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KOTULO TSATSI ENERGY PV3, NORTHERN CAPE PROVINCE

FRESHWATER RESOURCE STUDY AND ASSESSMENT

Version: 1.0

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KOTULO TSATSI ENERGY PV3, NORTHERN CAPE PROVINCE.

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I. DECLARATION OF CONSULTANTS INDEPENDENCE

» act/ed as the independent specialist in this application;
» regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
» do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
» have and will not have any vested interest in the proposed activity proceeding;
» have disclosed, to the applicant, EAP and competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
» have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
» am aware that a false declaration is an offense in terms of regulation 48 of GN No. R. 326.

REPORT AUTHOR

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

31 March 2023

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);
- 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);
- The Aquatic Biodiversity Protocol published in GN NO. 1105 of 30 October 2020

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Refer to Appendix 2 for curriculum vitae, Appendix 3 for relevant work experience and Appendix 4 for SACNASP Registration.

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1. INTRODUCTION

Applicant

Savannah Environmental (Pty) Ltd. on behalf of Kotulo Tsatsi Energy (Pty) Ltd.

Project

The project will be known as Kotulo Tsatsi PV3.

Proposed Activity

The Applicant, Kotulo Tsatsi Energy (Pty) Ltd, is proposing the construction of a photovoltaic (PV) solar energy facility (known as the Kotulo Tsatsi Energy PV3) located on a site located approximately 70km south-west of the town of Kenhardt and 60km north east of Brandvlei in the Northern Cape Province. The solar energy facility will comprise several arrays of PV panels and associated infrastructure and will have a contracted capacity of up to 480MW. The facility will be located within the farm Portion 2 of Farm Styns Vley 280. The PV facility is planned to be located within an area previously authorised for CSP project infrastructure, which is adjacent to the authorised Kotulo Tsatsi Energy PV1 and PV2 Facilities as well as the authorised CSP3 facility and associated infrastructure. The project site falls under the Hantam Local Municipality which is part of Namakwa District Municipality. The site is accessible via an existing gravel farm road (known as Soafskolk Road) which provides access to the farm off of the R27 which is located east of the project site.

The PV infrastructure assessed in this application is in response to the Applicant's need to change the authorised generation technology for the facility located on the farm Portion 2 of Farm Styns Vely 280. That is, a technology change from the previously authorised CSP project infrastructure to PV project infrastructure. In this regard, the solar PV facility will be connected to the grid via a 132kV grid connection solution to the authorised 400kV collector substation located on Portion 2 of Farm Styns Vley 280, and will comprise on-site switching substations, facility substations and a 132kV power line within a 500m wide corridor.

A development area[1] of ~ 1840ha was defined through the Scoping evaluation of the site and has now been assessed for the facility footprint. The development footprint[2] has an extent of ~1200ha.

Infrastructure associated with the solar PV facility contracted capacity of up to 480MW will include (also refer to Figure 2):

- Solar PV array comprising PV modules and mounting structures.
- Inverters and transformers.
- Cabling between the project components.
- Access roads, internal distribution roads and fencing around the development area.
- Substation and BESS hubs, including:
  - Battery Energy Storage System (BESS)
  - On-site facility substations, switching substations
- 132kV power line within a 300m wide corridor to facilitate the connection between the PV Facility and the authorised 400kV collector substation.
- O&M and laydown area hub, including:
  - Site offices and maintenance buildings, including workshop areas for maintenance and storage.
  - Laydown areas and temporary construction camp area.

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[1] The development area is that identified area (located within the project site) where the Kotulo Tsatsi Energy PV3 facility is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints. The development area is ~1834ha in extent.

[2] The development footprint is the defined area (located within the development area) where the PV panel array and other associated infrastructure for Kotulo Tsatsi Energy PV3 is planned to be constructed. This is the actual footprint of the facility, and the area which would be disturbed.

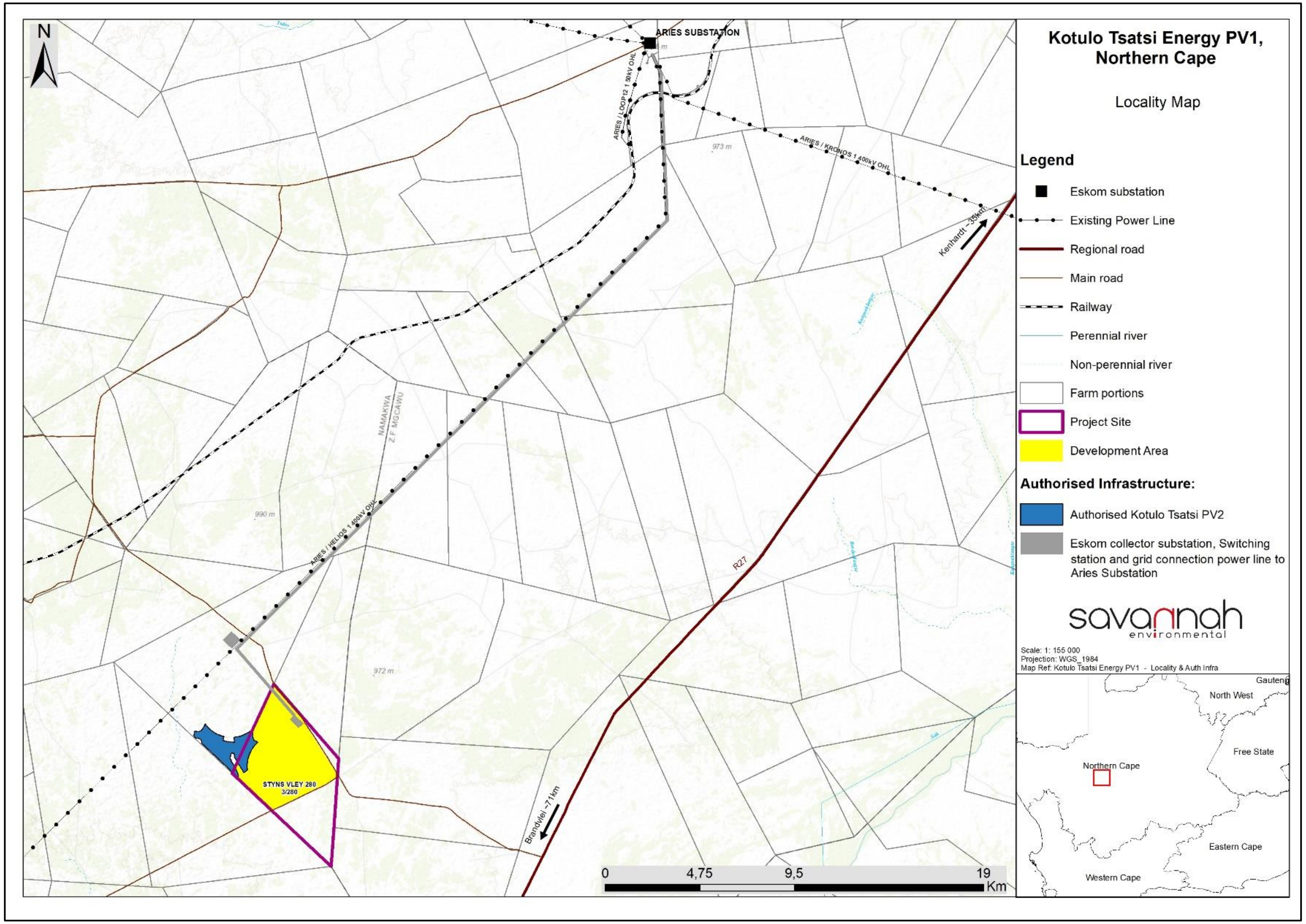

Figure 1: Location map of the proposed Kotulo Tsatsi PV 3 (Map provided by Savannah Environmental).

