlands, occurring within the project site, as mapped within the NFEPA spatial coverage map, are provided below in Table 6.

Table 6: Summary of NFEPA Natural Wetlands mapped within the 500m regulated area.

Hydrogeomorphic Unit	Number of Wetlands	Average Size (ha)	Largest Feature (ha)	FEPA Priority Wetlands (amount)	Average Size of FEPA Priority Wetlands (ha)	Largest FEPA Priority Wetland (ha)	WETLAND CONDITION				
							AB: Natural or Good	C: Moderately Modified	Heavily to Critically Modified		
									Z1[2]	Z2[3]	Z3[4]
Channelled valley-bottom	6	21.5	129.03	4	0.14	0.22	5	1			
Depression	1	0.6	0.6	0	N/A	N/A	1				
Seep	3	10.5	30.73	0	N/A	N/A	1				2
Valleyhead Seep	1	0.02	0.02	0	N/A	N/A	1				
TOTAL	**11**	**14.6**	**-**	**4**	**0.14**	**61**	**8**	**1**	**0**	**0**	**2**

The above table indicates that almost half (18%) of all the wetland features have been significantly modified (less than 25% of natural land cover remain). Approximately 82% of all wetlands found within the regulated area can be regarded is largely natural or in a good condition. Of these nine intact wetlands, four are regarded as FEPA priority wetlands. Most of these FEPA priority wetlands are small in size (>1 ha) (refer to Figure 6). The bulk of the wetlands that occur within the project site is closely associated with the watercourse/river features (channelled valley bottom wetlands, unchanneled valley bottom wetlands and most of the seepages) (refer to Figure 6).

Refer to Section 4.3.1, for a description of the potential impacts, associated with SEF development, on freshwater resource features and their associated catchments.

With meticulous planning, especially in terms of the layout design and location of infrastructure, as well as the implementation of effective mitigation measures, the significance of these impacts can be significantly reduced to acceptable levels. It is furthermore recommended that the crossing of wetland features should be avoided as far

[2] Wetlands that overlap with a 1:50,000 "artificial" inland waterbody from the Department of Land Affairs: Chief Directorate of Surveys and Mapping (2005-2007).
[3] Majority of the wetland unit is classified as "artificial" in the wetland delineation GIS layer.
[4] Percentage natural land cover <25%.

as possible and where crossing of wetland/watercourse features are unavoidable, only existing crossings may be used or be upgraded.

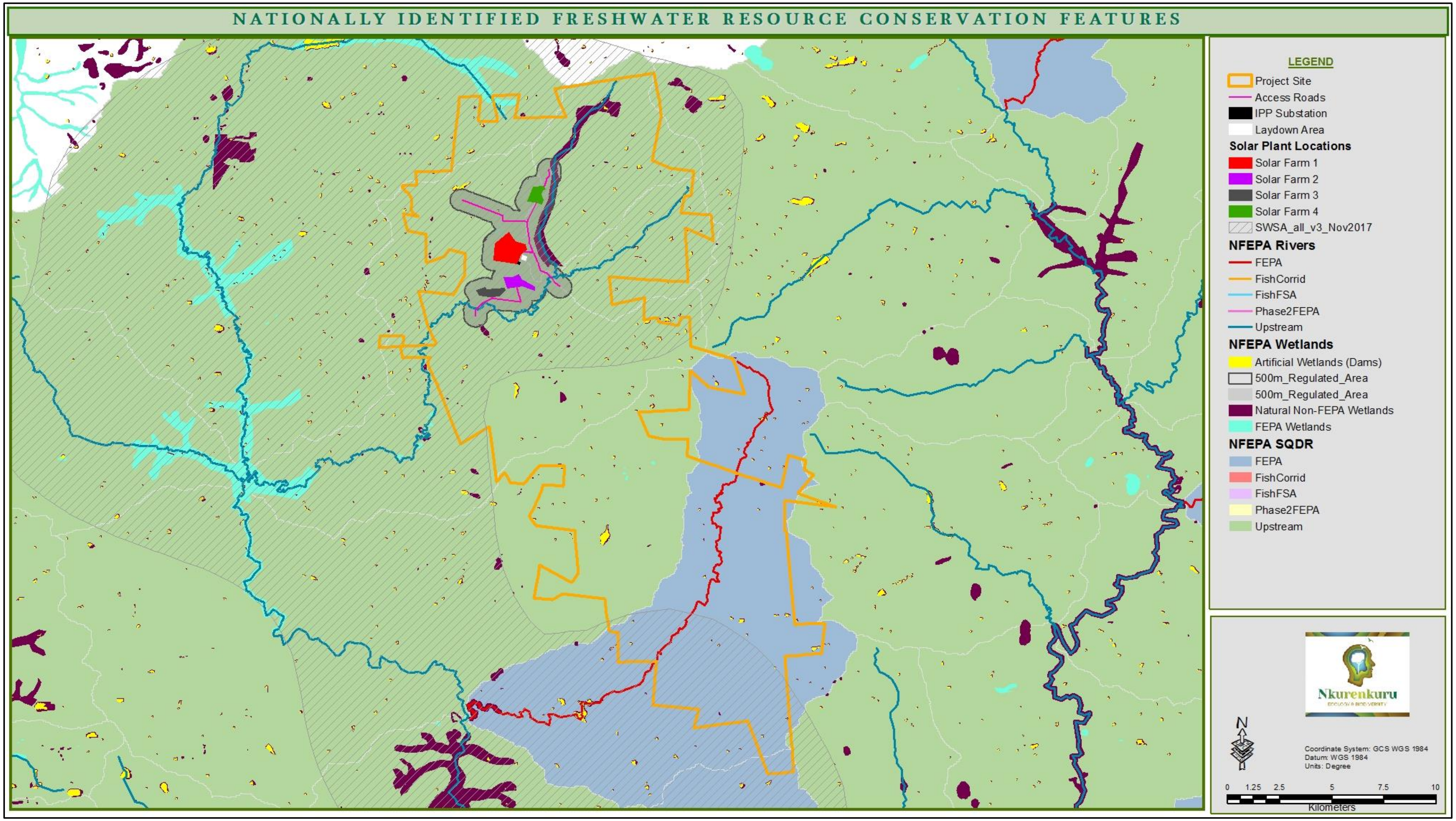

Figure 6: Nationally identified aquatic resource conservation priority areas found within the greater surroundings of the proposed project site.

4.3.3. Critical Biodiversity Areas and Broad Scale Ecological Processes

The Mpumalanga Biodiversity Conservation Plan (MBCP) is a plan developed conjointly by the Mpumalanga Tourism and Parks Agency (MPTA) and Department of Agriculture and land Administration (DALA) to guide conservation and land-use decisions in the province in order to support sustainable development.

Freshwater Critical Biodiversity Areas (CBA) have been identified for the entire Mpumalanga Province and are published by SANBI (http://bgis.sanbi.org/). This biodiversity assessment identifies CBAs representing biodiversity priority areas that should be maintained in a natural to near-natural state. CBA maps show the most efficient selection and classification of land portions to be safeguarded so that ecosystem functioning is maintained and national biodiversity objectives are met (see Table 7 for a summary of the different freshwater features underpinning the various CBA maps and also refer to

Table 8 for a summary of the land-use guidelines recommended for each feature).

According to Figure 7, Figure 8 and, Figure 9 only about 6.43% of the 500m regulated area comprises Freshwater CBAs and ESAs (CBA Wetlands: 0.02% and ESA Wetlands: 6%).

According to the MBCP's Freshwater CBA spatial data, no infrastructure associated with this development will be located within any Freshwater CBA or ESA Features and subsequently the proposed development will not directly impact any such provincially important conservation features.

As already mentioned, more recent, available wetland spatial data sets indicate that wetland features have been under-mapped within the NFEPA Wetland coverage (main source used for identifying freshwater CBAs and ESAs). Subsequently, the coverage of ESA Wetlands should be much higher. This was confirmed during the desktop and in-field delineation of wetland features within the project site.

From a developmental perspective, the following recommendations and additional requirements are provided:

- The following buffer areas are recommended, and should be for maintaining the freshwater resource features REC (Recommended Ecological Category) allowing the persistence of the current present ecological status as well as their functions and services.
    - All small, endorheic seepages and depressions with a low to moderate Ecological Importance: 50m buffers from the outer edge of the freshwater resource features.
    - All larger outward draining (exoreic), interconnected wetland features with high Ecological Importance: 100m buffers from the outer edge of the freshwater resource features.

- All freshwater features with their buffer areas have been classified as either Very High- or High sensitive and should be regarded as "No-Go" areas apart from the following activities and infrastructure which may be allowed (although restricted to an absolute minimum footprint):
    - only activities relating to the route access:
        - the use/upgrade of existing roads and watercourse crossings are the preferred options;
        - Where no suitable existing roads and watercourse crossings exist, the construction of new access roads and watercourse crossings can be allowed, however this should be deemed as a last resort.

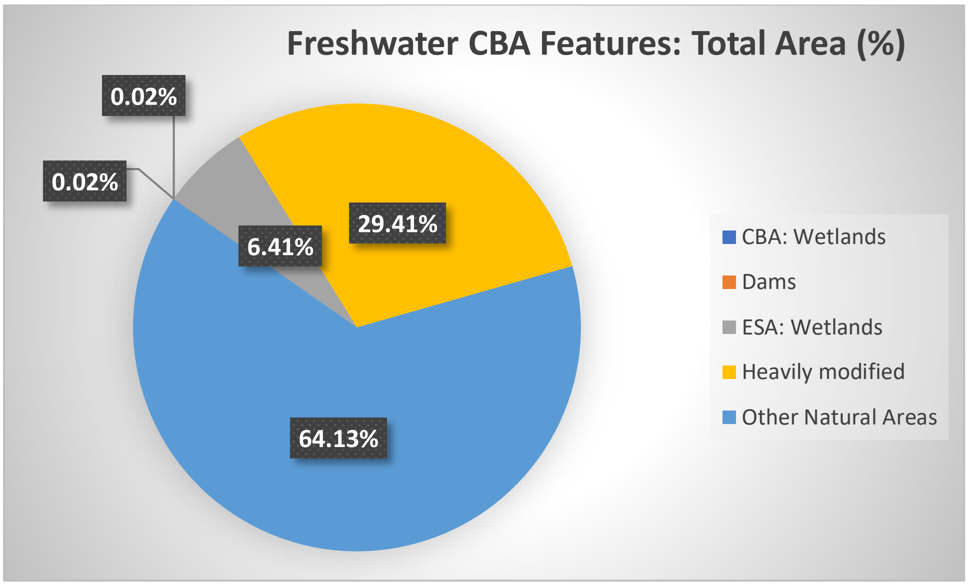

Figure 7: Percentage coverage of Freshwater CBAs within the 500m regulated area.

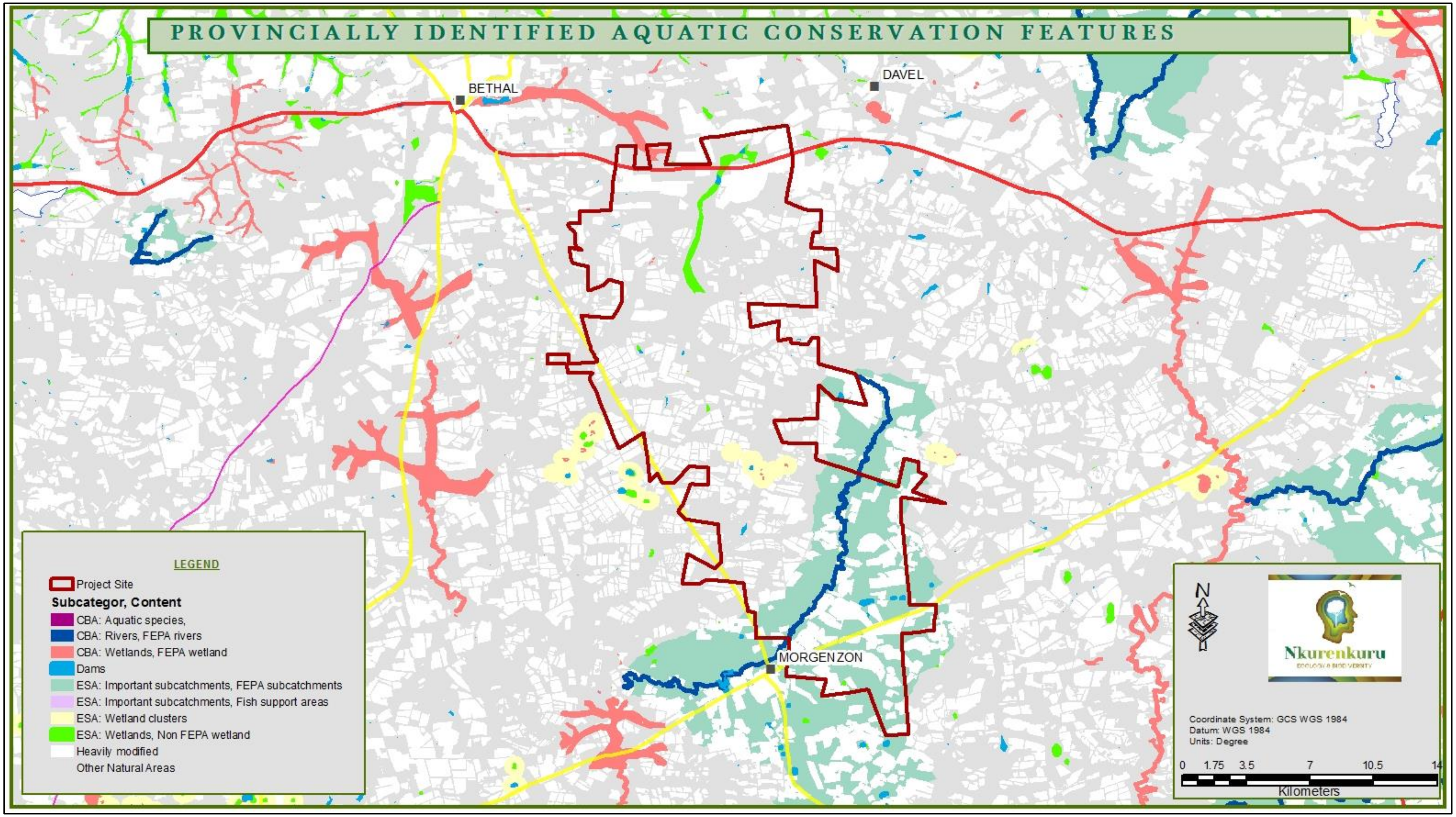

Figure 8: Provincially identified freshwater conservation priority areas found within the greater surroundings of project site.

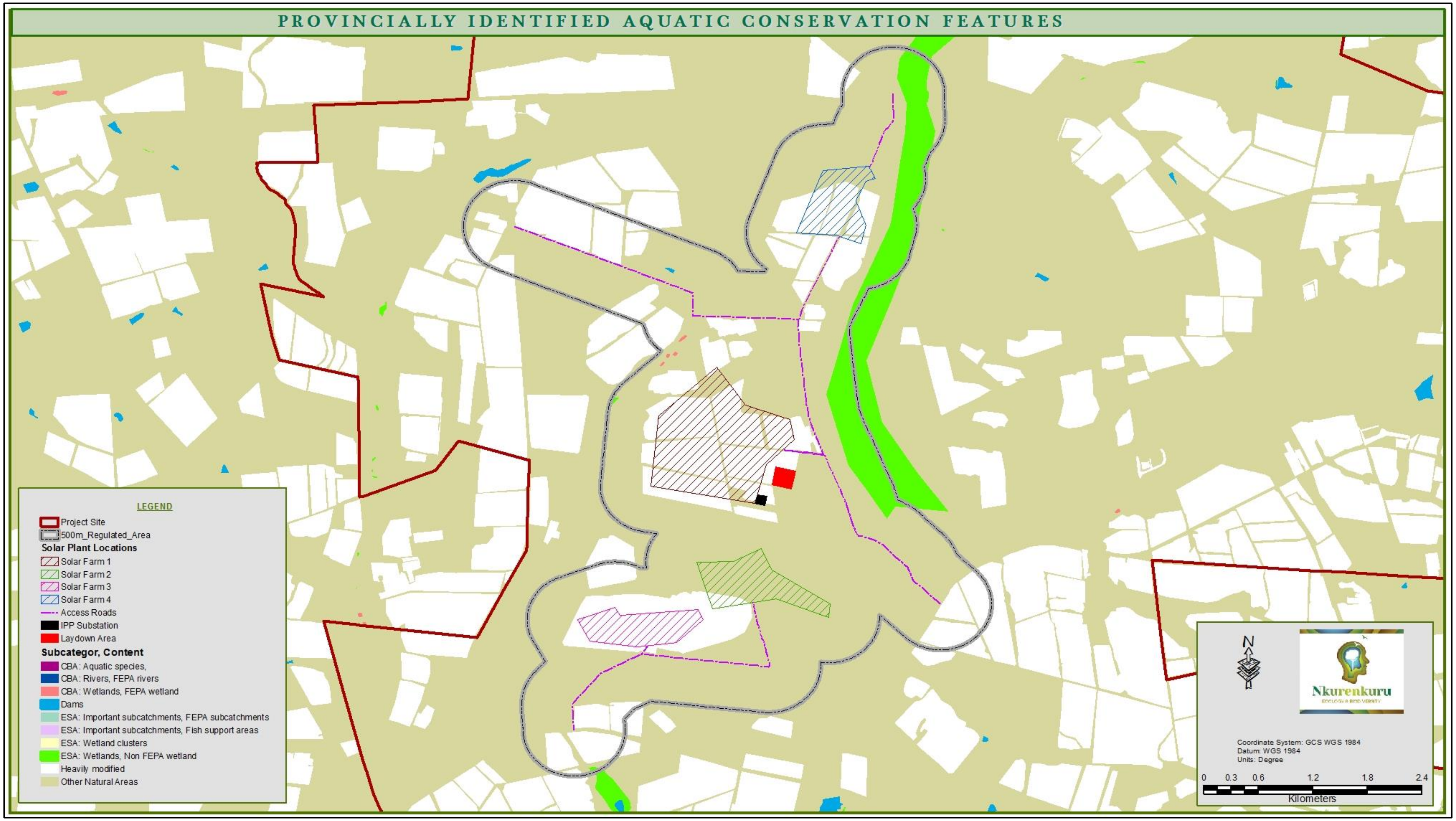

Figure 9: Provincially identified freshwater conservation priority areas found within project site and 500m regulated area.

Table 7: Summary of the different categories occurring within the Mpumalanga Freshwater CBA map.

MAP CATEGORY	DESCRIPTION	SUB-CATEGORY	DESCRIPTION
Critical Biodiversity Areas (CBAs)	All areas required to meet biodiversity pattern and process targets; CBAs are areas of high biodiversity value that should be maintained in a natural or near-natural state.	CBA: Rivers	Rivers, with a 100 m buffer, that need to be maintained in a good ecological condition in order to meet biodiversity targets for freshwater ecosystems. This category includes FEPA rivers and all FEPA free-flowing rivers. The FEPA rivers include those required to meet biodiversity targets for threatened fish species.
		CBA: Wetlands	Wetlands that are important for meeting biodiversity targets for freshwater ecosystems; the ecological condition of these wetlands needs to be maintained or improved, and their loss or deterioration must be avoided. This category includes FEPA wetlands.
		CBA: Aquatic Species	Areas considered critical for meeting the habitat requirements for selected aquatic invertebrate species (dragonflies, damselflies, crabs). These species are known to occur only at one or a few localities and are at high risk of extinction if their habitat is lost. Fish species are included under the CBA River category
Ecological Support Areas (ESA)	Areas that are not essential for meeting targets, but that play an important role in supporting the functioning of CBAs and that deliver important ecosystem services.	ESA: Wetland Cluster	Clusters of wetlands embedded within a largely natural landscape to allow for the migration of fauna and flora between wetlands.
		ESA: Wetlands	All non-FEPA wetlands. Although not classed as FEPAs, these wetlands support the hydrological functioning of rivers, water tables and freshwater biodiversity, as well as providing a host of ecosystem services through the ecological infrastructure that they provide.
		ESA: Important Sub-catchments	Sub-catchments that either contain river FEPAs and/or Fish Support Areas.
		ESA: Fish Support Area	Sub-catchments that harbour fish populations of conservation concern, based on FEPA data augmented with regional data sets.
		ESA: Strategic Water Source Area	High rainfall areas that produce 50% of Mpumalanga’s runoff in only 10% of the surface area, thus supporting biodiversity and underpinning regional water security.

Other Natural Areas (ONA)	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions.		
Moderately or Heavily Modified Areas	Areas in which significant or complete loss of natural habitat and ecological function has taken place due to activities such as ploughing, hardening of surfaces, open-cast mining, cultivation and so on.	Heavily Modified	Heavily Modified: All areas currently modified to such an extent that any valuable biodiversity and ecological function has been lost.
		Moderately Modified: Old lands	Artificial water bodies that have impacted on wetland or river ecosystems. These areas may still have a recharge effect on wetlands, groundwater and river systems and may support river- or water-dependent fauna and flora, such as water birds and wetland vegetation.

Table 8: Land-use guidelines for the various terrestrial and aquatic categories.

MAP CATEGORY	DESIRED MANAGEMENT OBJECTIVE	GUIDELINES
TERRESTRIAL FEATURES		
PA	Must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity. A benchmark for biodiversity.	» All operational aspects of managing these areas must be subject to their main purpose, which is to protect and maintain biodiversity and ecological integrity, and should be governed by a formally approved management plan and land-use activities that support the primary function of these areas as primary sites for biodiversity conservation. » The management plan must identify allowable activities, which should be consistent at least with the CBA Irreplaceable category; the location of these allowable activities should be captured in a zonation plan in the management plan. » Activities relating to the construction of roads, administrative or tourism infrastructure and services (such as water reticulation systems, power lines and the likes) that are required to support the primary function of the protected area and its allowable activities, must be subject to at least a basic scoping report, or a full EIA, as specified by NEMA, and the protected area management plan. » In the case of Protected Environments, a variety of agricultural land uses may be allowed, such as livestock grazing, plantation forestry and some cultivation. The location of these land-use activities must be informed by the CBA maps, and should be specified in the zonation plan of the management plan for the protected environment. All areas of natural habitat that are zoned for conservation use, should be subject to implementation of the land-use guidelines for protected areas, CBAs, and ESAs.
CBA: Irreplaceable	Maintain in a natural state with no further loss of natural habitat.	**General Guidelines.** » Biodiversity loss and land-use change in Irreplaceable CBAs should be monitored as a matter of priority, to prevent unauthorised land-use change or degradation by neglect or ignorance. » Where appropriate, these areas should be incorporated into the formal Protected Area system through biodiversity stewardship agreements (contract Nature Reserves or Protected Environments). Ideally, conservation management activities should be the primary land-use in all irreplaceable areas, or they should at least be » managed in ways that have no negative impact on species, ecosystems or ecosystem services. » Extensive (widespread, low-intensity) livestock or game ranching, if well-managed, is compatible with the desired management objectives for these areas. These land-uses are acceptable if they take into account the specific biodiversity features (e.g. rare

		species or vegetation remnants) and vulnerabilities (e.g. infestation by invasive alien plants) at each site, if they comply with recommended stocking rates, if any associated infrastructure (required to support the ranching activities) is kept to low levels. **Specific Guidelines (for meeting minimum requirements).** » In general, Irreplaceable sites must be avoided in terms of the mitigation hierarchy. » A specialist study must be part of the Scoping and EIA process for all land-use applications in these areas, using the services of an experienced and locally knowledgeable biodiversity expert who is approved by the MTPA. » Applications for land use of any kind should be referred to the biodiversity specialists in MTPA and DARDLEA for evaluation. » Degraded areas included in the land parcel, but not the land-use proposal, should be restored to natural ecosystem functioning where possible. » Provision of alternative land as a 'biodiversity offset' in exchange for biodiversity loss in these areas CANNOT be considered except in exceptional circumstances and would need to be considered on a case by case basis.
CBA: Optimal	Maintain in a natural state with no further loss of natural habitat.	**General Guidelines.** » Acceptable land uses are those that are least harmful to biodiversity, such as conservation management, or extensive livestock or game farming. Large-scale cultivation, mining and urban or industrial development are not appropriate. » Extensive (widespread, low-intensity) livestock and game ranching, if well-managed (see above), is compatible with the desired management objectives for these areas. **Specific Guidelines (for meeting minimum requirements).** » If small-scale land-use change is unavoidable, it must be located and designed to be as biodiversity-sensitive as possible. » A specialist study must be part of the scoping and EIA process for all land-use applications in these areas, using the services of an experienced and locally knowledgeable biodiversity expert who is SACNASP registered. » Provision for biodiversity offsets in exchange for biodiversity loss should only be considered as a last resort and at a ratio consistent with national policy.

5. AQUATIC/FRESHWATER RESOURCE BASELINE ASSESSMENT

This section sets out the findings of the baseline assessment of those water resources units and includes:

- Delineation, Classification and Habitat Descriptions;
- Present Ecological State (PES) Assessment;
- Ecological Importance and Sensitivity (EIS) Assessment;

The on-site / in-field assessment of the freshwater resource indicators was conducted by Gerhard Botha from Nkurenkuru Biodiversity and Ecology on the 24th to 27th of April 2022.

- Ultimately, 28 freshwater resource features were identified (Table 10) and delineated within the 500m regulated area and include;
    - Five (5) channelled valley-bottom wetlands
    - One (1) unchanneled valley-bottom wetland,
    - Nineteen (19) seepage wetlands; and
    - Three (3) floodplain wetlands
- Only five wetland features will be impacted through access and underground cable route crossings.
- No other infrastructure is located within any freshwater resource feature.

The dominant drainage/wetland features within the project site are the floodplain wetlands, within which almost all of the other wetland features apart from a few endorheic wetland features (2 seepages), drain into directly. All of the freshwater resource features on and around the site are intermittent or ephemeral, being inundated only for brief periods each year, with periods of drought that are unpredictable in duration.

Artificial wetland features (impoundments/dams) are also a noteworthy hydrological feature within the project site with one-hundred and twenty dam features present within the project site. Most of these dam features are instream impoundments (especially common within the channelled valley-bottom wetlands) and are typically fairly small farm dams which is fairly easily breached or allow some seepage.

5.1. Aquatic/Freshwater Resource Delineation

The water body delineation and classification were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (2009) (refer to Table 9, Figure 10 and Figure 11).

For the DWS definitions of different hydrological features refer to Appendix 1.

Table 9: Summary of the wetlands delineated and classified within the entire project site.

Hydrogeomorphic Type	Number of Features	Coverage (ha)	Coverage (%)	Total Coverage of Project Site (%)	Wetland Conditions (PES)				
					A	B	C	D	E
Channelled Valley-Bottom	60	1604	32	5.8	3	28	19	6	3
Uncahnnelled Valley-Bottom	35	603	12	2.2	2	0	15	11	11
Floodplain	7	1610	32	5.8	0	7	0	0	0
Seep	209	1225	24	4.4	23	91	49	26	20
Depression	7	34	1	0.1	5	0	2	0	0
Total	**318**	**5076**	**100.0**	**18.2**	**33**	**126**	**85**	**43**	**34**

Table 10: Summary of the wetlands delineated and classified within the 500m regulated area.

Wetland Number	Hydrogeomorphic Type	Total Extent of HGM Unit	Extent of HGM Unit within 500m Regulated Area (Ha)	Extent of HGM Unit within 500m Regulated Area (%)
12	Unchannelled Valley-Bottom	36.62	9.70	0.389%
17	Floodplain	358.16	104.25	4.182%
19	Floodplain	120.91	56.76	2.277%
20	Floodplain	53.57	33.07	1.327%
22	Channelled Valley-Bottom	103.55	0.00	0.000%
27	Channelled Valley-Bottom	87.20	48.14	1.931%
36	Channelled Valley-Bottom	7.63	7.63	0.306%
37	Channelled Valley-Bottom	13.16	1.26	0.051%
39	Seepage	1.82	1.82	0.073%
42	Seepage	4.96	0.62	0.025%
45	Seepage	59.15	53.87	2.161%
52	Seepage	8.98	8.98	0.360%
53	Seepage	4.00	3.83	0.154%
54	Seepage	4.87	4.87	0.195%
75	Seepage	34.95	6.74	0.270%
76	Seepage	13.83	13.83	0.555%
79	Seepage	35.68	21.12	0.847%
82	Seepage	2.30	2.30	0.092%
83	Seepage	4.38	4.38	0.176%
84	Seepage	5.93	3.53	0.142%
85	Seepage	5.81	0.64	0.026%
86	Seepage	1.67	0.09	0.004%
87	Seepage	1.90	1.08	0.043%
89	Seepage	1.34	1.34	0.054%
92	Seepage	3.85	3.85	0.154%
93	Seepage	4.10	4.10	0.165%

94	Seepage	7.49	7.49	0.301%
106	Channelled Valley-Bottom	111.33	35.72	1.433%
	Total	**1099.15**	**441.02**	**100**

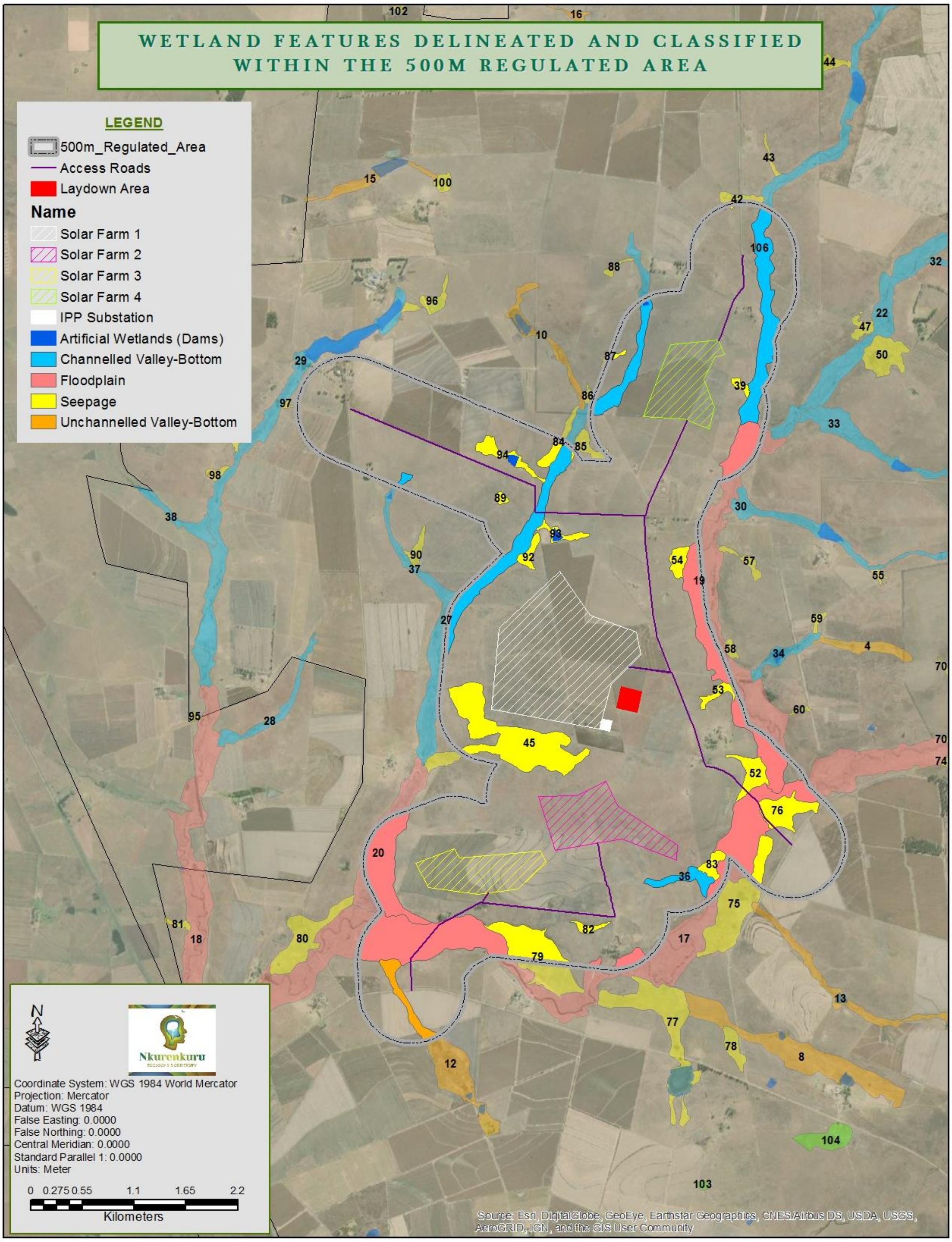

Figure 10: Mapping delineated and classified hydrogeomorphic wetland units occurring within the 500M regulated area.