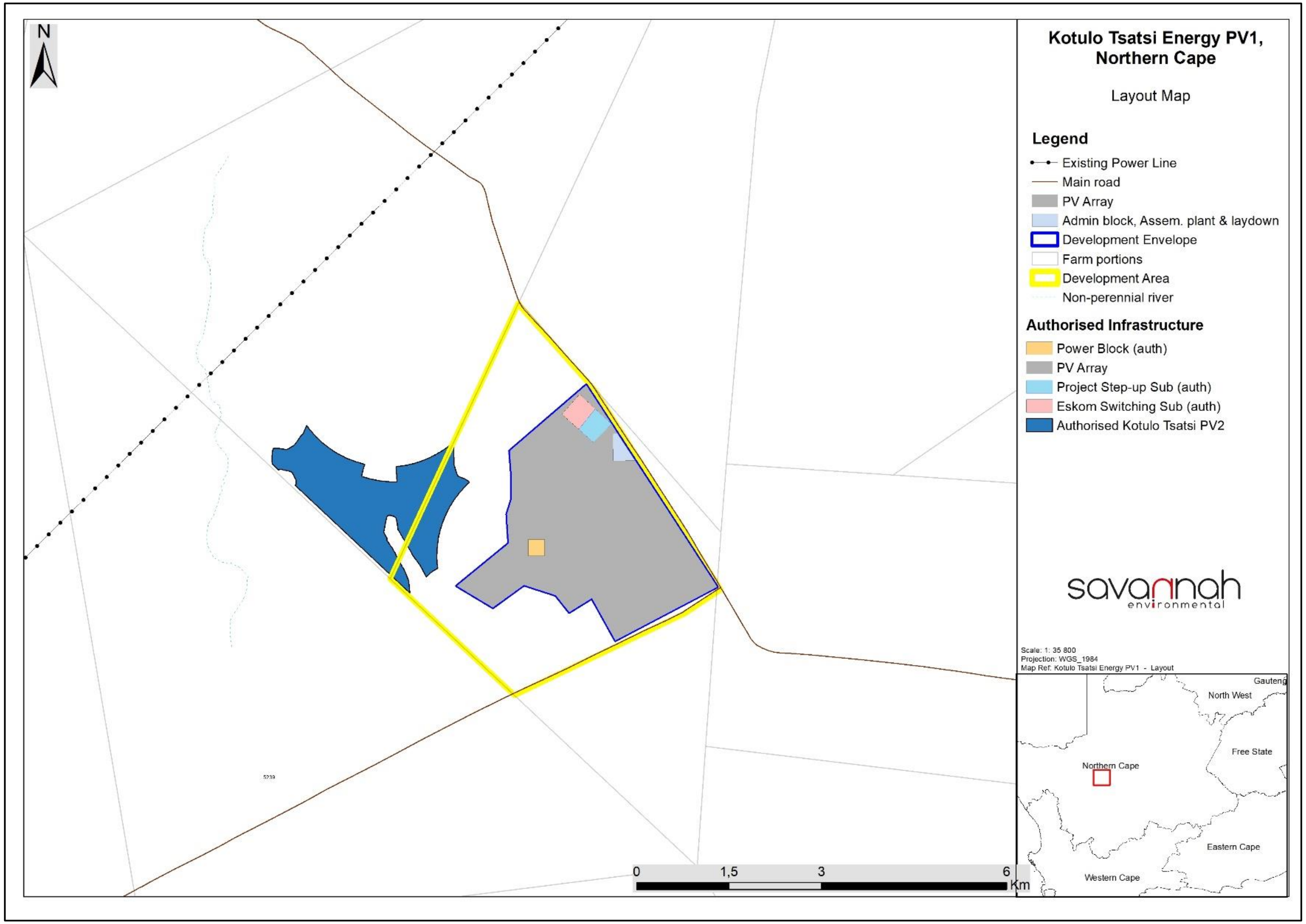

Figure 2: Layout Map for the Kotulo Tstatsi PV1.

Terms of reference

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. 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);
» Undertaking a rapid water resource screening and risk assessment to determine which desktop delineated/mapped watercourses/wetlands are likely to be measurably affected by the proposed activities. This was used to flag watercourses/wetlands for further infield assessments as well as identify those watercourses/wetlands to be unaffected and not require further assessment (i.e. wetlands/rivers within adjacent catchments, upstream or some distance downstream of the predicted impact zone);
» 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.

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.

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.

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;
    (i) promote conservation; and
    (ii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

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.

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).

Other pieces of legislation that may also be of some relevance to freshwater resources include:

» 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

Assessment Approach and Philosophy

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). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance, and Present Ecological State (PES) assessment methods used in this report.

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 3 below.

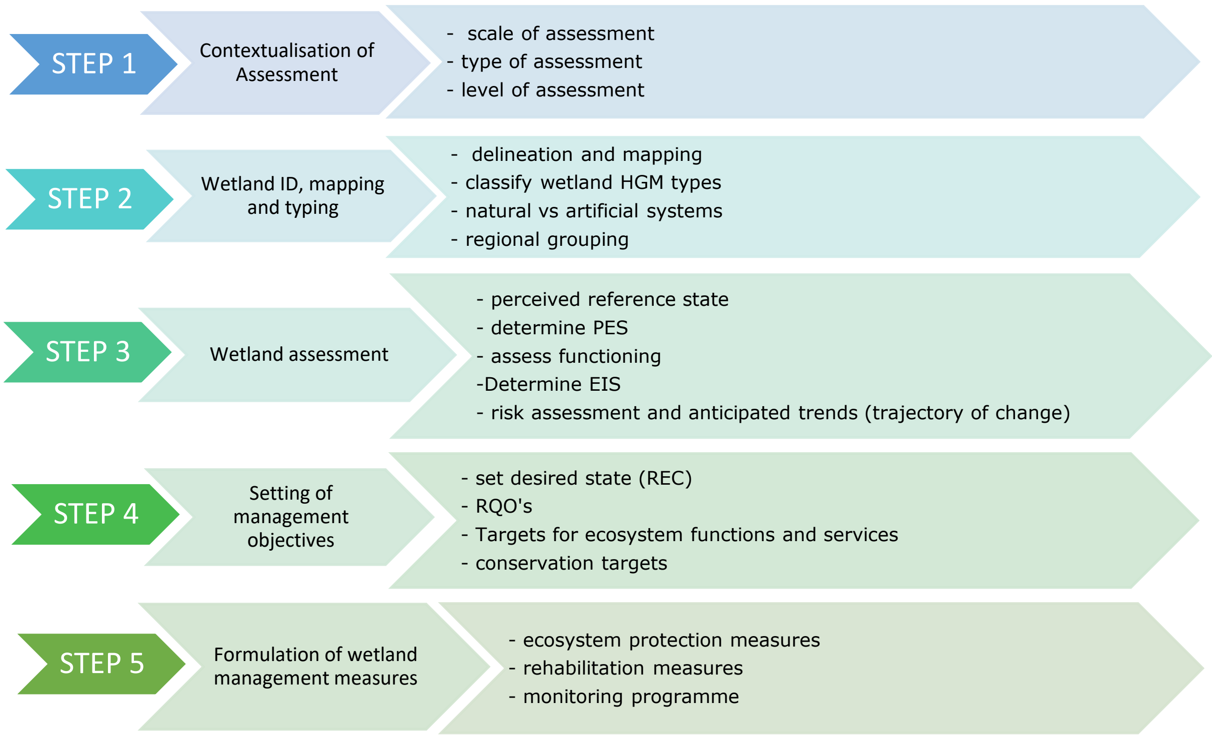

Figure 3: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

Data scouring and review

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 1):

Vegetation:

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2006) as well as the National List of Threatened Ecosystems (2011), where relevant.

» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map obtained from the SANBI Database).

» The IUCN conservation status of the species in the list was also extracted from the database and is based on the Threatened Species Programme, Red List of South African Plants (Version 2017.1).

» 3Foxes Biodiversity Solutions, 2021. Impact Assessment for the Proposed Kotulo Tsatsi Energy PV1 Development: *Fauna and Flora Specialist Study.* Unpublished report Prepared by 3Foxes Biodiversity Solutions for Savannah Environmental. March 2021.

Ecosystem:

» Freshwater and wetland information were extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands, and catchments defined under the study.

» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (NPAES).

» Critical Biodiversity Areas were obtained from the 2017 Western Cape Biodiversity Spatial Plan (WC-BSP), for the Witzenberg municipality.

» 3Foxes Biodiversity Solutions, 2021. Impact Assessment for the Proposed Kotulo Tsatsi Energy PV1 Development: *Fauna and Flora Specialist Study.* Unpublished report Prepared by 3Foxes Biodiversity Solutions for Savannah Environmental. March 2021.

» The Biodiversity Company, 2021. Agricultural Compliance Statement for the proposed Kotulo Tsatsi PV1 Project. Unpublished report. Prepared by The Biodiversity Company for Savannah Environmental. December 2020.

» The Freshwater Consulting Group, 2016. Environmental Impact Assessment for Solar Reserve Kotulo Tsatsi PV2 Project and associated infrastructure, Northern Cape Province: *Freshwater Resource Assessment*. Unpublished report. Prepared by The Freshwater Consulting Group for Savannah Environmental. November 2016.