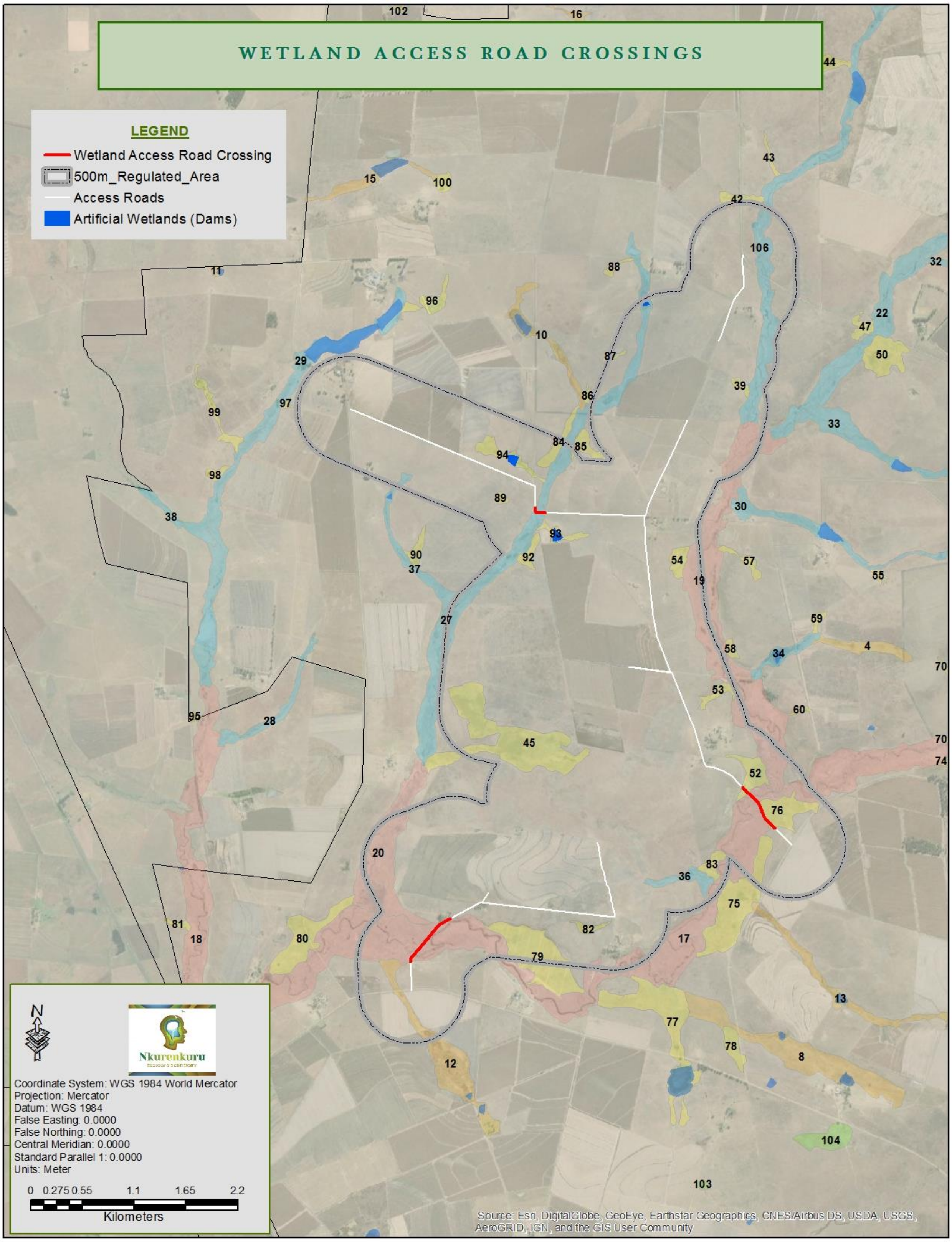

Figure 11: Planned wetland access road crossings.

5.2. Classification and Description of Surface Water Resource Features

5.2.1.1. Floodplain Wetlands

Floodplain wetlands are linear fluvial, net depositional valley bottom surfaces which have a meandering channel. These wetlands occur on mostly flat to gently-sloping land and are formed by the adjacent alluvial river channel. These floodplains wetlands are subject to periodic inundation by overtopping. The meandering channel flows within an unconfined to slightly confined (normally only to one side) depositional valley, and ox-bows or cut-off meanders frequently occur within the floodplain areas. The floodplain surface usually slopes away from the channel margins due to preferential sediment deposition along the channel edges and areas closest to the channel (natural levee). This can result in the formation of backwater swamps at the edges of the floodplain margins. River-derived depositional processes, may also result in the formation of point bars, scroll bars, and levees (Figure 12). The flat surfaces present along the along the margins of a river (deposited during previous eras of differing climate and/or sediment load), are known as terraces. Terraces are generally not geomorphologically active, (are not currently being built by river depositional processes). Floodplains are typically flooded (or inundated), on average, several times per year, during moderate peak flow events (such as a 1.5-year or 2-year flood). Terraces may be overtopped, but only by larger, less frequent floods (e.g. 50-year or 100-year events).

Water and sediment enter floodplain wetlands mainly as overspill from a major river channel during flooding (Figure 13). Water movement through the wetland is predominantly horizontal and bidirectional (i.e. in and out of the wetland), in the form of diffuse surface or subsurface flow, although significant temporary containment of water may occur in floodplain depressions. Water generally exits a floodplain wetland as diffuse surface and/or subsurface flow (often returning to the river channel), but infiltration and evapotranspiration of water from a floodplain wetland can also be significant, particularly if there are a number of depressional areas within the wetland.

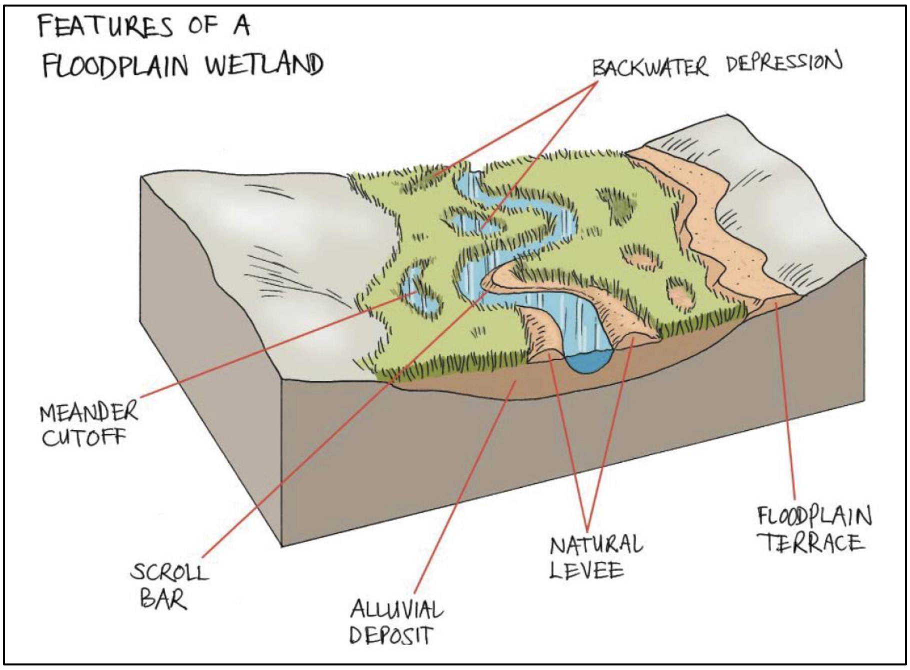

Figure 12: Illustration of the typical features/micro-habitats associated with floodplains wetlands (copied from Ollis et al., 2013).

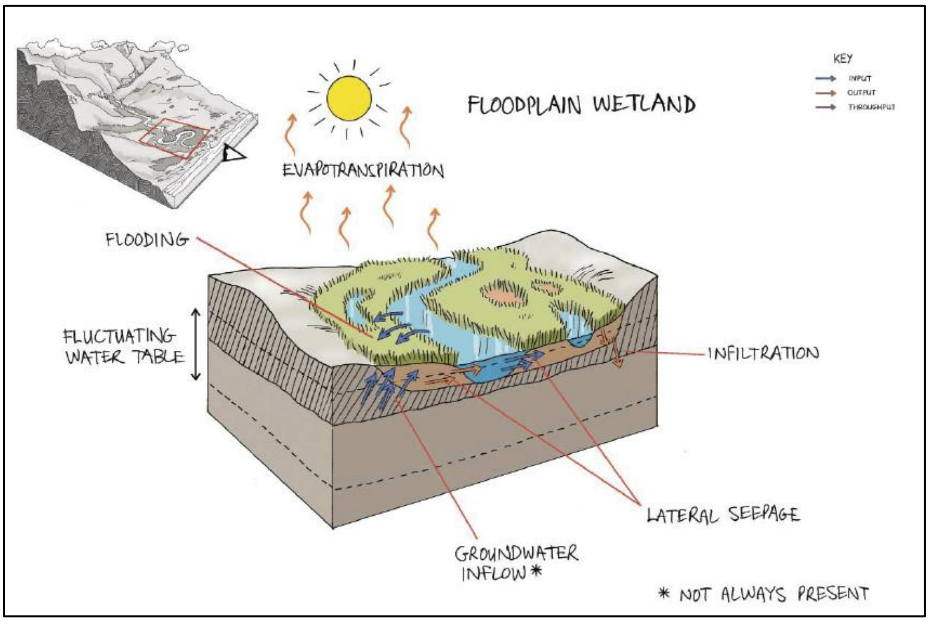

Figure 13: Conceptual illustration of a floodplain wetland, showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

5.2.1.2. Channelled Valley-Bottom Wetlands:

Wetland systems characterised by their location within moderately well-defined valley floors with the presence of an active channel, but without typical diagnostic floodplain features. Flows within these systems are characteristically confined within a define channel. Dominant water inputs to these wetlands are from the watercourse/channel flowing through the wetland, predominantly as surface flow resulting from flooding, or as a form of overland flow from adjacent hillslopes and other smaller watercourses and valley-bottom wetlands, with substantially less groundwater discharge. Water generally exits a channelled valley-bottom wetland in the form of diffuse surface or subsurface flow in the adjacent river, with infiltration into the ground and evapotranspiration of water also being potentially significant Figure 14. The "master variable" responsible for shaping such an ephemeral watercourse is associated with the flow regime of the system, which includes variations and patterns in surface flow magnitude, frequency, duration, and timing (Poff et al., 1997). It follows that the size and shape of a watercourse is controlled in large part by the dominant discharge in a particular region (Lichvar & Wakeley, 2004). Fluvial morphology is frequently associated with extreme discharge events; streams and floodplains trap sediments and nutrients in addition to attenuating flood waters (Graf 1988; Leopold 1994).

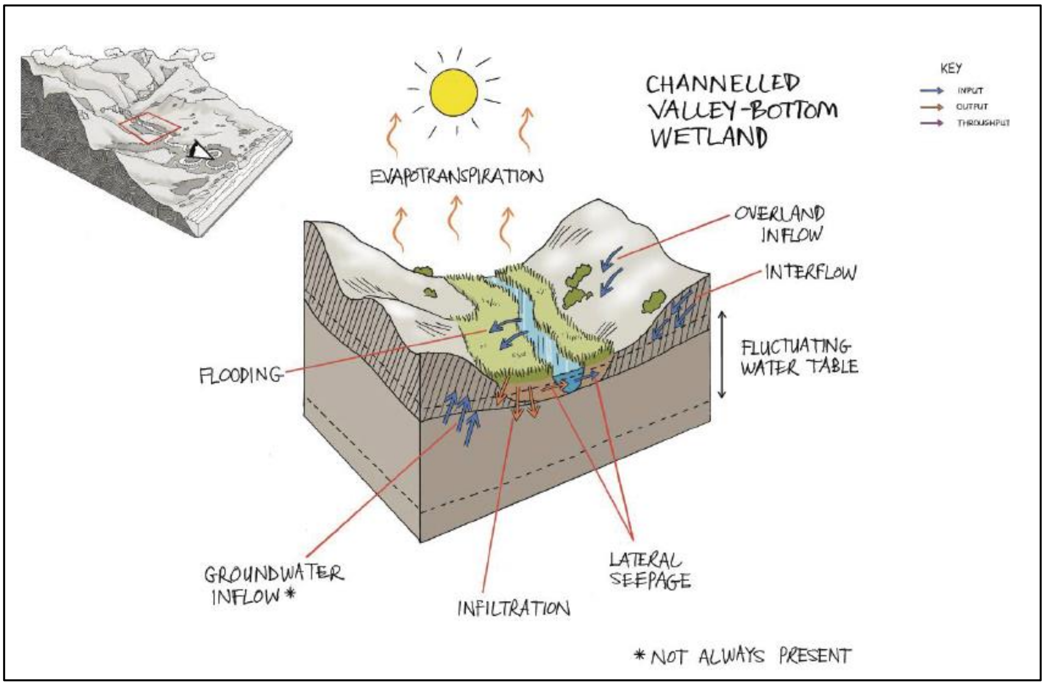

Figure 14: Conceptual illustration of a channelled valley-bottom wetland, showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

5.2.1.3. Unchannelled Valley-Bottom Wetlands:

Unchannelled valley-bottom wetlands are characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows. These wetlands are generally formed when a river channel loses confinement and spreads out over a wider area, causing the concentrated flow associated with the river channel to change to diffuse flow (i.e. the river becomes an unchannelled valley-bottom wetland). This is typically due to a change in gradient brought about by a change in base level at the downstream edge of the wetland (for example, where an erosion-resistant dolerite dyke is present) and the resulting accumulation of sediment. In some cases, an unchannelled valley-bottom wetland could occur at the downstream end of a seep, where a slope grades into a valley near the head of a drainage line. Water inputs are typically from an upstream channel that becomes dominated by diffuse (surface and subsurface) flow as it enters the wetland and seepage from adjacent slopes (Figure 15). There may also be groundwater input into the wetland. Water characteristically moves through the wetland in the form of diffuse surface or subsurface flow, but the outflow may be in the form of either diffuse or concentrated surface flow. Infiltration and evapotranspiration from unchanneled valley-bottom wetlands can be significant, but horizontal, unidirectional, diffuse surface flow tends to dominate these wetland systems.