» Future Flow Groundwater and Project Management Solutions, 2015. Solar Reserve Kotulo Tsatsi CSP & PV Project – Environmental Impact Assessment for CSP1: *Hydrological Study*. Unpublished report. Future Flow Groundwater and Project Management Solutions for Savannah Environmental. 19 January 2015.

Table 1: Information and data coverages used to inform the ecological and freshwater resource assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**Colour Aerial Photography**	Desktop mapping of habitat/ecological features as well as drainage network.	National Geo-Spatial Information (NGI)
	Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
	1:50 000 Relief Line (20m 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 (2006, 2018)
	NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	CSIR (2011)
	NBA2018 National Wetland Map 5 (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	NBA (2018)

	DWA Eco-regions (GIS Coverage)	Understand the regional biophysical context in which water resources within the study area occur.	DWA (2005)
Conservation and Distribution Context	**NFEPA: River, wetland and estuarine FEPAs** (GIS Coverage)	Shows location of national aquatic ecosystems conservation priorities	CSIR (2011)
	National Biodiversity Assessment – Threatened Ecosystems (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2011)
	Critical Biodiversity Areas of the Northern Cape (GIS Coverage)	Determination of provincial terrestrial/freshwater conservation priorities and biodiversity buffers	SANBI (2016)

The desktop delineation of all freshwater resources within 500m of the proposed development / activities was undertaken by analysing available 20m 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 QGIS 3.8.2 and ArcMap 10.4.1 GIS software. All of the mapped freshwater resources were then broadly subdivided into distinct resource units (i.e. classified as ephemeral channels and drainage lines, washes and ephemeral rivers and wetlands). This was undertaken based on aerial photographic analysis and professional experience in working in the region. Please note that the desktop map was updated as part of the finalisation of the assessment to include the detailed delineation of the units occurring within the study area.

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 assessments undertaken as part of this study are listed in Table 2 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 2: 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).
Freshwater Ecological Importance and Sensitivity (EIS)	EIS (Ecological Importance and Sensitivity) assessment tool (DWAF 1999c; Rountree & Malan, 2013)

Buffers for rivers and watercourses	The national Preliminary Guideline for the Determination of Buffer Zones for River, Wetlands and Estuaries (MacFarlane *et al.,* 2014).

Assumptions and Limitations

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 NC Province at the time of the assessment.

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 areas is based on several indicators, including topography (macro-channel features), the presence of alluvial deposition and vegetation indicators. The boundaries mapped in this specialist report, therefore, represent the approximate boundary of riparian 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 and cost constraints and therefore, the representation of the species sampled at the time of the site visit should be critically evaluated.
  - The site was sampled outside of the wet season.
  - The footprint was covered in detail with the result that the results are considered highly reliable and it is unlikely that there are any significant species or features present that were not recorded.

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 assessment practitioner'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 currently available tools and techniques to undertake assessments of freshwater resources, the area 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. STUDY AREA

Regional/Local Biophysical Setting

The project is located on Portion 2 of the farm Styns Vley 280, situated approximately 70km (south-west) from the town of Kenhardt and 60km (north) of the town of Brandvlei (Figure 1) within the Hantam Local Municipality and the Namakwa District Municipality in the Northern Cape Province. The site is accessible via an existing gravel farm road (known as Soafskolk Road) which provides access to the farm off of the R27 which is located east of the project site.

The Kotulo Tsatsi Energy PV3 will have a generating capacity of up to 480MW and will cover an area of approximately 810 ha.

Land use within the project site is mostly for farming. Farming practices consist of sheep farming with some "free" roaming game. Due to the aridity and unsuitable soils, cultivation is not a common practice, however the occasional small patch of cultivated areas (predominantly fodder such as Lucerne) are found within the deeper alluvial soils of some ephemeral washes. Due to the aridity of the area large tracts of land is still fairly natural. Infrastructure are mostly in the form of kraals, water points, boreholes farm track, gravel roads and small dwellings.

Prominent anthropogenic features (natural and unnatural) within the region include the Aries Substation, Aries – Kronos 1 400kV and Aries – Helios 1 400kV Power Lines and the R27 Route (Figure 1). The project site lies west of the R27 Route and access to the site can be gained via a gravel Soafskolk road. Apart from these anthropogenic features, vast areas of landscape are still mostly natural (very poorly developed) and predominantly used for livestock and wildlife farming. Fences, occasional tracks and kraals tend to be the main anthropogenic features, within these areas.

The site lies in an arid area of very low rainfall (< 200 mm per year). The mean annual rainfall recorded at Brandvlei, to the south of the site, is only 127 mm, falling predominantly in late summer and autumn (Desmet and Cowling, 1999). Rainfall amounts can vary significantly from year to year, and thunderstorms are typical during the early rainy season (Namakwa Bioregional Plan 2008). The average midday temperatures for Kenhardt range from 19.3°C in July to 35.5°C in January. The region is the coldest during July when the temperatures on average drop to 2.2°C during the night, but can go below 0˚C. The first occurrence of frost may be experienced as early as May and marks the end of the growing season (if not brought on earlier due to a lack of moisture availability).

The study site occurs within the Quaternary Catchment D57D (Lower Orange Water Management Area), which is drained by the ephemeral Sak River and its associated tributaries (Figure 4).

The Hydrological Characteristics of D57D are summarised as follows:

» Mean Annual Precipitation = 137.68mm;
» Mean Annual Runoff = 1.6mm; and
» Hydrological Zone = K.

The Kotulo Tatsi Energy PV3 project is located within the Nama Karoo Level 1 ecoregion (Kleynhans
et al., 2005). The Nama Karoo ecoregion incorporates a number of northward flowing rivers, with the main system into which these rivers flow being the Orange River. The characteristics of the ecoregion are:

» Topography is diverse, but plains with a moderate to high relief and lowlands, hills and mountains with moderate to high relief are dominant. Vegetation consists almost exclusively of Nama Karoo vegetation types;
» Most of the rivers in the region are seasonal to ephemeral, such as the Hartbees and Sak rivers.

- » Perennial rivers that traverse this region are the Riet and Orange;
- » Rainfall is moderate to low in the east, decreasing to arid in the west. Coefficient of variation of annual precipitation is moderate to high in the east to very high in the west;
- » Drainage density is generally low, but medium to high in some parts;
- » Median annual simulated runoff is moderate to low in the east, decreasing to arid in the west, and
- » Mean annual temperature is moderate to low in the east, increasing to moderate to high in the west.

The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge et al., 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers. These drainage systems were disrupted both by progressive aridification and by uplift along the Griqualand–Transvaal axis, causing the dismembering of several (Partridge & Maud, 2000).

Four main drainage systems traverse this geographic province; from east to west these are the Boesak, Vis/Hartbees and Brak rivers. The rivers to the east (Boesak and Vis/Hartbees) display remarkable uniformity, with flat slopes, wide valley cross-sectional profiles, concave longitudinal profiles and exponential BFCs (Macro-reach Best Fit Curves: aggregading alluvial river systems where there is no significant lateral input of water or sediment). The sediment storage surrogate descriptors are consequently WF (a sediment storage surrogate descriptor indicative of high sediment storage capability).

A summary of the biophysical features and the setting of the project site and surroundings are summarised in Table 3 below.

Table 3: Summary of the biophysical setting of the projects site as well as the surroundings

Biophysical Aspect	Desktop Biophysical Details	Source
Physiography (for affected property)		
Av. Elevation a.m.s.l	924 m	Google Earth & ArcGis
Max. Elevation a.m.s.l	944 m	Google Earth & ArcGis
Min. Elevation a.m.s.l	905 m	Google Earth & ArcGis
Av. slope	0.9%	Google Earth & ArcGis
Maximum slope	3.06%	Google Earth & ArcGis
Landscape Description	The site can be described as gently undulating to flat with few isolated outcrops, draining south-east into ephemeral	Google Earth & Mucina and Rutherford, 2006,

<table>
<tr><td></td><td colspan="2">water washes that drain into the Verneuk Pan System 18 to 45 km southeast and east of the study area.

Watercourses are numerous across this flat landscape, draining water off slopes, and more slowly across plains or basins. Due to the low gradient of most of the terrain, these drainage lines proliferate, sometimes with a number of lines running more or less in parallel across the plains, creating a wash effect.
Drainage patterns are also fairly dynamic due to the lack of gradient, as a small obstruction to flow (plant roots, rocks, burrows etc.) can change the way water moves across the flat surface. In many instances, water flows into flat endorheic pans.

On the project site, there are a number of rivers running across the site, all of which ultimately confluence with the Grootvloer / Brandvlei pan systemto the south. The Sak River also flows into the vast panlands around Brandvlei, and then into the Grootvloer pan just to the north, which only flows out northwards during periods of high flow, flowing into the Hartbees River and then the Orange River.</td><td>ArcGis, ARC, Todd, 2021 and Own visual observations.</td></tr>
<tr><td rowspan="2">Land Type Classification</td><td colspan="2">Symbol</td><td rowspan="2">ARC</td></tr>
<tr><td colspan="2">Fc137</td></tr>
<tr><td rowspan="2">Terrain Type</td><td>Symbol</td><td>Description</td><td rowspan="2">ARC</td></tr>
<tr><td>A2</td><td>Level plains or plateaus with some relief.</td></tr>
<tr><td>Geomorphic Province</td><td colspan="2">Northern Cape Pan Veld</td><td>Partridge et al., 2010</td></tr>
<tr><td>Geology and Soils</td><td colspan="2">The geology of the study area is relatively varied, comprising mostly of Ecca and Dwyka shales (AGIS 2007, Van Tol 2014). Soils are minimally developed, usually shallow on hard weathering rock. Lime is generally present. Depressions and drainage lines typically have a slightly deeper soil accumulation, with larger valley floor depressions having the deepest soils. However, as these soils originate from long-term deposition off higher areas and are fine grained, they have also accumulated many of the minerals and salts weathered from rocks, hence are alkaline saline-sodic with the pH usually >8 (AGIS 2007, Van Tol 2014).</td><td>ARC & SA Geological Dataset, Almond (2010)</td></tr>
<tr><td rowspan="4">Prominent Soil Forms</td><td>Terrain Position</td><td>Soil Forms</td><td rowspan="4">ARC</td></tr>
<tr><td>Crest</td><td>Typically comprise of bare solid rock, fractured rock and shallow, rocky soils (shallow profiles underlain by rock or lithic material) with the dominant soil forms being Mispah, and Rock and occasionally Clovely and Glenrosa.</td></tr>
<tr><td>Mid-slope</td><td>Also typically associated with shallow, rocky soil profiles and/or bare rock and include the soil forms, Mispah, Clovely and bare rock.</td></tr>
<tr><td>Toe-slope</td><td>Tend to also have shallow soil profiles underlain by rock or lithic material. The</td></tr>
</table>

		dominant soil forms are Clovelly and Mispah and the occasional exposure of bare rock.	
	Valley bottom, depression and floodplain	Slightly deeper soils with some occasional soil, profiles. The most prominent soil forms found within the valley bottoms is Clovelly. Where alluvial/colluvial sediments have accumulated, forming deeper soil profiles (associated with depression and ephemeral wash systems) Oakleaf are the dominant soil form.	
Climate			
Köppen-Geiger Climate Zone	BWh (Arid, Hot, Desert)		Climate-data.org
Mean annual temperature	20.7°C		Climate-data.org
Warmest Month & Av. Temp.	January: 27.9°C		Climate-data.org
Coldest Month & Av. Temp.	July: 12.3°C		Climate-data.org
Mean Frost Days (per year)	6		Cape Farm Mapper
Rainfall Seasonality	Late summer to autumn (Highest in March)		DWAF, 2007
Mean annual precipitation	137.68 mm		Schulze, 1997
Mean annual runoff	1.6 mm		Schulze, 1997
Mean annual evaporation	2200 - 2600 mm		Schulze, 1997
Surface Hydrology (for proposed development area)			
DWA Ecoregions	21.04 (Nama Karoo)		DWA, 2005
Wetland vegetation group	Nama Karoo Bushmanland		CSIR, 2011
Water management area	Lower Orange Water Management Area		DWA
Quaternary catchment	D57D		DWA
Sub Quaternary Catchments	Name (Symbol)	Extent (km^2)	DWA
	4 552	1182	
Vegetation Overview (for affected property)			
Biome	Nama Karoo		Mucina & Rutherford, 2018
Vegetation Types	Nama Karoo: Bushmanland Basin Shrubland Ephemeral Washes and depressions, even though not indicated within VegMap, are most likely consistent with the description Bushmanland Vloere (Inland Azonal).		Mucina & Rutherford, 2018

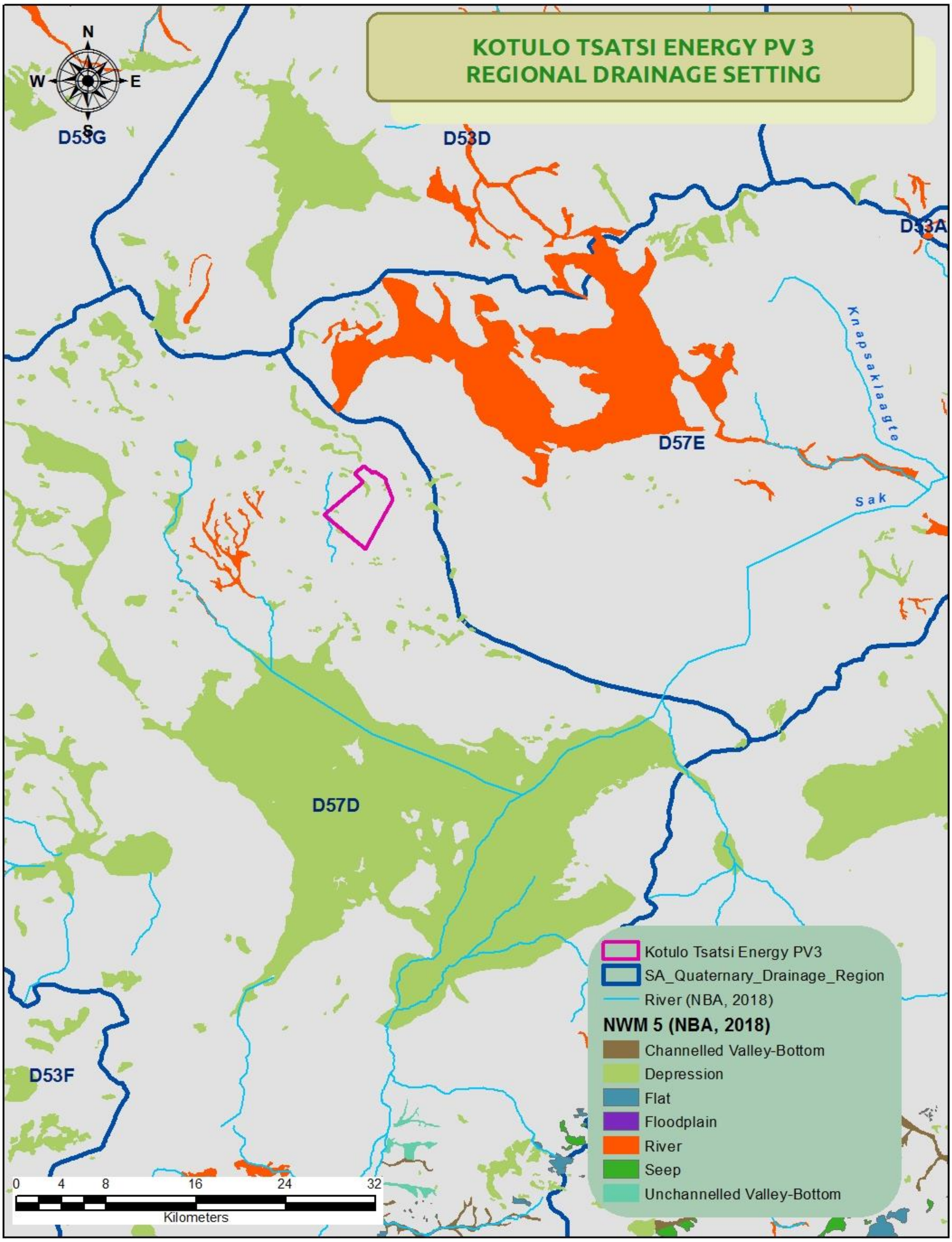

Figure 4: Proposed location of the Kotulo Tsatsi Energy PV3 project site relative to the major hydrological features within the region as mapped by SANBI (2018).

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 4). Take not that only conservation features applicable to freshwater resource features will be investigated and discussed within the assessment.

Table 4: Summary of the conservation context details for the study area.

<table>
<tr><th colspan="2">Conservation Planning Dataset</th><th colspan="2">Relevant Conservation Feature</th><th>Location in Relationship to Project Site</th><th>Conservation Planning Status</th></tr>
<tr><td rowspan="5">NATIONAL LEVEL</td><td rowspan="3">National Freshwater Ecosystem Priority Area</td><td colspan="2">Unknown (Reach code: D57D130000)
&

Unknown (Reach code: D57D070000)</td><td>This river flows across a small portion of the project site (south-western corner), however the proposed development footprint excludes this river.