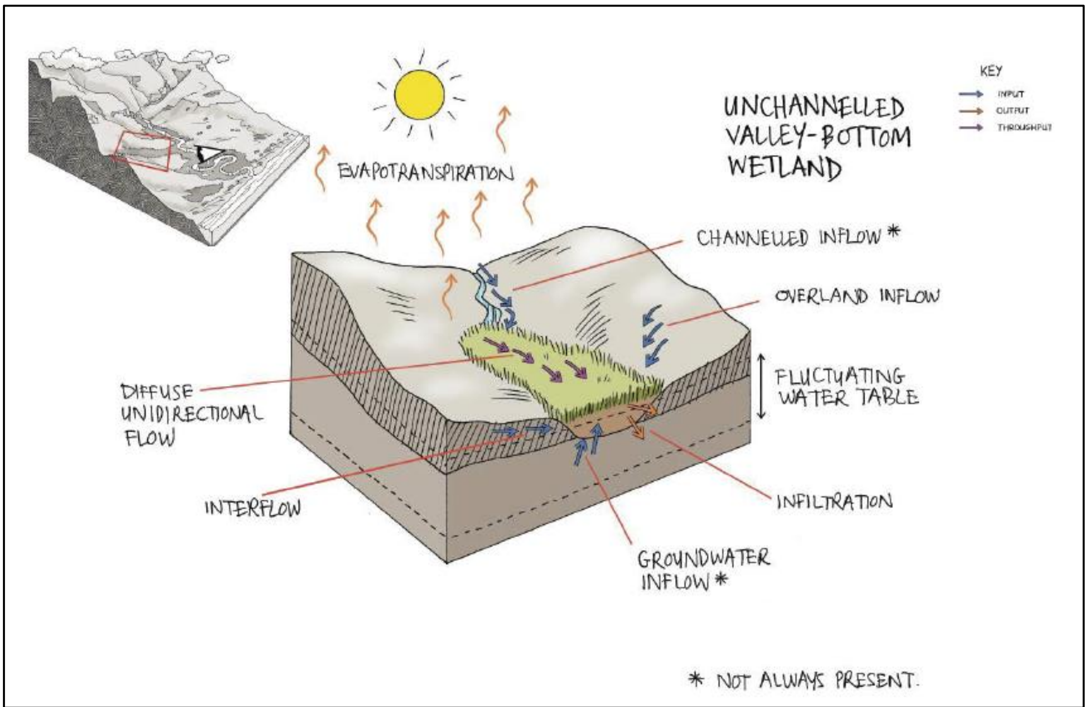

Figure 15: Conceptual illustration of an unchannelled valley-bottom wetland, showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

5.2.1.4. Depression Wetlands:

A wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Depressions may be flat-bottomed (in which case they are often referred to as pans) or round-bottomed and may have any combination of inlets and outlets or lack them completely. Water input are typically surface and groundwater-fed (Figure 16). Wetland separated from underlying aquifer by lower permeability layer. Input from groundwater discharge, when groundwater table is high, precipitation, surface runoff and possibly spring flow. Groundwater input may be restricted by lower permeability layer. Output by evaporation and groundwater recharge when groundwater table low.

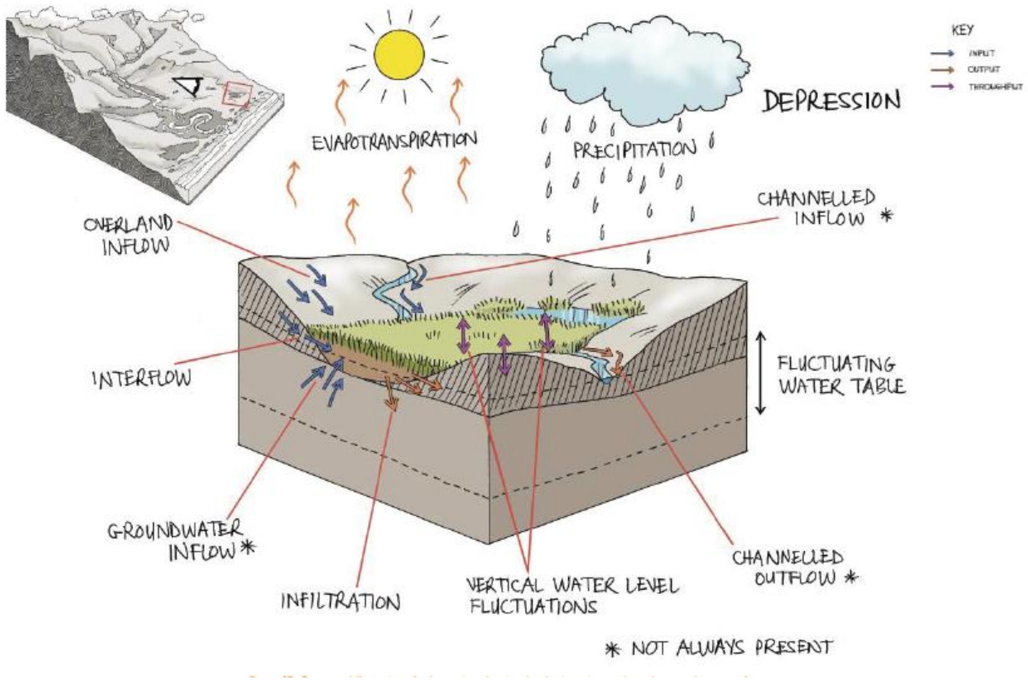

Figure 16: Conceptual illustration of a depression wetland, showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

5.3. Terrain and Soils

A hydromorphic soil displays unique characteristics resulting from its prolonged and repeated saturation. Once a soil becomes saturated for an extended time, roots and microorganisms gradually consume the oxygen present in pore spaces in the soil. In an unsaturated soil, oxygen consumed in this way would be replenished by diffusion from the air at the soil surface. However, since oxygen diffuses 10 000 times more slowly through water than through air, the process of replenishing depleted soil oxygen in a saturated soil is significantly slower. Thus, once the oxygen in a saturated soil has been depleted, the soil effectively remains anaerobic.

Prolonged anaerobic soil conditions result in a change in the chemical characteristics of the soil. Certain soil components, such as iron and manganese, which are insoluble under aerobic conditions, become soluble when the soil becomes anaerobic, and can thus be leached out of the soil profile.

Iron is one of the most abundant elements in soils, and is responsible for the red and brown colours of many soils. Once most of the iron has been dissolved out of a soil as a result of prolonged anaerobic conditions, the soil matrix is left a greyish, greenish or bluish colour, and is said to be gleyed.

A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic conditions in the soil. Lowering of the water table results in a switch from anaerobic to aerobic soil conditions, causing dissolved iron to return to an insoluble state and be deposited in the form of patches, or mottles, in the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these bright, insoluble iron compounds. Thus, soil that is gleyed but has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated.

- Permanent saturated zones: Soil forms were mainly characterized by very dark black to dark greys brown vertic, and occasionally melanic soils containing varying amounts of organic material (low moderate to moderate amounts of organic material) and no mottles. These vertic/melanic topsoil horizons typically overly dark grey to light brownish grey gley subsoil horizons. The most prominent soil form found within this zone was Rensburg. Willowbrook was occasionally encountered as well as Mkuze (within floodplains). Towards, the far southern portion of the project site, where more loamy soils were encountered, the permanent saturated zone was characterized by both Rensburg as well as Katspruit soil forms.
- Seasonal and temporary saturated zones: Black to dark grey or dark grey-brown clay matrix with little organic material and some high chroma mottles (orange and yellow). The prominent soil forms encountered within this zone were Rensburg, Mkuze, Glen and Bonhein and Rustenburg. Towards, the far southern portion of the project site, where more loamy soils were encountered, the seasonal saturated zone was characterized by Westleigh and Pindene soil forms. Organic material was fairly low. High chroma mottles (orange and yellow) were abundant.

5.4. Vegetation Description

The vegetation of the wetland areas are characterised by a 75 – 100% cover. Native trees were absent from the wetland areas, except for scattered individuals of *Salix babylonica* along larger river channels. The shrub layer was approximately 50 cm in height, with the forb layer being 50 cm and the graminoid layer 90 cm.

A total of 77 plant species (63 native and 14 alien) were recorded within this type. No endemic species were found is unit; however, one protected species was found, namely *Crinum bulbispermum*. The unit did not contain any Red List species.

Some of the dominant species were *Cyperus congestus*, *C. fastigiatus*, *C. rigidifolius*, *Eleocharis dregeana*, *Fingerhuthia sesleriiformis*, *Fuirena coerulescens*, *Leersia hexandra*, *Pennisetum thunbergii*, and *Setaria nigrirostris*. The following native species were unique to the wetland habitats:

- *Agrostis eriantha var. eriantha*
- *Alectra sessiliflora*
- *Aristida bipartita*
- *Brachiaria eruciformis*
- *Carex glomerabilis*
- *Crinum bulbispermum*
- *Cycnium tubulosum subsp. tubulosum*
- *Cyperus congestus*
- *Cyperus fastigiatus*
- *Cyperus haematocephalus*
- *Cyperus rigidifolius*
- *Denekia capensis*
- *Diclis rotundifolia*
- *Eleocharis dregeana*
- *Falkia oblonga*
- *Fingerhuthia sesleriiformis*
- *Fuirena coerulescens*
- *Gomphostigma virgatum*
- *Hemarthria altissima*
- *Hermannia erodioides*
- *Imperata cylindrica*
- *Jamesbrittenia aurantiaca*
- *Juncus exsertus*
- *Leersia hexandra*
- *Lobelia acutangula*
- *Lobelia sonderiana*
- *Mentha longifolia subsp. capensis*
- *Moraea pallida*
- *Nerine angustifolia*
- *Panicum coloratum*
- *Pelargonium minimum*
- *Pennisetum thunbergii*
- *Schoenoplectus decipiens*
- *Scirpoides burkei*
- *Sebaea leiostyla*
- *Setaria nigrirostris*
- *Trifolium africanum*
- *Wahlenbergia undulata*

All wetland areas that were inspected were in fairly good condition (no significant transformation, and/or secondary vegetation) and relatively free from any alien species, except for scattered individuals of *Cosmos bipinnatus*, *Oenothera rosea*, *Paspalum dilatatum*, *Physalis peruviana*, and *Schkuhria pinnata*. Three NEM:BA listed invasive species were also occasionally recorded, namely *Cirsium vulgare*, *Verbena bonariensis*, and *Xanthium spinosum*.

5.5. Present Ecological State (PES), Conservation Importance and Final Sensitivity Rating

Wetlands form at the interface between terrestrial and aquatic environments, and between groundwater and surface-water systems. The complex interaction of inflows and outflows of water, sediment, nutrients and energy over time is what shapes the physical template of the wetland and understanding theses fluxes and interactions considered is fundamentally important in developing an understanding the occurrence, morphology and dynamics of different wetland systems (Ellery et al., 2009).

The Present Ecological State (PES) of an aquatic system represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habit and biota, as well as ecosystem functioning (Category E).

The Present Ecological State (PES) and the Ecological Importance and Sensitivity Scores (EIS) were based on the current state and function of the natural systems observed, or where systems contributed to the ecological character of the development footprint. These ratings were then translated in the respective sensitivity ratings of the various aquatic systems (High to Low), and used to prepare a sensitivity map, used in guiding the preparation of the layout. This was also conducted in conjunction with the other specialists to determine the layout to reduce the number of overall impacts.

The following summary is present of the PES/EIS score of the natural wetlands found within the project site.

Table 11: Summary of the wetlands PES/EIS.

Wetland Number	Hydrogeomorphic Type	Wetland Condition (PES)	Ecological Sensitivity (ES)	Ecological Importance (EI)	Final EI&S (after modification)
12	Unchannelled Valley-Bottom	E	High	Moderate	High
17	Floodplain	B	Low	High	Very High
19	Floodplain	B	Moderate	High	Very High
20	Floodplain	B	Moderate	High	Very High
22	Channelled Valley-Bottom	B	Moderate	High	Very High
27	Channelled Valley-Bottom	B	Moderate	High	Very High
36	Channelled Valley-Bottom	A	High	Moderate	Very High
37	Channelled Valley-Bottom	C	High	Moderate	High
39	Seepage	B	High	Moderate	Very High
42	Seepage	D	High	Moderate	High
45	Seepage	C	High	Moderate	High
52	Seepage	C	High	Moderate	High
53	Seepage	B	High	Moderate	Very High
54	Seepage	B	High	Moderate	Very High
75	Seepage	B	Moderate	Moderate	Very High
76	Seepage	B	High	Moderate	Very High
79	Seepage	A	High	Moderate	Very High
82	Seepage	B	High	Low	Very High
83	Seepage	A	High	Moderate	Very High
84	Seepage	B	High	Moderate	Very High
85	Seepage	B	High	Moderate	Very High
86	Seepage	A	High	Moderate	Very High
87	Seepage	A	Very High	Low	Very High
89	Seepage	B	Very High	Low	Very High
92	Seepage	A	High	Moderate	Very High
93	Seepage	D	High	Low	High
94	Seepage	D	High	Moderate	High
106	Channelled Valley-Bottom	C	Moderate	High	High

The bulk of the wetlands were in natural to moderately modified conditions, with instream farm dams, roads, grazing pressures and channel erosion being the most significant forms of disturbance.

The numerous small gravel dams and road crossings, found with most of the wetland features have had a low-moderate to moderate impact on the flow character of these wetland features as well as local vegetation cover and bed and channel morphology, however these impacts are mainly associated with a small area surrounding the source of the impact. Erosional features are also a common feature around theses disturbed areas. Vegetation cover, in some areas, have been somewhat historically transformed due to historical land use practices (cattle grazing).

"*The Ecological Importance and Sensitivity (EIS) of a wetland is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).*

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:
» Ecological Importance;
» Hydrological Functions; and
» Direct Human Benefits

A summary of the EI&S importance assessment scores and ratings for wetlands is provided in Table 11 above. The ES has been adjusted as follows:

- » All wetland features with high lateral and longitudinal connectivity, especially in relationship to other wetland features have been upgraded to very high sensitive (Figure 17 and **Error! Reference source not found.**) due to the fact that these features, collectively contribute significantly to biodiversity maintenance, spatial heterogeneity, hydrological connectivity. Collectively these areas form ecological corridors for the movement of fauna and flora. Furthermore, these habitats provide valuable habitat for faunal Species of Conservation Concern (SCC) including:
    - Serval (*Leptailurus serval*): Near Threatened;
    - Vlei rat (*Otomys irroratus*): Near Threatened; and
    - Cape clawless otter (*Aonyx capensis*): Near Threatened.

» All endorheic wetland features, wetland features that are not directly connected to the larger extensive wetland network or that have been fractured/isolated through agricultural practices are classified as High Sensitive (Figure 17 and **Error! Reference source not found.**). Even though these wetland features do not provide functions and services to the extent of the more connected and larger wetland features, these wetlands still provide some functions and services. Furthermore, most of these wetland features are fairly small and any direct impacts on these wetland habitats may have a significant impact on the drivers of these wetland features as well as the associated biodiversity. Another feature of these wetlands is the fact that, even though small in size, they are located within relatively small catchment areas, thus these wetlands' percentage coverage in relationship to their catchments are fairly significant, making these wetland features vulnerable to catchment disturbances.