Located outside of the project site (approximately 9.1 km to the south-west)</td><td>Both rivers are classified as Upstream FEPAs</td></tr>
<tr><td colspan="2">Wetlands</td><td>According to NFEPA coverage three FEPA wetlands (depressions) are located within the project site, whilst a fourth FEPA wetland (depression) partially extends into the project site. However, none of these features are located within the proposed solar PV field/development footprint.</td><td>FEPA Wetlands</td></tr>
<tr><td>Wetland Vegetation</td><td>Nama Karoo Bushmanland</td><td>Channelled Valley-Bottom, Unchannelled Valley-Bottom, Depression, Flat, Floodplain, Seep, Valley Head Seep

Most of the freshwater resource features identified within the project site where ephemeral washes and drainage lines with a single depression wetland identified. These ephemeral washes fulfil similar functions and services as Valley-bottom wetlands.</td><td>Least Threatened</td></tr>
<tr><td rowspan="2">Vegetation Types</td><td colspan="2">Bushmanland Basin Shrubland</td><td>According to VegMap (2018) the bulk of the project site is covered by this vegetation type.</td><td>Least Concerned</td></tr>
<tr><td colspan="2">Bushmanland Vloere</td><td>Small, isolated, inland azonal features located in relatively close proximity to the project site, although still outside of the project site (to the west).

Ephemeral washes and depression wetland identified within the project site resemble this vegetation type to some extent.</td><td>Least Concerned</td></tr>
</table>

	Threatened Ecosystems	Not Classified	Ecosystems of Study Area	Least Concern
PROVINCIAL AND REGIONAL LEVEL	NCBSP: Critical Biodiversity Areas	Critical Biodiversity Area 1	Depression wetlands. Three located within the project site and one partially located within the project site. None of these CBA1 wetlands are located within the proposed development footprint area.	CBA1
		Critical Biodiversity Area 2	Buffer areas surrounding the depression wetland clusters (CBA2). Such a buffer area is located just to the north-west of the project site and is excluded from the development footprint.	CBA2
		Ecological Support Area	Upstream Management Rivers (NFEPA data) and buffer area. A small portion of such an ESA is located within the south-western portion of the project site. However, the proposed development footprint is outside of this ESA	ESA
		Other Natural Areas	The bulk of the project site including the entire development footprint is located within such ONAs	ONA

National Level of Conservation Priorities (Threatened Ecosystems)

The vegetation types of South Africa have been categorised according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale these thresholds are, as depicted in the table below, determined by the best available scientific approaches (Driver *et al*. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al*. 2005).

Table 5: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

The National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004), lists national vegetation types that are afforded protection on the basis of rates of transformation. The threshold for listing in this legislation is higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

According to Mucina and Rutherford (2018), the impacted vegetation types is classified as Least Threatened and is furthermore not listed within the Threatened Ecosystem List (NEMA:BA).

The Bushmanland Vloere vegetation type represents the vegetation associated with inland saline habitats (depression of pan wetlands). According to the VegMap (2018) no such features are present within the project site.

Based on the desktop and infield delineation of freshwater resource features within the project site, a small depression wetland has been identified within the site that can be considered to represent the Bushmanland Vloere vegetation. This depression wetland has, however, not been mapped within the VegMap or the 2018 NBA wetlands layer.

A more accurate freshwater resource delineated map is depicted in Figures 7, which indicates that only two turbines will be located within the boundaries of an azonal aquatic habitat.

National Freshwater Ecosystem Priority Areas (2011)

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).

A review of the NFEPA coverage for the study area (Figure 5) revealed that that the entire project site is located within a sub-quaternary catchment classified as an "Upstream Management Area". These UMA 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 (Driver et al., 2011). The most important drainage feature within this sub-quaternary catchment is the Sak River. This ephemeral watercourse drains in a north-west direction and is classified as a Lowland River (according to geomorphological zonation) with a V1, V2 and/or V3 valley form. According to DWAFs 1999 Present Ecological State for mainstream rivers this watercourse was classified as Largely Natural (Class B) (Kleynhans, 2000).

A number of freshwater wetlands have been listed within the region, according to the NFEPA spatial coverage. Almost all of these wetlands have been classified as depressions with the most notable depression wetland being the Groot Vloer Pan to the south of the project site. Within the project site two small depression features have been identified, both of which has been classified as Freshwater Priority Areas (FEPAs), however, these features are located outside of the proposed development footprint. During the site visit all of these depression wetlands were confirmed. Additionally, three other wetland features have been identified during the site visit.

The NFEPA project also maps and classifies a number of "Wetland Vegetation Groups" that are based on groupings of national vegetation types (Mucina & Rutherford, 2006) expected to share similar types of wetlands and used in combination with the landform map to identify wetland ecosystem types (Driver et al., 2011). The assumption here is that wetlands in a particular vegetation group are likely to be more similar to one another than to wetlands in other vegetation groups (since broad vegetation groupings reflect differences in geology, soils and climate, which in turn affect the ecological characteristics and functionality of wetlands). The "Wetland Vegetation Group" GIS layer (CSIR, 2011) identifies a single general group of wetlands based on wetland vegetation, namely; Nama Karoo Bushmanland. Freshwater Resource Ecosystem Threat Status for the different hydro-geomorphological features located within the Vegetation Group is summarised in Table 4. The only listed hydro-geomorphological feature present within the project site (outside of the proposed development footprint), is a depression wetland. All of the hydro-geomorphological features located within this Wetland Vegetation Group are classified as Least Concerned.

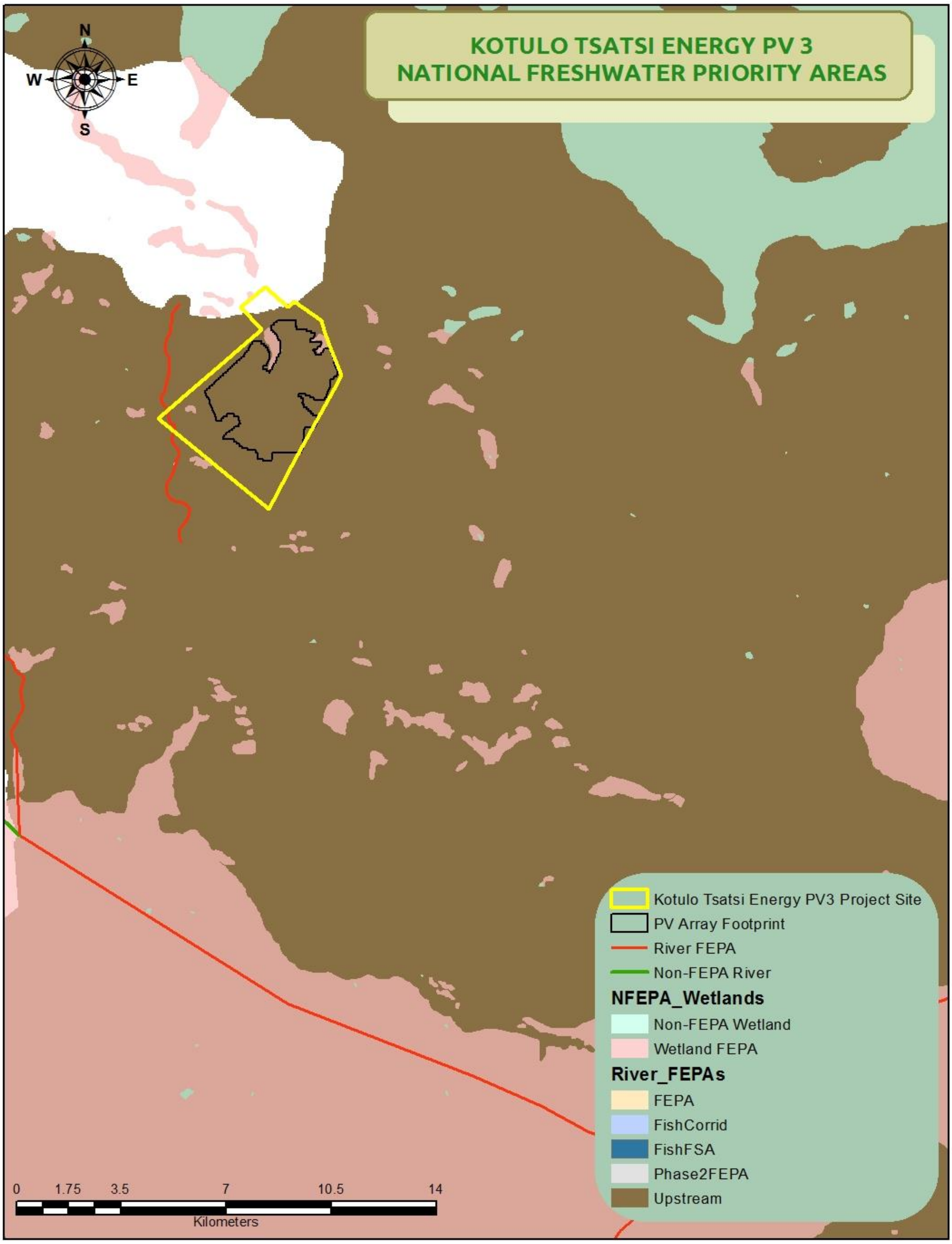

Figure 5: Map showing the location of the study site relative to the Freshwater Ecosystem Priority Areas (FEPAs).