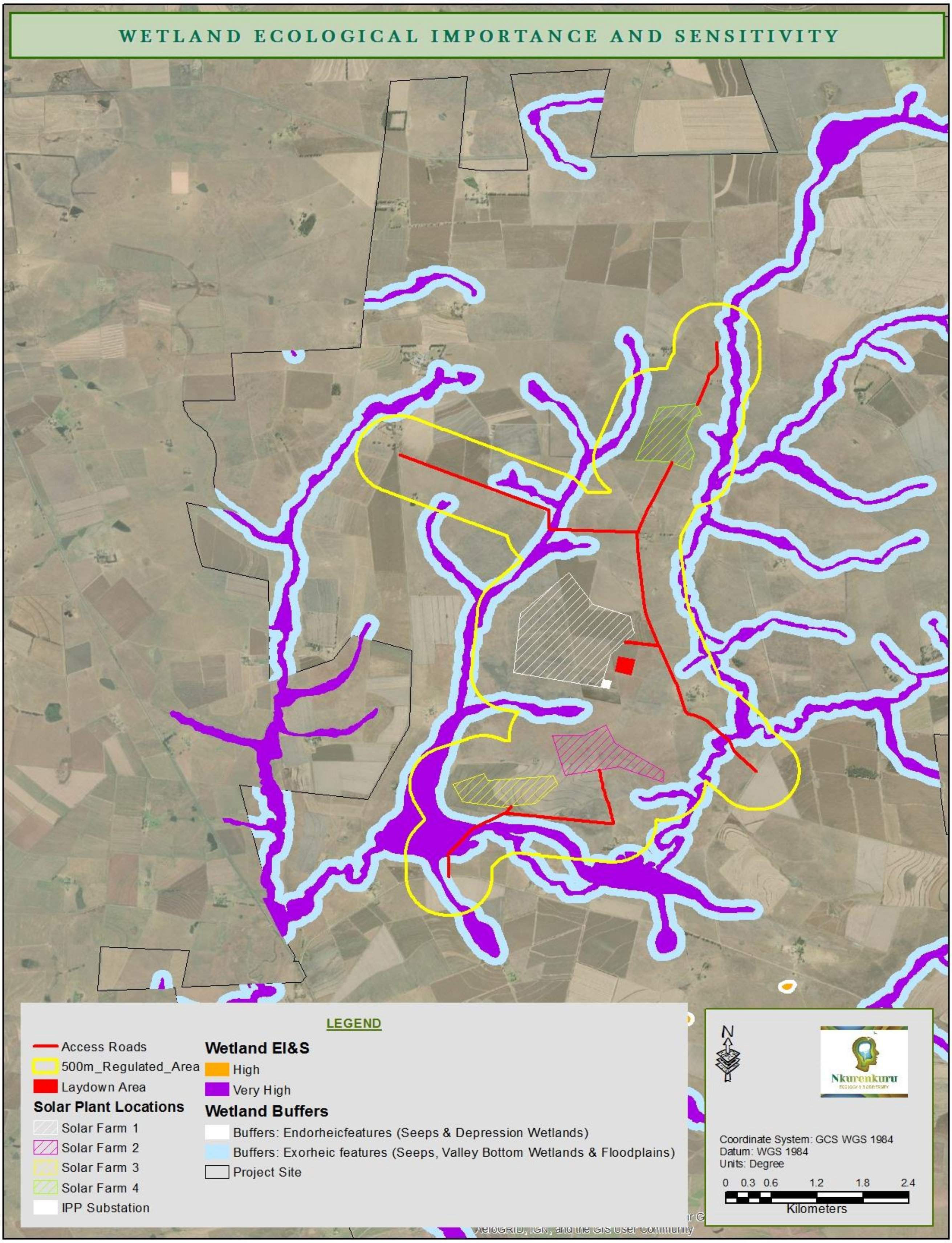

Figure 17: Wetland/Freshwater Resource Sensitivity mapping of the 500m regulated area.

5.6. Wetland Buffer Zones

The 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 project site.

» The following buffer areas are recommended, and should be implemented for maintaining the freshwater resource features REC (Recommended Ecological Category) allowing the persistence of the current present ecological status as well as their functions and services.
  - All small, endorheic seepages and depressions with a High Ecological Importance: 50m buffers from the outer edge of the freshwater resource features (Figure 17 and **Error! Reference source not found.**) .
  - All larger interconnected wetland features with Very Ecological Importance: 100m buffers from the outer edge of the freshwater resource features (Figure 17 and **Error! Reference source not found.**).

» All freshwater features with their buffer areas have been classified as either Very High- or High sensitive and should be regarded as "No-Go" areas apart from the following activities and infrastructure which may be allowed (although restricted to an absolute minimum footprint):
  - only activities relating to the route access and cabling:
    - the use/upgrade of existing roads and watercourse crossings are the preferred options.

6. ASSESSMENT OF PROPOSED IMPACTS

6.1. Identification of Potential Impacts and Associated Activities (General)

Freshwater ecosystems, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to these ecosystems. When making inferences on the impact of development activities on aquatic ecosystems it is important to understand that these impacts speak specifically to their effect on the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) or functional importance/value of aquatic ecosystems. All of these are linked to the physical components and processes of aquatic ecosystems, including hydrology, geomorphology and vegetation as well as the biota that inhabit these ecosystems. Anthropogenic activities can generally impact either directly (e.g. physical change to habitat) or indirectly (e.g. changes to water quantity & quality). Figure 18 shows how impacts to aquatic ecosystems such as habitat loss, flow modification and pollution can have a number of negative ecological consequences for the receiving aquatic environment, ranging from loss of sensitive species to reduced ecosystem goods & services provision.

Freshwater resource ecological impacts associated specifically with Ummbila WEF is discussed below. Potential impacts have been split into Construction- and Decommissioning Phase Impacts and Operational Phase Impacts.

According to the proposed layout, construction, operation and decommission will lead to potential direct and potential indirect loss of / or damage to freshwater resource features. This may potentially lead to localised loss of freshwater resources and may in-turn lead to downstream impacts that affect a greater extent of freshwater resources or impact on function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to freshwater resource features can have an impact on the functioning of those features.

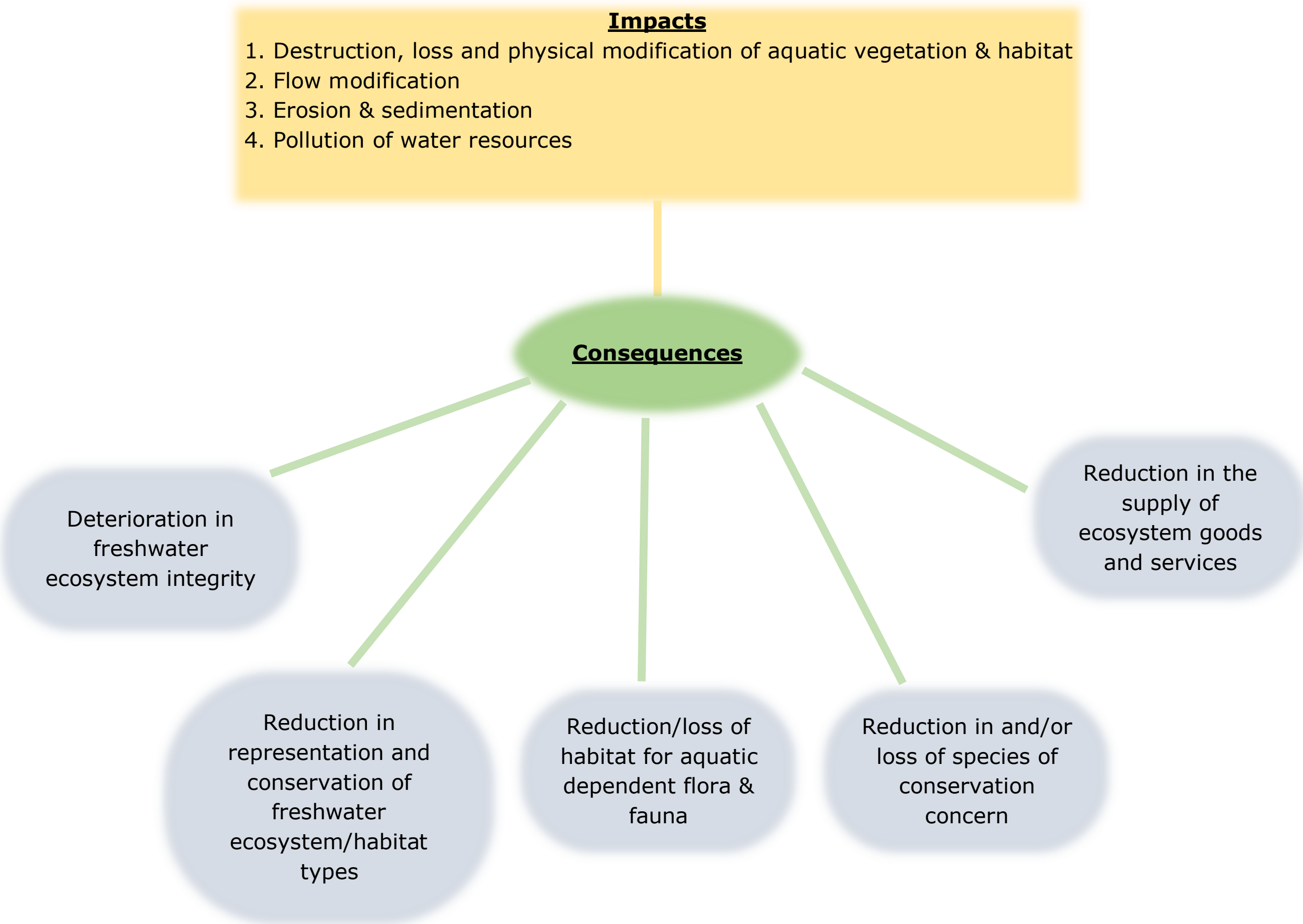

Figure 18: Negative ecological consequences for Freshwater Resource Features as a result of direct and indirect anthropogenic impacts.

6.2. Impact of Proposed Solar Panels and Supporting Infrastructure

Construction and Planning Phase

SEFs require an initial high intensity disturbance of a fairly large surface area including the clearance of the vegetation cover and the levelling of earth on different terraces where necessary and the compaction of local soil within the development footprint. Concrete foundations for the framework on which the PV panels will be mounted. Soil disturbance, vegetation clearance and hardened surfaces will also be associated with the construction of access and internal roads within the PV solar facility. The internal substation would also need to be constructed within the site. Temporary laydown and storage areas would need to be placed within the site for the construction works.

All of the above-mentioned supporting infrastructure (apart from access roads) are located well outside any freshwater resource features as well as their associated buffer areas and as such impacts on freshwater resource features will be avoided.

In terms of the location of the PV solar facilities, none of these proposed facilities are located within any of the delineated freshwater resource features as well as their recommended buffer areas and as such direct impacts on freshwater resource features will be avoided.

Activities during the construction phase of the project will result in local disturbance of vegetation cover during clearing and site preparation, this may potentially lead to some indirect impacts on downslope freshwater resource features. 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 concrete for wind turbines and other construction activities.

Generally, with mitigation measures in place, impacts will be localised, short-term and of low intensity and is expected to have 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 facilities will operate continuously, mostly unattended and with low maintenance required for the duration of the SEFs lives (±20 years). The SEFs is likely to be monitored and controlled remotely, with maintenance only taking place when required.

The PV panels as well as the hard surfaces created by the development may lead to increased runoff (reduction in infiltration) and the potential interception and channelling of surface runoff, particular on surfaces with a steeper gradient. This may potentially lead to:

- A modification to the water input characteristic (input in quantity and a change in water input pattern);
- Increased erosion;
- Sedimentation of the downslope areas; and
- Impairment of freshwater resource functions and services

Subsequently, a localised long-term impact (more than 20 years) of moderate to low intensity (depending on the distance between the PV panels 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 freshwater resource features in the area.

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.

6.2.1. Impact of Proposed Associated Linear Infrastructure (Access Roads)

Construction and Planning Phase

The internal access roads will need to cross some freshwater resource features, all of which will be on existing gravel roads.

The proposed construction will involve the upgrade of the existing local road network and where no available routes are available, new routes will be constructed. It is envisaged that most of the proposed road development will be an upgrade of existing infrastructure, with only limited construction of new road sections and will include some of the typical activities described in the table below (Table 12 listing the activities likely to be associated with this development), taken from the South African pavement engineering manual, Chapter 12: Construction Equipment and Method Guidelines (SANRAL).

Table 12: Activities likely to be associated with this development.

Road Construction Activity	IMPORTANCE SCORES (0-4) AND RATINGS
Roadbed preparation	Clearing of vegetation and associated organic material (roughly 200 mm) below the natural ground level and potentially up to 5m to the sides of the planned route. » Where necessary, and possible, subsurface drainage is provided to drain the roadbed and ensure that dry conditions prevail. » The quality of the in-situ soils are assessed to ensure compliance with the minimum requirements. Any unsuitable material is removed and replaced or treated to facilitate compaction of the pavement layers over this layer. The roadbed must be effectively compacted to achieve the required density and in-situ shear strength.
Fills	Construction of fill embankments, either earth or rock fills will be required.
Cuts	Cutting back and stabilization of steep banks to prevent erosion.
Borrow Pit Establishment	Excavation, crushing and processing of appropriate stone materials required for construction.
Crushed stone base	This involves the construction of crushed stone and crushed slag-based layers. A crushed stone base is the most popular base in pavements constructed in South Africa.
Compaction of soils and gravels	Compaction of material layers is one of the most important determinants of the performance of a constructed fill or pavement structure. The effect of compaction on a material is to improve particle interlock and to reduce the voids between the particles.
Cementitious stabilisation	Stabilising road building material with cementitious agents such as cement and lime, or blends of cement with mineral components such as fly ash, ground granulated blast furnace slag and limestone is common practice in South Africa.
Modification of materials	In many situations, the available gravels do not meet the necessary requirements for the pavement layer. In these cases, the materials can be modified. Several

	physical or natural methods of modification are available, which are used depending on the availability of materials. Should the necessary material not be available, then chemical modification may be used.
Concrete pavements	Concrete pavements are rigid pavement structures that are generally constructed using slipform or side form pavers.
Proprietary products	The construction of layers using proprietary products is essentially the same as the construction of granular layers. The products are typically used as a compaction aid for granular materials. The manufacturer may, however, have special requirements that should be followed.
Construction of watercourse crossings	This includes the construction of culverts and bridges where the road crosses watercourses. These crossings are designed according to SANRAL's Drainage manual with a key focus on limiting the risk of damage to the road from flooding.
Installation of road drainage	Surface drainage involves the installation of a drainage system to effectively remove water from the road surface in order to limit risks to road users. This includes the construction of surface drainage, minor culverts and discharge points to deflect flows away from the road surface and sensitive embankments.
Cold recycling	Recovery and reuse of material from an existing pavement without the addition of heat. The cold recycling process, which has become a very popular construction method since the introduction of in-situ recycling machines. The shortage of construction material, especially in built-up areas, has resulted in the process becoming very popular as a rehabilitation option for strengthening pavement layers

In terms of watercourse crossings, the following methods/options will most likely be used:

» For seasonal to ephemeral watercourses with sandy substrates and gentle gradients:
  - Stabilising of road structures up to level of watercourse bed, so water continues to flow across the road.
» For larger seasonal watercourses with stronger flows, deeper channels and steeper embankments:
  - Building up of the road structure to level of terrestrial land adjacent to river bed, with culver systems incorporated for water to pass below road.

The major direct impacts associated with the internal roads relate to the:

» Transformation and/or loss of habitat within the rivers and riparian areas (e.g. habitat infilling for road fill embankments, alteration of profiles at crossings)
» Transformation and/or loss of indigenous vegetation within the riparian zones;
» Potential invasive alien plant growth;
» Potential flow and water quality impacts; and
» Potential impacts on the soil (erosion of watercourse channels).

Wetland and riverine vegetation and habitat can be impacted directly through the complete removal or partial disturbance of existing indigenous riparian and wetland vegetation during the construction of the watercourse/wetland crossings (stripping of vegetation and infilling), leading to the deterioration in the ecological condition of aquatic vegetation and availability of habitat supporting aquatic biota. This is associated with the construction footprint being located within or across a watercourse/wetland and by machinery and workers accessing the site. In many cases, clearing and disturbance is not only limited to the construction zone and may include areas used by machinery and workers to access the site and to construct temporary drainage, storm water and erosion control measures. The result is either the complete loss or the disturbance and partial loss of indigenous vegetation communities and habitat in the broader area. Likely secondary consequences of such direct physical disturbance impacts include a reduction in channel bank stability, exposed bank erosion and in-stream, riparian and wetland habitat sedimentation down slope and downstream. Also, in general, with increased human presence associated with construction projects, increased pressure on natural resources may result through the hunting/poaching/trapping of fauna as well as the harvesting of indigenous plants for various uses. Noise and dust caused by human activities can also affect the use of adjoining habitat by various species. The construction/upgrade of the watercourse/wetland crossings will result in the trampling and destruction of watercourse/wetland vegetation. Excavation activities associated with the road crossings and the installation of the underground cables, will require complete and permanent (for road crossings) removal of vegetation within the watercourses/wetlands. Movement of construction vehicles within the construction sites will also result in trampling of vegetation within the watercourses and riparian zones and could extend beyond the immediate watercourse/wetland crossing footprints for access purposes.

Local loss of riparian, instream and wetland vegetation and habitat, within the vicinity of the construction area. Careless and uncontrolled construction activities can result in a deterioration in the Present Ecological Status of these watercourse reaches and wetlands as well as reduce the ability of these features to fulfil their functions and services. However, the magnitude/severity of these impacts can be greatly reduced (to acceptable levels) through the implementation of effective mitigation measures. Such mitigation measures will ensure that the RECs of the affected watercourse reaches and wetlands are preserved and that impacts are restricted to a local scale (within the vicinity of the construction area). The preparation of the roadbed involves the complete removal of all existing indigenous vegetation and topsoil within the road footprint. The impact from clearing and disturbance is not limited to the construction zone however and will include areas used by machinery and workers to access the site and to construct ancillary infrastructure such as road drainage and erosion control measures. The result is either the complete loss (within the road bed and embankment footprint) or the disturbance and partial loss of indigenous vegetation communities (broader road reserve), impacting directly on the ecological condition and functionality of these ecosystems.

Potential indirect impacts associated with the internal roads may include the following:

» Habitat fragmentation: Fragmentation of habitat and reduced ecological connectivity
    - Alteration in faunal movement and floral dispersal (impacting plant species recruitment):

- Interruption of important movement/migration corridors.
- » Reduced habitat patch size and core to edge ratio
  - Increased stress to sensitive habitats and species, alteration of the composition of communities and the displacement of sensitive species.
- » Increased intensity of edge disturbances, as a result of construction activities (e.g. noise, dust and light pollution)
  - Alteration of the composition of communities and the displacement of freshwater fauna sensitive to human presence, noise pollution and light pollution.
  - Increased intensity of dust pollution, smothering of vegetation with dust, increased plant stress and mortality, alteration of plant species composition, degradation in habitat condition.
- » Invasion of construction corridor with alien invasive species and increased alien invasive propagule sources within proximity to the freshwater habitats. Increased alien invasive plant invasion, alteration of plant species composition, degradation of freshwater habitat.

Based on the current layout five freshwater resource features (wetlands) will be crossed by access roads (Figure 11). All wetland road crossings will occur along existing crossings and these roads will merely be upgraded. A localised short- and longer-term impact of low significance is expected on the identified freshwater resource ecosystems in the area at the points at which the infrastructure will need to cross the 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.

6.2.2. Operation Phase:

An impact of very low significance is expected on any of the aquatic features that would be associated with maintenance activities and the fact that there will be a limited increase in the extent of new road surface area (existing roads will be upgraded and include all of the wetland road crossings).

A localized longer-term impact of low intensity may occur, that is expected to have a low overall significance in terms of its impact on the identified aquatic ecosystems in the area.

The longer-term maintenance activities during the operation phase: Road development across watercourses/wetlands and in the vicinity of watercourses/wetlands is likely to introduce unnatural disturbance to the aquatic ecosystems and habitat and generally promotes the establishment of disturbance-tolerant species, including colonization by Invasive Alien Plants (IAPs), weeds and pioneer plant species, particular where there is an existing seed source for these plants nearby. Although this impact is initiated during the construction phase of the project, it is likely to persist well into the operation phase. IAPs can have far-reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss in South Africa. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, promote erosion, change litter accumulation and soil properties and promote of suppress fire. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses.

Potential impacts associated with the internal roads may include the following:

- » Direct transformation and modification of habitat
  - Direct destruction and/or disturbance of aquatic habitats during maintenance and repair activities. This may intern have an effect on local functionality and biota.
  - Indirect impacts resulting from the alteration of hydrological and geomorphic processes as a result of activities outside of and within the freshwater resource features.
- » The slight increase in road surface will likely result in a minimal increase in surface runoff / stormwater discharges to the freshwater resource features. Road networks tend to intercept, direct and concentrate flows which potentially may change the volume and timing of peak flows reaching aquatic ecosystems. This increase in peak discharge may increase the stream power, thereby increasing the risk of erosion and channel incision. In addition, the diversion of flow through culverts at road crossings will narrow the width of the flow / concentrate flows and increase the velocity of flows at the culvert outlets. These impacts may result in the following consequences:
  - Stream bed and bank erosion (incision and widening)
  - Increase in sediment inputs to downstream freshwater ecosystems/habitats, subsequently affecting the movement of water and water quality.

Due to the nature of the development, there will be some permanent local loss of vegetation and habitat (road surface, stormwater infrastructure). However, there is a potential for some rehabilitation along the areas adjacent the watercourse/wetland crossing infrastructure. It is extremely important to restrict disturbances and activities to a small as possible footprint area, preventing any unnecessary disturbances, outside of these footprints. Also as previously mentioned (Construction Phase), all of these watercourse/wetland crossings will be long already disturbed areas (upgrade of existing watercourse crossings). Subsequently, the extent of permanent habitat/vegetation loss will be reduced to an acceptable level without threatening the impacted watercourse and wetland RECs. These disturbed areas may also, furthermore, be prone to the invasion of IAPs, however the magnitude/threat of this impact is regarded as moderate due to the low presence of IAPs within the area as well as the harsh climatic conditions.

6.2.3. 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

6.3. Assessment of Impacts

CONSTRUCTION PHASE		
Impact 1: Loss of freshwater resource features during the construction.		
Environmental Parameter	Direct (access roads) and indirect (all other infrastructure) physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of riparian/wetland habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of watercourse/wetland geomorphological profiles (including stream beds and banks).	
Issue/Impact/Environmental Effect/Nature	Possible ecological consequences may include: » Reduction in representation and conservation of freshwater ecosystem/habitat types; » Reduction in the supply of ecosystem goods & services; » Reduction/loss of habitat for aquatic dependent flora & fauna; and » Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species). As already mentioned, » Internal roads and the underground cabling option are the only two aspects that will directly impact aquatic habitats through the direct disturbance and replacement of the of riparian/aquatic/wetland zones along the crossing points, These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in the loss and/or damage to vegetation and alteration of natural geomorphological and hydrological processes within the freshwater resource features. Compacted soils are also not ideal for supporting vegetation growth as they inhibit seed germination.	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Permanent (5)	Long-term (4)
Magnitude	Moderate (5)	Minor (3)
Probability	Probable (3)	Probable (3)
Significance	**Medium (39)**	**Low (24)**
Status	Negative	Negative

Reversibility	Low – Destruction of wetland vegetation will not be remedied easily.	Low – Destruction of wetland vegetation will not be remedied easily.
Irreplaceable loss of resources	Local loss of resources	No loss of resources
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and where deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).	
Mitigation: Internal Access Roads	» Existing crossings should be utilized/upgraded; » During construction, disturbance to the freshwater ecosystems should be limited as far as possible. » Engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian vegetation (reduce footprint as much as possible). » All crossings over watercourses/wetlands should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river/wetland channel. » The erosion and stormwater management measures included in the stormwater management plan for the SEF must be implemented. » During the construction phase, monitor culverts to see if erosion issues arise and if any erosion control is required. » Where possible, culvert bases must be placed as close as possible with natural levels in mind so that these don't form additional steps / barriers. » Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » All alien plant re-growth must be monitored, and should it occur, these plants should be eradicated. » Road infrastructure and cable alignments should coincide as far as possible to minimise the impact. » Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required.	
Mitigation:	» The underground MV cabling, where crossing watercourses/wetlands, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder.	

Underground MV cabling	» Ideally the construction disturbance footprint should be kept to an area no wider than 5 m. » All material stockpiles should be located outside freshwater resource features. » Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench; » Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). » Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed. » The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. » If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented. » There should be reduced activity at the site after large rainfall events when the soils are wet. » No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion. » During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. » Disturbed areas may need to be rehabilitated and revegetated.	
Residual Impacts	Without Mitigation: » Locally altered vegetation structure, » Possible impact on the remaining catchment due to changes in run-off characteristics in the development site. With Mitigation: » Residual impacts are unlikely to occur within these freshwater resource habitats.	
Impact 2: Increase in sedimentation and erosion.		
Environmental Parameter	Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition	
Issue/Impact/Environmental Effect/Nature	Caused by soil erosion and earthworks that are associated with construction activities. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and » Reduction/loss of habitat for aquatic dependent flora & fauna. This may furthermore, influence water quality downstream	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)

Duration	Long Term (4)	Short Duration (2)
Magnitude	Moderate (6)	Minor (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (18)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Local loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off. » Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas.	
Mitigation: Internal Access Roads	» The duration of construction work within the watercourses/wetlands must be minimised as far as practically possible through proper planning and phasing. » Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » Any erosion problems observed during the construction phase should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas. o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective	

	» Construction of gabions and other stabilisation features to prevent erosion must be undertaken, if deemed necessary. » Under no circumstances must new channels be created for flow diversion and conveyance purposes unless approved as part of an EA or WUL » No stormwater runoff must be allowed to discharge directly into any watercourse/wetland along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation. » There should be reduced activity during the construction phase at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » Existing crossings should be utilized/upgraded; » Where no existing crossings are available the construction of new crossings can be considered. o Where new watercourse/wetland crossings are required, the engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian/wetland vegetation (reduce footprint as much as possible). o All crossings over watercourses/wetlands should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel/ and wetland feature. o During the construction phase, monitor culverts to see if erosion issues arise and if any erosion control is required. o Where possible, culvert bases must be placed as close as possible with natural levels in mind so that these don’t form additional steps / barriers. o Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor’s EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).
Mitigation: Underground MV Cables	» The underground MV cabling, where crossing watercourses/wetlands, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder. » All construction activities occurring directly within the watercourses/wetlands to take place within the dry season. » Ideally the construction disturbance footprint should be kept to an area no wider than 5 m. » Regular monitoring for erosion. o Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. o Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. o Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed.

	o Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain. » The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. » If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented. » There should be reduced activity at the site after large rainfall events when the soils are wet. » No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » Watercourse/wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel. The immediate crossings within a watercourse/wetland area is therefore permissible for trenching as well as the associated machinery, vehicles and construction personnel. » Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench; » Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.
Impact 3: Potential impact on localised surface water quality.	
Environmental Parameter	Alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and » Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).
Issue/Impact/Environmental Effect/Nature	During preconstruction and construction, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery, construction and maintenance activities could be washed downslope via the ephemeral systems.

	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Very Short Duration (1)	Very Short Duration (1)

Magnitude	Moderate (7)	Minor (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (12)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Local loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, and all supporting infrastructure	» Implement appropriate measures to ensure strict use and management of all hazardous materials used on site » Implement appropriate measures to ensure Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.) » Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site. » Implement appropriate measures to ensure strict control over the behavior of construction workers. » Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced. » Appropriate ablution facilities should be provided for construction workers during construction and on-site staff during the operation of the substation and WEF.	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

OPERATIONAL PHASE		
Impact 4: Impact on watercourse/wetland systems through the possible increase in surface runoff on watercourse/wetland form and function during the operation and decommissioning phases.		
Environmental Parameter	Alteration to the hydrological character of the freshwater resource features	
Issue/Impact/Environmental Effect/Nature	This might occur during the operation phase, when hard or compacted surfaces (hard engineered surfaces, roads etc.) increase the volume and velocity of the surface runoff. This could impact the hydrological regime through the increase in flows that are concentrated in certain areas. If flows are too concentrated with high velocities, scour and erosion may occur, with a complete reduction or disturbance of riparian habitat.	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Whole Site (2)	Local (1)

Duration	Long Term (4)	Long Term (4)
Magnitude	Moderate (6)	Minor (4)
Probability	Highly Probable 4)	Probable (3)
Significance	**Medium (48)**	**Low (27)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Unlikely	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» Any storm-water within the site must be handled in a suitable manner as per the management measures in stormwater management plan » Stormwater from bare, compacted areas, hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas. » No stormwater runoff must be allowed to discharge directly into the watercourses. o 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. » Stormwater run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any stormwater leaving the WEF site.	
Mitigation: Internal Access Roads	» No stormwater runoff must be allowed to discharge directly into any water course along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation. » For the crossing of small seasonal to ephemeral watercourses with sandy substrates and gentle gradients: o Road structures should be stabilized up to the level of the watercourse bed to allow for natural flow across the road. o It is crucial that the road surface is level within the watercourse without any flow concentration. » Where the road structure will be built up to the level of the terrestrial land adjacent to the river bed (larger seasonal watercourses with stronger flows, deeper channels and steeper embankments): o Engineering team must provide an effective means to allow/simulate natural flow patterns without the consecration/modification of flow through the culverts which must be incorporated into the detailed stormwater management plans based on the final design of the Pofadder WEF 1. o Culverts should be sized to transport not only water, but other materials that might be mobilized (i.e. debris) and cause blockages to flow. o Appropriate erosion protection measures must be installed to reduce bed erosion / scour. » The base (invert) of culverts must be aligned with the natural ground level of the bed of the channel to limit risks of erosion. Where necessary, additional measures such as drop-inlets or stepped inlet weirs must be constructed to address such risks.	