Critical Biodiversity Areas and Broad Scale Ecological Processes

Critical Biodiversity Areas have been identified for areas of the Northern Cape Province and are published on the SANBI website (bgis.sanbi.org). This biodiversity assessment identifies CBAs which represent biodiversity priority areas that should be maintained in a natural to near-natural state. The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to maintain ecosystem functioning and meet national biodiversity objectives (refer to Table 6 for the different land management objectives set out for each CBA category). According to these maps, large tracks of terrestrial land within the region falls within Other Natural with the south-western corner being classified as a CBA. These terrestrial CBA features will not be dealt with or assessed within this study/report as this forms part of the terrestrial biodiversity assessment. All CBAs and ESAs relevant to aquatic resource features will be discussed and assessed below.

Table 6: Relationship between Critical Biodiversity Areas categories (CBAs) and land management objectives

CBA category	Land Management Objective
Protected Areas (PA) & CBA 1	***Natural landscapes:*** Ecosystems and species are fully intact and undisturbed. These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. These are landscapes that are at or past their limits of acceptable change.
CBA 2	***Near-natural landscapes:*** Ecosystems and species largely intact and undisturbed. Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. These are landscapes that are approaching but have not passed their limits of acceptable change.
ESA	***Functional landscapes:*** Ecosystem moderately to significantly disturbed but still able to maintain basic functionality. Individual species or other biodiversity indicators may be severely disturbed or reduced. These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural Areas) and Transformed	Production landscapes: Manage land to optimise sustainable utilisation of natural resources.

The majority of the CBA1 features within the region are associated with depression wetlands (Figure 6) and represent aquatic features in natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure. Three such CBA1 depression wetland are located within the project site, whilst a fourth CBA1 depression wetland is partially located within the project site. According to the current proposed development footprint, all of these CBA1 wetlands will be avoided. During the site survey these wetland features have been confirmed and delineated along with three other depression wetlands. All of these depression wetlands have been classified as High Sensitive and are furthermore regarded as No-Go areas.

The identified CBA2 features are buffer zones around the CBA1 wetland clusters and are regarded as vital areas for connectivity, maintenance and conservation of these CBA1 features. Such a CBA2 buffer area is located just north-west of the project site and will not be impacted by the proposed development.

The unnamed Upstream River (NFEPA spatial data), as well as a 500m buffer area have been classified as an ESA. This is a fairly short river that flows in a southern to south-eastern direction within a small portion of the river traversing the south-western corner of the project site. The extent of this river within the project site have been delineated and mapped and has been classified as High Sensitive and a No-Go area. According to the current layout this ephemeral wash is excluded from the proposed development footprint and subsequently will not be directly impacted by the proposed project.

The majority of the project site, including the entire development area is located within an ONA.

Based on, on-site delineation and observations, it is unlikely that the current layout of the PV facility will threaten the integrity of these CBAs and ESAs.

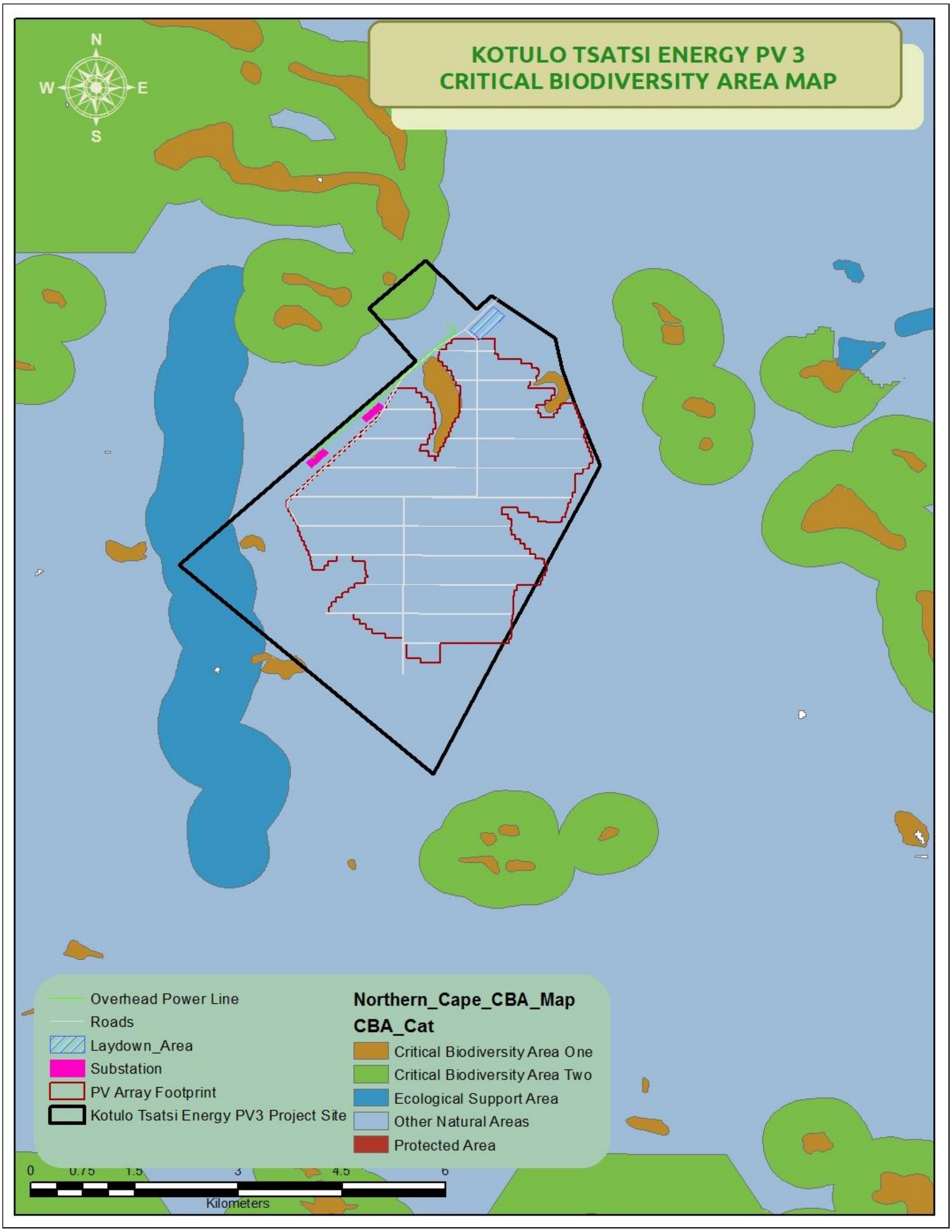

Figure 6: Provincial Level Aquatic Conservation Planning Context.

Baseline Assessment Results.

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

- Delineation, Classification & 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 from the 14st to the 16th of January 2021.

On the Kotulo Tsatsi Energy PV3 project site, there are a number of rivers running across the site, all of which ultimately confluence with the Grootvloer / Brandvlei pan/depression system to the south. The Sak River also flows into these extensive depression features around Brandvlei, and then into the Grootvloer pan/depression just to the north, which only flows out northwards during periods of high flow, flowing into the Hartbees River and then the Orange River.

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.

A dominant feature of the site is the alluvial floodplains or washes. These systems are difficult to classify, as their hydrological and geomorphological characteristics (the way water and sediment flows into, through and out of these features) are difficult to determine, and the ecological functioning and importance of these alluvial features are little known. They are typically characterised by multiple channels that traverse a floodplain, valley floor or alluvial fan. Surface water may flow along a particular channel in one year, but due to their being little topographic definition or gradient across the landscape, a parallel channel may be eroded the following year, leading to a network of channels. Some freshwater ecologists call these features "dendritic drainage systems", while others refer to them as washes or floodplains. They tend to be classified as rivers rather than wetlands as they show very few wetland characteristics in the strictest sense.