Mitigation: Underground Grid Line Option	» The underground grid line, where crossing watercourses, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder. » Refer to the mitigation measures provided below addressing sedimentation and erosion.	
Residual Impacts	Altered streambed/wetland morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.	
Impact 5: Increase in sedimentation and erosion		
Environmental Parameter	Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition	
Issue/Impact/Environmental Effect/Nature	For the operation phase, this refers to the alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition, caused by soil erosion, as well as instability and collapse of unstable soils during project operation. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and Reduction/loss of habitat for aquatic dependent flora & fauna.	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Long Term (4)	Very Short Duration (1)
Magnitude	Moderate (6)	Minor (4)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (18)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Local loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Any storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Site rehabilitation should aim to restore surface drainage patterns, natural soil and vegetation as far as is feasible. » An erosion control management plan should be utilised to prevent erosion » Erosion control measures such as silt fences (for areas of works) and gravel strips may be considered at the impact zone where water falls from the solar panels onto the soil surface (due to deterioration in	

	natural grassland because of poor maintenance or lack of solar radiation). » Storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the Solar PV site. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas.
Mitigation: Access Roads	» Any disturbed areas should be encouraged to be rehabilitated as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas. o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective
Mitigation: Underground MV Cabling	» Regular monitoring for erosion. o Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. o Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » The areas where vegetation is destroyed and disturbed will need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. » If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented.
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.

DECOMMISSIONING PHASE	
Impact 6: *Loss of freshwater resource features*.	
Environmental Parameter	Direct physical destruction or disturbance of aquatic habitat caused by vegetation disturbance of riparian/wetland habitat, encroachment/colonisation of habitats by invasive alien plants and

	alteration of river/wetland geomorphological profiles (including stream beds and banks).	
Issue/Impact/Environmental Effect/Nature	Possible ecological consequences may include: » Reduction in representation and conservation of freshwater ecosystem/habitat types; » Reduction in the supply of ecosystem goods & services; » Reduction/loss of habitat for aquatic dependent flora & fauna; and » Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species). As already mentioned, » Internal roads and the underground cabling option are the only two aspects that will directly impact aquatic habitats through the direct disturbance and replacement of the of riparian/aquatic/wetland zones along the crossing points, These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in the loss and/or damage to vegetation and alteration of natural geomorphological and hydrological processes within the freshwater resource features. Compacted soils are also not ideal for supporting vegetation growth as they inhibit seed germination.	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Permanent (5)	Long-term (4)
Magnitude	Moderate (6)	Minor (4)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (56)**	**Low (27)**
Status	Negative	Negative
Reversibility	Low – Destruction of wetland vegetation will not be remedied easily.	Low – Destruction of wetland vegetation will not be remedied easily.
Irreplaceable loss of resources	Local loss of resources	No loss of resources
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» Any areas disturbed during the decommissioning phase should be encouraged to be rehabilitated as fast and effective as possible and where deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).	

Mitigation: Internal Access Roads & Underground MV cabling Option	» During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. ▪ Disturbed areas will need to be rehabilitated and revegetated ▪ Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) will be required.	
Residual Impacts	Without Mitigation: » Locally altered vegetation structure, » Possible impact on the remaining catchment due to changes in run-off characteristics in the development site. With Mitigation: » Residual impacts are unlikely to occur within these freshwater resource habitats.	
Impact 7: Increase in sedimentation and erosion.		
Environmental Parameter	Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition	
Issue/Impact/Environmental Effect/Nature	Caused by soil erosion and earthworks that are associated with decommissioning activities. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and » Reduction/loss of habitat for aquatic dependent flora & fauna. This may furthermore, influence water quality downstream	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Long Term (4)	Short Duration (2)
Magnitude	Moderate (6)	Minor (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (18)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Local loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» Any erosion problems observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur. » There should be regular monitoring for erosion for at least 2 years after decommissioning by the applicant to ensure that no erosion problems develop as a result of the disturbance, and if they do, to immediately implement erosion control measures.	

	» All bare areas, affected by the development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential where applicable. » There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
Mitigation: Internal Access Roads & Underground MV Cabling Option	» The duration of decommissioning work within the watercourses/wetlands must be minimised as far as practically possible through proper planning and phasing. » Watercourse/wetland areas other than the immediate impact areas are to be demarcated as no-go areas for vehicles and construction personnel. The immediate decommissioning site within a watercourse/wetland area is therefore permissible for activities associated with the decommissioning phase. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » Any erosion problems observed during the construction and operational phases should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » There should be regular monitoring for erosion for at least 2 years after decommissioning by the applicant to ensure that no erosion problems develop as a result of the disturbance, and if they do, to immediately implement erosion control measures. » Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas. o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective » Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench; » Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). » There should be reduced activity during the decommissioning phase at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.
Impact 8: Potential impact on localised surface water quality.	
Environmental Parameter	Alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands &

	rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and » Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).	
Issue/Impact/Environmental Effect/Nature	During decommissioning, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery, construction and maintenance activities could be washed downslope via the ephemeral systems.	
	Pre-Mitigation Impact Rating	**Post Mitigation Impact Rating**
Extent	Neighbouring Areas (3)	Local (1)
Duration	Very Short Duration (1)	Very Short Duration (1)
Magnitude	Moderate (7)	Minor (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (12)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Local loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation Measures	» Implement appropriate measures to ensure strict use and management of all hazardous materials used on site » Implement appropriate measures to ensure Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.) » Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site. » Implement appropriate measures to ensure strict control over the behavior of construction workers. » Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced. » Appropriate ablution facilities should be provided for construction workers during construction and on-site staff during the operation of the substation and SEF.	

Residual Impacts	Residual impacts will be negligible after appropriate mitigation.

6.4. Cumulative Impacts

Existing renewable energy projects that were considered in terms of their potential cumulative terrestrial ecological impacts, that are in an approximate 30 km radius of the Ummbila Emoyeni SEF, are illustrated below in **Error! Reference source not found.**. Apart from the planned 666 MW Ummbila Emoyeni Wind Energy Facility, only four other renewable facilities are located within the 30 km radius namely:

» The proposed 9.5MW Forzando North Coal Mine PV Solar Facility to the north; and
» the 95.9MW Tutuka PV Solar Facility to the west;
» 200MW Hendrina South WEF; and
» 200MW Hendrina North WEF

Of the proposed renewable energy facilities, all except for the 9.5MW Forzando North Coal Mine PV Solar Facility and the tow Hendrina WEFs (South and North), are located within the Upper Vaal Water Management Area. Subsequently, the Forzando PV facility as well as the two Hendrina WEFs will be excluded from the cumulative assessment.

The proposed Ummbila WEF as well as the proposed Ummbila Solar PV Projects are located within Kwaggalaagt River's catchment which is an important tributary of the Blesbokspruit River. Subsequently these REF developments are likely to have a cumulative impact on this important freshwater resource feature as well as the wetland features associated with this river. The Tukuta PV facility is located within a separate quaternary catchment, with the Leeuspruit River being the primary drainage feature. As such this PV facility can also be excluded from the proposed cumulative impact assessment.

Based on the proposed location of the Ummbila Solar PV facilities, minimal freshwater resource features will be directly impacted by these PV facilities' road infrastructure (wetland road crossings). However, all of the proposed wetland road crossings will occur along existing crossings and as such these crossings will be merely upgrading, avoiding any significant impacts on these features. As such these PV facilities will not have a significant impact on the aquatic environment. In terms of the proposed Ummbila Emoyeni WEF development, the proposed layout indicates very limited impacts on the aquatic environment as the proposed structures, of this development, for the most part, will avoid delineated watercourses and wetlands, with the exception of unavoidable watercourse/wetland crossings by the proposed access roads.

Subsequently, the most significant potential impact associated with the project are as a result of the proposed upgrade of existing wetland road crossings, which can be mitigated such that its impact on the aquatic ecosystems will be of a low significance.

Subsequently it can be concluded that the cumulative impact of the proposed project would not be significant provided mitigation measures are implemented.

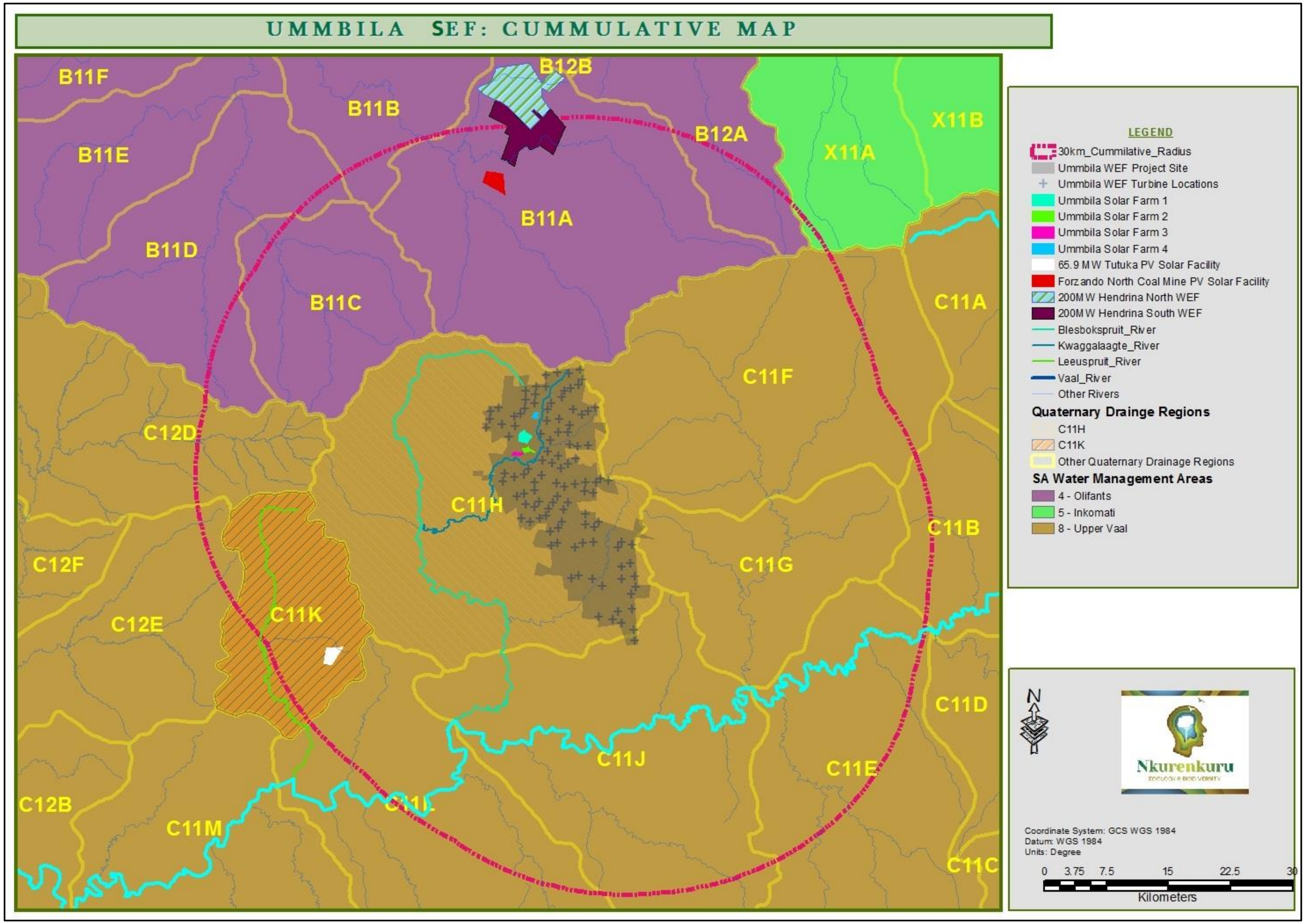

Figure 19: Location Map of the proposed Ummbila SEF relative to the other renewable facilities planned within a radius of 30 km.

CUMULATIVE IMPACTS		
Impact 9: Impact ecological processes as well as ecological functioning of important freshwater/wetland habitats associated with the Kwaggaspruit and Blesbokspruit Rivers.		
Environmental Parameter	Compromised ecological processes as well as ecological functioning of important habitats associated with the Kwaggaspruit and Blesbokspruit Rivers	
Issue/Impact/Environmental Effect/Nature	Transformation of intact freshwater resource habitats could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to habitat fragmentation and potential disruption of habitat connectivity and furthermore impair their ability to respond to environmental fluctuations. This is especially of relevance for larger watercourses and wetlands serving as important groundwater recharge and floodwater attenuation zones, important microhabitats for various organisms and important corridor zones for faunal movement	
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Local (2)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (2)	Minor (4)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (14)**	**Low (20)**
Status	Negative	Negative
Reversibility	Moderate to Low	Moderate to Low
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	
Mitigation: PV solar facilities, Substation and Laydown Areas (excluding roads and mv cabling)	» The potential stormwater impacts of the proposed developments 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.	
Mitigation:	» Existing crossings should be utilized/upgraded » The engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian vegetation (reduce footprint as much as possible).	

Internal Access Roads & MV Cabling Option	» All crossings over watercourses should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel, » During the construction and operation /decommissioning phases, monitor culverts to see if erosion issues arise and if any erosion control is required. » Where possible culvert bases must be placed as close as possible with natural levels in mind so that these don't from additional steps / barriers. » Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off. » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » All alien plant re-growth must be monitored and should it occur these plants should be eradicated. » 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. o 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.

7. CONCLUSION AND RECOMMENDATIONS

Nkurenkuru Ecology and Biodiversity was appointed by Windlab (Pty) Ltd to undertake the freshwater resource study and assessment for the proposed Ummbila Emoyeni Solar Energy Facility.

Emoyeni Renewable Energy Farm (Pty) Ltd is proposing the development of a commercial Solar Energy Facility and associated infrastructure on a site located ~6km south-east of Bethal and 1km east of Morgenzon, within the Mpumalanga Province.

This study has been commissioned to meet the requirements of the EIA process in the form of a EIA Assessment as set out by the National Environmental Management Act (1998) and a Water Use Licence Application as set out by the National Water Act (Act 36 of 1998). Furthermore, this study should and has been done in accordance with the "newly" Gazetted Protocols 3(a),(c) and (d) in terms of Section 24(5)(a) and 24(5)(h) of NEMA (Published on the 20th of March 2020); and meet the requirements as set out within the Aquatic Biodiversity Protocol published in GN NO. 1105 of 30 October 2020.

According to the guidelines specified within GN509 of 2016 all wetlands within a radius of 500m of the facility footprint were identified and mapped.

- A total of 28 freshwater resource features were identified and delineated within the 500m regulated area and include;
    - Five (5) channelled valley-bottom wetlands
    - One (1) unchanneled valley-bottom wetland,
    - Nineteen (19) seepage wetlands; and
    - Three (3) floodplain wetlands
- Only five wetland features will be impacted through access and underground cable route crossings.
- No other infrastructure is located within any freshwater resource feature.

Overall, with the exception of erosion, dams and present road crossings (most prominent impacts), these freshwater systems are still in a fairly natural, to moderate functional condition.

All wetland features with high lateral and longitudinal connectivity, especially in relationship to other wetland features have been upgraded to very high sensitive due to the fact that these features, collectively contribute significantly to biodiversity maintenance, spatial heterogeneity, hydrological connectivity. Collectively these areas form ecological corridors for the movement of fauna and flora. Furthermore, these habitats provide valuable habitat for faunal Species of Conservation Concern (SCC) including:

- Serval (*Leptailurus serval*): Near Threatened;

- Vlei rat (*Otomys irroratus*): Near Threatened; and
- Cape clawless otter (*Aonyx capensis*): Near Threatened.

All endorheic wetland features, wetland features that are not directly connected to the larger extensive wetland network or that have been fractured/isolated through agricultural practices are classified as High Sensitive. Even though these wetland features do not provide functions and services to the extent of the more connected and larger wetland features, these wetlands still provide some functions and services. Furthermore, most of these wetland features are fairly small and any direct impacts on these wetland habitats may have a significant impact on the drivers of these wetland features as well as the associated biodiversity. Another feature of these wetlands is the fact that, even though small in size, the are located within relatively small catchment areas, thus these wetlands' percentage coverage in relationship to their catchments are fairly significant, making these wetland features vulnerable to catchment disturbances.

The following buffer areas are recommended, and should be implemented for maintaining the freshwater resource features REC (Recommended Ecological Category) allowing the persistence of the current present ecological status as well as their functions and services.

- » All small, endorheic seepages and depressions with a High Ecological Importance: 50m buffers from the outer edge of the freshwater resource features.
- » All larger interconnected wetland features with Very Ecological Importance: 100m buffers from the outer edge of the freshwater resource features.

- » All freshwater features with their buffer areas have been classified as either Very High- or High sensitive and should be regarded as "No-Go" areas apart from the following activities and infrastructure which may be allowed (although restricted to an absolute minimum footprint):
  - only activities relating to the route access and cabling:
    - the use/upgrade of existing roads and watercourse crossings are the preferred options;
    - All underground cabling should be laid either within access roads or next to access roads (as close as possible).

With mitigation measures in place, impacts on the freshwater resource features' integrity and functioning can be potentially reduced to sufficiently low levels. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.

Based on the outcomes of this study it is my considered opinion that the proposed project detailed in this report could be authorised from a freshwater resource perspective.

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9. APPENDICES

Appendix 1 Specialist Curriculum Vitae

CURRICULUM VITAE:

Nkurenkuru

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
Postal Address	:	PO Box 12500 Brandhof 9324
Residential Address	:	3 Jock Meiring Street Park West Bloemfontein 9301
Cell Phone Number	:	084 207 3454
Email Address	:	gabotha11@gmail.com
Profession/Specialisation	:	Ecological and Biodiversity Consultant
Nationality:	:	South African
Years Experience:	:	8
Bilingualism	:	Very good – English and Afrikaans

Professional Profile:

Gerhard is a Managing Director of Nkurenkuru Ecology and Biodiversity (Pty) Ltd. He has a BSc Honours degree in Botany from the University of the Free State Province and is currently completing a MSc Degree in Botany. He began working as an environmental specialist in 2010 and has since gained extensive experience in conducting ecological and biodiversity assessments in various development field, especially in the fields of conventional as well as renewable energy generation, mining and infrastructure development. Gerhard is a registered Professional Natural Scientist (Pr. Sci. Nat.)

Key Responsibilities:

Specific responsibilities as an Ecological and Biodiversity Specialist include, inter alia, professional execution of specialist consulting services (including flora, wetland and fauna studies, where required), impact assessment reporting, walk through surveys/ground-truthing to inform final design, compilation of management plans, compliance monitoring and audit reporting, in-house ecological awareness training to on-site personnel, and the development of project proposals for procuring new work/projects.

Skills Base and Core Competencies

- Research Project Management
- Botanical researcher in projects involving the description of terrestrial and coastal ecosystems.
- Broad expertise in the ecology and conservation of grasslands, savannahs, karroid wetland, and aquatic ecosystems.
- Ecological and Biodiversity assessments for developmental purposes (BAR, EIA), with extensive knowledge and experience in the renewable energy field (Refer to Work Experiences and References)
- Over 3 years of avifaunal monitoring and assessment experience.
- Mapping and Infield delineation of wetlands, riparian zones and aquatic habitats (according to methods stipulated by DWA, 2008) within various South African provinces of KwaZulu-Natal, Mpumalanga, Free State, Gauteng and Northern Cape Province for inventory and management purposes.
- Wetland and aquatic buffer allocations according to industry best practice guidelines.
- Working knowledge of environmental planning policies, regulatory frameworks, and legislation
- Identification and assessment of potential environmental impacts and benefits.
- Assessment of various wetland ecosystems to highlight potential impacts, within current and proposed landscape settings, and recommend appropriate mitigation and offsets based on assessing wetland ecosystem service delivery (functions) and ecological health/integrity.
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to execution
- Qualitative and Quantitative Research
- Experienced in field research and monitoring
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa and include a number of projects located in sensitive and ecological unique regions.

Education and Professional Status

Degrees:

- *2015:* Currently completing a M.Sc. degree in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2009:* B.Sc. Hons in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2008:* B.Sc. in Zoology and Botany, University of the Free State, University of the Free State, Bloemfontein, RSA.

Courses:

- *2013*: Wetland Management (ecology, hydrology, biodiversity, and delineation) – University of the Free State accredited course.
- *2014*: Introduction to GIS and GPS (Code: GISA 1500S) – University of the Free State accredited course.

Professional Society Affiliations:

- The South African Council of Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400502/14 (Botany and Ecology).

Employment History

- December 2017 – Current: Nkurenkuru Ecology and Biodiversity (Pty) Ltd
- 2016 – November 2017: ECO-CARE Consultancy

- *2015 - 2016*: Ecologist, Savannah Environmental (Pty) Ltd
- *2013 – 2014*: Working as ecologist on a freelance basis, involved in part-time and contractual positions for the following companies
  - Enviroworks (Pty) Ltd
  - GreenMined (Pty) Ltd
  - Eco-Care Consultancy (Pty) Ltd
  - Enviro-Niche Consulting (Pty) Ltd
  - Savannah Environmental (Pty) Ltd
  - Esicongweni Environmental Services (EES) cc
- *2010 - 2012*: Enviroworks (Pty) Ltd

Publications

Publications:

- Botha, G.A. & Du Preez, P.J. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. S. *Afr. J. Bot*., **98**: 172-173.

Congress papers/posters/presentations:

- Botha, G.A. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. 41st Annual Congress of South African Association of Botanists (SAAB). Tshipise, 11-15 Jan. 2015.
- Botha, G.A. 2014. A description of the vegetation of the Nxamasere floodplain, Okavango Delta, Botswana. 10th Annual University of Johannesburg (UJ) Postgraduate Botany Symposium. Johannesburg, 28 Oct. 2014.

Other

- Guest speaker at IAIAsa Free State Branch Event (29 March 2017)
- Guest speaker at the University of the Free State Province: Department of Plant Sciences (3 March 2017):

References:

- Christine Fouché
  Manager: GreenMined (Pty) LTD
  Cell: 084 663 2399
- Professor J du Preez
  Senior lecturer: Department of Plant Sciences
  University of the Free State
  Cell: 082 376 4404

Appendix 2 Specialist Work Experience and References

WORK EXPERIENCES

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References

Gerhard Botha

ECOLOGICAL RELATED STUDIES AND SURVEYS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Ecological Assessment (Basic Assessment)	Moeding Solar
2019	Expansion of the Raumix Aliwal North Quarry, Eastern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	GreenMined
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Faunal and Flora Rescue and Protection Plan	Zevobuzz
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Zevobuzz
2018	Proposed Kruisvallei Hydroelectric Power Generation Scheme in the Ash River, Free State Province	Ecological Assessment (Basic Assessment)	Zevobuzz
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Ecological Assessment (Basic Assessment)	Eskom
2018	Clayville Thermal Plant within the Clayville Industrial Area, Gauteng Province	Ecological Comments Letter	Savannah Environmental
2018	Iziduli Emoyeni Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Emoyeni Wid Farm Renewable Energy
2018	Msenge Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Amakhala Emoyeni Renewable Energy

2017	H2 Energy Power Station near Kwamhlanga, Mpumalanga Province	Ecological Assessment (Scoping and EIA phase assessments)	Eskom
2017	Karusa Wind Farm (Phase 1 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	Soetwater Wind Farm (Phase 2 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Ecological Assessment	Savannah Environmental
2016 - 2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Ecological Assessment (Scoping and EIA phase assessments)	Cresco
2016	Buffels Solar 2 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	Buffels Solar 1 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	132kV Power Line and On-Site Substation for the Authorised Golden Valley II Wind Energy Facility near Bedford, Eastern Cape Province	Ecological Assessment (Basic Assessment)	Terra Wind Energy
2016	Kalahari CSP Facility: 132kV Ferrum–Kalahari–UNTU & 132kV Kathu IPP–Kathu 1 Overhead Power Lines, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Kalahari CSP Facility: Access Roads, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Karoshoek Solar Valley Development – Additional CSP Facility including tower infrastructure associated with authorised CSP Site 2 near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 7 and 8 Facilities near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 9 Facility near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Lehae Training Academy and Fire Station, Gauteng Province	Ecological Assessment	Savannah Environmental
2016	Metal Industrial Cluster and Associated Infrastructure near Kuruman, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Northern Cape Department of Economic Development and Tourism
2016	Semonkong Wind Energy Facility near Semonkong, Maseru District, Lesotho	Ecological Pre-Feasibility Study	Savannah Environmental
2015 - 2016	Orkney Solar PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015 - 2016	Woodhouse 1 and Woodhouse 2 PV Facilities near Vryburg, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy

2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Expansion of the existing Komsberg Main Transmission Substation near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Proposed Karusa Facility Substation and Ancillaries near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Eskom Karusa Switching Station and 132kV Double Circuit Overhead Power Line near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Karusa Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Facility Substation, 132kV Overhead Power Line and Ancillaries, near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Soetwater Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Expansion of the existing Scottburgh quarry near Amandawe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2015	Expansion of the existing AFRIMAT quarry near Hluhluwe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2014	Tshepong 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Transalloys circulating fluidised bed power station near Emalahleni, Mpumalanga Province	Ecological Assessment (for EIA)	Trans-Alloys
2014	Umbani circulating fluidised bed power station near Kriel, Mpumalanga Province	Ecological Assessment (Scoping and EIA)	Eskom
2014	Gihon 75MW Solar Farm: Bela-Bela, Limpopo Province	Ecological Assessment (for EIA)	NETWORX Renewables

2014	Steelpoort Integration Project & Steelpoort to Wolwekraal 400kV Power Line	Fauna and Flora Pre-Construction Walk-Through Assessment	Eskom
2014	Audit of protected *Acacia erioloba* trees within the Assmang Wrenchville housing development footprint area	Botanical Audit	Eco-Care Consultancy
2014	Rehabilitation of the N1 National Road between Sydenham and Glen Lyon	Peer review of the ecological report	EKO Environmental
2014	Rehabilitation of the N6 National Road between Onze Rust and Bloemfontein	Peer review of the ecological report	EKO Environmental
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks
2011	Rocks Farm chicken broiler houses	Botanical Assessment (for EIA)	EnviroWorks
2011	Botshabelo 132 kV line	Ecological Assessment (for EIA)	CENTLEC
2011	De Aar Freight Transport Hub	Ecological Scoping and Feasibility Study	EnviroWorks
2011	The proposed establishment of the Tugela Ridge Eco Estate on the farm Kruisfontein, Bergville	Ecological Assessment (for EIA)	EnviroWorks
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Vegetation Rehabilitation Plan for illegally cleared areas	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Invasive Plant Management Plan	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Protected and Endangered Species Walk-Through Survey	NEOTEL
2011	Optic Fibre Infrastructure Network, Swartland Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2011	Optic Fibre Infrastructure Network, City of Cape Town Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2010	Construction of an icon at the southernmost tip of Africa, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	New boardwalk from Suiderstrand Gravel Road to Rasperpunt, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	Farm development for academic purposes (Maluti FET College) on the Farm Rosedale 107, Harrismith	Ecological Assessment (Screening and Feasibility Study)	Agri Development Solutions
2010	Basic Assessment: Barcelona 88/11kV substation and 88kV loop-in lines	Botanical Assessment (for EIA)	Eskom Distribution
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks

WETLAND DELINEATION AND HYDROLOGICAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
In progress	Steynsrus PV 1 & 2 Solar Energy Facilities near Steynsrus, Free State Province	Wetland Assessment	Cronimet Mining Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Wetland Assessment (Basic Assessment)	Moeding Solar
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Wetland Assessment (Basic Assessment	Zevobuzz
2017	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy

2017	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Surface Hydrological Assessment (Basic Assessment)	Eskom
2017	Expansion of the Elandspruit Quarry near Ladysmith, KwaZulu-Natal Province	Wetland Assessment	Raumix
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Aquatic Assessment & Flood Plain Delineation	Savannah Environmental
2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Surface Hydrological Assessment (EIA phase)	Cresco
2016	Wolmaransstad Municipality 75MW PV Solar Energy Facility in the North West Province	Wetland Assessment (Basic Assessment)	BlueWave Capital
2016	BlueWave 75MW PV Plant near Welkom Free State Province	Wetland Delineation	BlueWave Capital
2016	Harmony Solar Energy Facilities: Amendment of Pipeline and Overhead Power Line Route	Wetland Assessment (Basic Assessment)	BBEnergy

AVIFAUNAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Avifauna Assessment (Basic Assessment)	Moeding Solar
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Avifauna Assessment (Basic Assessment)	Eskom
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Avifauna Assessment (Basic Assessment)	Eskom
2016	TEWA Solar 1 Facility, east of Upington, Northern Cape Province	Wetland Assessment (Basic Assessment	Tewa Isitha Solar 1
2016	TEWA Solar 2 Facility, east of Upington, Northern Cape Province	Wetland Assessment	Tewa Isitha Solar 2

ENVIRONMENTAL IMPACT ASSESSMENT

- Barcelona 88/11kV substation and 88kV loop-in lines – BA (for Eskom).
- Thabong Bulk 132kV sub-transmission inter-connector line – EIA (for Eskom).
- Groenwater 45 000 unit chicken broiler farm – BA (for Areemeng Mmogo Cooperative).
- Optic Fibre Infrastructure Network, City of Cape Town Municipality – BA (for Dark Fibre Africa (Pty) Ltd).
- Optic Fibre Infrastructure Network, Swartland Municipality – BA (for Dark Fibre Africa).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – EMP (for Eskom).
- Lower Kruisvallei Hydroelectric Power Scheme (Ash river) – EIA (for Kruisvallei Hydro (Pty) Ltd).
- Construction of egg hatchery and associated infrastructure – BA (For Supreme Poultry).

- Construction of the Klipplaatdrif flow gauging (Vaal river) – EMP (DWAF).

ENVIRONMENTAL COMPLIANCE AUDITING AND ECO

- National long haul optic fibre infrastructure network project, Bloemfontein to Laingsburg – ECO (for Enviroworks (Pty) Ltd.).
- National long haul optic fibre infrastructure network project, Wolmaransstad to Klerksdorp – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the Vredefort/Nooitgedacht 11kV power line – ECO (for Enviroworks (Pty) Ltd.).
- Mining of Dolerite (Stone Aggregate) by Raumix (Pty) Ltd. on a portion of Portion 0 of the farm Hillside 2830, Bloemfontein – ECO (for GreenMined Environmental (Pty) Ltd.).
- Construction of an Egg Production Facility by Bainsvlei Poultry (Pty) Ltd on Portions 9 & 10 of the farm, Mooivlakte, Bloemfontein – ECO (for Enviro-Niche Consulting (Pty) Ltd.).
- Environmental compliance audit and botanical account of Afrisam's premises in Bloemfontein – Environmental Compliance Auditing (for Enviroworks (Pty) Ltd.).

OTHER PROJECTS:

- Keeping and breeding of lions (*Panthera leo*) on the farm Maxico 135, Ficksburg – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of lions (*Panthera leo*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of wild dogs (*Lycaon pictus*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Existing underground and aboveground fuel storage tanks, TWK AGRI: Pongola – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Erf 171, TWK AGRI: Amsterdam – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 14 000 L of fuel (diesel) aboveground on Erf 32, TWK AGRI: Carolina – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 23 000 L of fuel (diesel) above ground on Portion 10 of the Farm Oude Bosch, Humansdorp – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 16 000 L of fuel (diesel) aboveground at Panbult Depot – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks, TWK AGRI: Mechanisation and Engineering, Piet Retief – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Portion 38 of the Farm Lothair, TWK AGRI: Lothair – Environmental Management Plan (for TWK Agricultural Ltd).