Ultimately, 115 freshwater resource features were identified and delineated and include; <u>seven</u> depression wetlands, <u>three</u> large primary river/wash (stream order 1 and 2 for the project area), <u>thirty-eight</u> minor/medium streams/washes (stream order 2-5), <u>hundred-and-seven</u> drainage/channel features (Figures 7). All of these freshwater resource features are ephemeral. There has been little change to the hydrological and geomorphological characteristics of most of the freshwater resource features, apart from two dam structure within one of the

major ephemeral washes. One of these dam structures have impacted a depression wetland located within the ephemeral wash. Furthermore, the depression wetland located within the north-eastern corner of the project site have been significantly impacted through past cultivation practices. The vegetation characteristics of all of these freshwater resource features have been impacted by grazing in the past. Subsequently, the majority of freshwater systems are still in a mostly natural, functional condition.

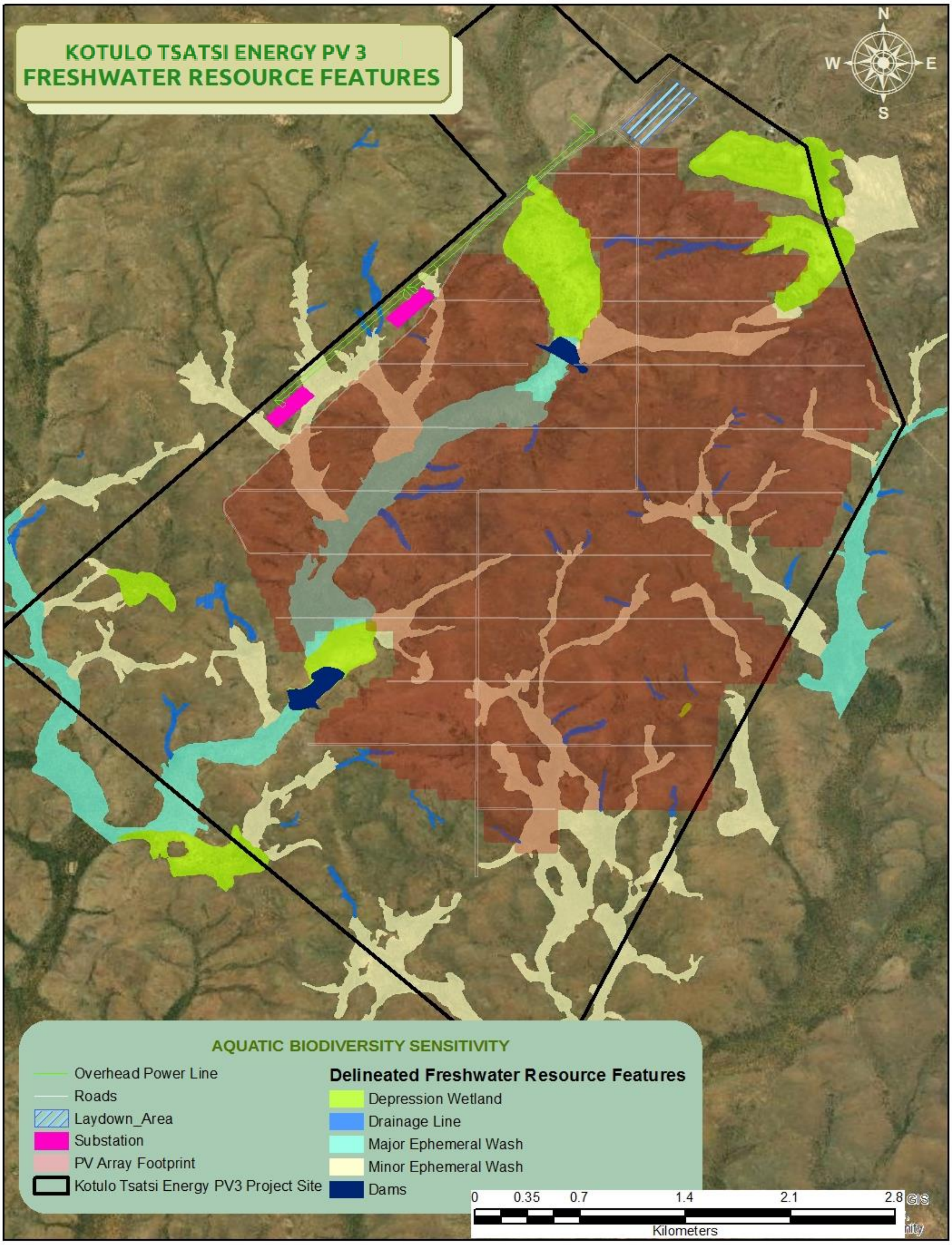

Figure 7: Delineated freshwater resource features.

Classification, Delineation and Description of Surface Water Resource Features

I. Surface Water 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).

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

Wetland Features:

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of seven wetland unit within the project site. Wetland ecosystems are in general the dominant drainage features in this landscape and comprised of ephemeral depressions (endorheic) hydrogeomorphic (HGM) units. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic). According to the current facility layout one small depression wetland is located within the PV solar development footprint, whilst the proposed PV solar development footprint slightly infringes into three depression wetlands. It is proposed that the facility layout be adjusted to exclude these wetland features as well as their associated buffer areas.

Such depression wetlands make up the majority of the lentic (non-flowing) systems of the greater landscape. This depression wetland is endorheic, i.e. isolated from other surface water ecosystems, usually with inflowing surface water but no outflow. There is generally little or no direct connection with groundwater, and this pan tends to be fed by unchanneled overland flow and interflow following rainfall events. Interflow is the lateral movement of water, usually derived from precipitation, that occurs in the upper part of the unsaturated zone between the ground surface and the water table. This water generally enters directly into a wetland or other aquatic ecosystem, without having occurred first as surface runoff, or it returns to the surface at some point down-slope from its point of infiltration. This depression wetland does however contain a small drainage line, which started as a small erosion feature.

Endorheic pans are the most common wetland type in arid and semi-arid environments (Allan *et al.*, 1995), and are generally thought to form as a result of the synergy of a number of factors and processes, including low rainfall, sparse vegetation, flat to gently sloping topography, disrupted drainage, geology (e.g. dolerite sills and dykes) grazing and deflation. The Bushmanland endorheic pans, or "vloere" as they are called locally, are one of the most extensive salt pan systems in South Africa (Mucina *et al.*, 2006). These pans are highly variable in size and form.

Inundation periods for this wetland is very short-lived (days to a few weeks) following sufficient precipitation. Similarly, the frequency is highly variable, from less than once a year to once every few decades. The flat, central portion of this pan is mostly devoid of vegetation, with a zonation of plants occurring around the margin.

Ephemeral Streams and Washes:

As mentioned, three major/primary washes, and 38 minor streams/washes were identified and delineated.

Arid streams and rivers can typically include discontinuous, ephemeral, compound, alluvial fan, anastomosing, and single-threaded channels, which vary due to a range of gradients (slopes), sediment sizes, and volumes and rates of discharge. Discontinuous ephemeral stream systems and alluvial fans are most prevalent in, but not restricted to, piedmont (foot hill) settings, while compound channels, anastomosing rivers, and single-thread channels with adjacent floodplains generally occupy the valley bottoms (Beven &Kirby 1993). Ephemeral and intermittent streams are the dominant stream types within the arid parts of southern Africa

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).

These delineated features represent larger and wider watercourses that include broad watercourses that may lack distinct channel development and are referred to as Washes or Wadis in Arabia, Arroyos in Spanish, and Laagtes in Afrikaans. These washes are all classified as Lower Foothill River in terms of the national classification system. Washes are typically discontinuous, diffuse channels on a flat topography in dry environments. Washes that lack distinct channel features do often display braided channel configuration referred to as *bar and swale* topography. Discontinuous streams can also display a stream pattern characterized by alternating erosional and depositional reaches. A summary of the classification and description of the various ephemeral washes/streams identified within the DWS regulated area are provided below in Table 7.

Smaller Ephemeral Channels and Drainage Lines:

Represent linear and narrow watercourses in the form of headwater drainage lines (second order drainage lines and channels). These features were captured as lines during the delineation process and are expected to be consistent with the NWA watercourse definition of 'natural channels that flow regularly or intermittently'. They can be marginal in nature with discontinuous or poorly developed channels that represent swales due to poor channel development in arid areas with low rainfall, high evapotranspiration and high infiltration in areas with sandy soils. No hydromorphic (wetland soil) or hydrophyte (wetland plant) indicators were recorded in these watercourses. Aerial imagery interpretations identified linear features with textural changes that were regarded to be associated with areas of preferential flows during cyclic surface flow events that can occur at frequencies that are several years apart. These features were considered as drainage lines and ephemeral channels.

These drainage systems differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation, and their need for different protection measures from land use activities (Gomi et al. 2002). These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions.

These drainage lines can contain discontinuous channels due to lower annual rainfall, longer rainfall intervals, and low runoff versus infiltration ratio due to greater transmission losses (Lichvar et al., 2004). Discontinuous channels are more common on low gradient topographies (e.g. basins and plains) in arid and semi-arid environments, with deeper substrates that result in lower energy fluctuations and greater water recharge into the surrounding soils during flow events.

These systems form part of a continuum between hillslopes and stream channels, which can be generally classified into four topographic units (Gomi et al. 2002):

- *Hillslopes have divergent or straight contour lines with no channelised flow.*
- *Zero-order basins have convergent contour lines and form unchannelised hollows.*
- *Transitional channels (temporary or ephemeral channels) can have defined channel banks, as well as discontinuous channel segments along their length, and emerge out of zero-order basin. They form the headmost definable portion of the drainage line network (first-order channels) and can have either ephemeral or intermittent flow.*
- *Well defined first and second-order streams that are continuous with either intermittent or perennial flow*

Site Photos

Examples of some of the freshwater resource features recorded within the DWS regulated area

Major/Primary Ephemeral Washes

Photo 1

Photo 2

Photo 3

Photo 4

Minor Ephemeral Washes and Streams

Photo 5

Photo 6

Photo 7

Photo 8

Drainage Lines


Photo 9


Photo 10


Photo 11


Photo 12

Depression Wetland


Photo 13:


Photo 14:


Photo 15:


Photo 16:

Table 7: Summary of delineated freshwater resource features.

<table>
<tr><th>Stream/ Wash</th><th colspan="2">Summary</th><th>General Description</th></tr>
<tr><td rowspan="10">Primary/Major Ephemeral Washes</td><td>Longitudinal Zone</td><td>Lower Foothill</td><td rowspan="10">These larger ephemeral watercourses are the most important hydrological features within project site.

These larger ephemeral washes are generally very old, well-established and stable floodplains – typical of the pre-river optimal runoff accumulation and flow systems of southern African drier ecosystems. In fact, the formation of cut-out sand-filled washes and larger rivers is actually the result of slow but persistent destabilisation of these floodplains. Historical records of the mid 18-hundreds by missionaries show that these floodplains, due to their configuration and seasonal abundance of grazing, were not only the preferred migration routes for wildlife, but were also used by indigenous tribesmen to drive large herds of livestock between winter- and summer grazing fields over vast distances (e.g. Vedder 1991).

The ecosystem processes here can be summarised as follows:
» These washes are relatively continuous fluvial systems, accumulating runoff from higher undulating areas to lower-lying pans, but always with the possibility of a unidirectional flow of water to lower-lying areas
» These systems are relatively wide, occasionally with wider lower-lying plains, thus runoff is seldom concentrated in a narrower channel
» As there is unidirectional flow of water, and, depending on rainfall volumes, flows may be high, there is accumulation of silts and sandy loams, but not an accumulation of excess minerals (as in pans where the water ends up).
» The deeper alluvial deposits enable a higher retention of water during moist seasons, which enables the establishment of a relatively permanent vegetation layer (shrubs and grasses)
» Fine-grained soils (accumulated from thousands of years of occasional runoff) generally have a low infiltration rate and surface layers dry out very quickly, but the vegetation layer does not only slow down accumulated runoff, but also significantly increases moisture</td></tr>
<tr><td>Valley Confinement</td><td>Mostly broad floodplain. Channels, where present, incised into floodplains which may be confined in some locations (either on one side or both – partly)</td></tr>
<tr><td>Channel Classification</td><td>Mostly diffuse. Shallow channels may form in some locations along these washes. Channels may be single to multiple</td></tr>
<tr><td>Channel pattern</td><td>Shallow meandering to Multi-thread (braided) with moderate sinuosity</td></tr>
<tr><td>Length</td><td>Vary between 1.5 km and 6.2 km</td></tr>
<tr><td>Slope</td><td>~0.72%</td></tr>
<tr><td>Drainage Direction</td><td>Mostly in a north-east to south-west direction</td></tr>
<tr><td>Width</td><td>Between 300 m and 400 m</td></tr>
<tr><td>Morphological Units</td><td>Flat sand bed, with the occasional shallow channel (single or multiple), or alluvial plane bed</td></tr>
</table>

	Sediment	» Deeper accumulations of fine-grained silt and occasional coarse sand on extensive valley floors » Channel centres with deeper alluvial deposits, with or without rock boulders, banks usually with clay-enriched soils	infiltration to such degree that ground water reserves can also be significantly replenished. o Note that excessive minerals are effectively filtered out by these layers of fine-textured soils before being able to get into the ground water, and then periodically flushed out to lower-lying large pan systems » Whilst there is thus a high permanent shrub component, reaching up to 6 m height in places and providing nesting, shelter, browsing, there is also the potential for a strong palatable dwarf shrub and herbaceous (grass) layer, which will provide valuable grazing beyond the rainfall season. » The larger – wider and longer these valley floor systems - the more valuable they become as migration corridors for game and livestock. Areas of higher soil deposition/accumulations within these larger ephemeral washes are unique features with their composition and ecosystem processes intermediary between large pans and the typical ephemeral washes. Soils within these sections have been deposited through thousands of years by runoff events from surrounding higher-lying areas. However, if flooding events are large enough there is some unidirectional flow either into lower-lying drainage lines or associated pans. Otherwise, runoff will accumulate and remain stationary similar to pan systems, thus soils generally appear to have a higher mineral content (higher than valley floors), but do not reach the high mineral accumulation levels of pans. This, as well as underlying geology (often with a high amount of surface rockiness), leads to very differential water infiltration and retention levels, and thus also a very varied mosaic of vegetation. Some of these areas show numerous developments of small washes, whilst others have distinct banded vegetation interspersed with large bare patches. After sufficient rainfall events, it can be expected that the herbaceous layer will change significantly, whilst the dry hard soils will turn into deep, impassable muds. The prevalence of standing surface water is expected to be extremely limited, hence it is expected that invertebrate populations will not show the same dynamics as in pans. However, occasional high grass cover will lead to a seasonal preferred grazing area. Again, the slightly higher salinity of the soils leads to a shorter-lived and less sustainable
	Key plant species	*Rhigozum trichotomum, Lycium pumilum, Salsola rabieana, Rosenia humilis, Phaeoptilum spinosum, Asparagus bechuanicus, Stipagrostis ciliata, Salsola tuberculata, Eriocephalus pauperrimus, Pentzia incana, Plinthus cryptocarpus, Aristida congesta.* Areas of high soil deposition ("vloere") is characterized with: *Rhigozum trichotomum, Salsola melanantha, Salsola tuberculata, Parkinsonia africana, Stipagrostis ciliata, Eriocephalus pauperrimus, Eriocephalus ericoides, Salsola namaqualandica, Lycium pumilum, Enneapogon desvauxii*	

			herb layer than the valley floors. This variety of soil surface characteristics and topsoil depth creates a diverse range of microhabitats, and accordingly species composition varies across these different sections and is overall very high although local species diversity is average.
Minor Ephemeral Washes	Longitudinal Zone	Mostly lower foothills	These smaller washes are typically found within smaller valley floor areas, indicating that these smaller valley floors do not have the same flood-buffering capacities as the larger ephemeral washes. Generally, the steeper the surrounding undulating low slopes, the larger the drainage lines with a more pronounced and deeper sand-bed in the centre, resulting from many centuries of accumulation of sands. The riparian vegetation consists of a relatively dense low shrub. High shrub cover within the riparian vegetation is extremely variable, ranging from almost none to dense stands of *Lycium*, *Phaeoptilum* and *Rhigozum.* These smaller, more isolated valley floor systems in general were found to be more prone to degradation – often visible by the formation of smaller washes and/or occasional dense encroachment by spiny high shrubs, most notably of *Rhigozum trichotomum*. It was then also quite significant that these smaller valley floor systems had a much lower apparent utilisation by livestock and game, although the presence of smaller fauna (birds, rodents) still seemed higher than on surrounding rocky plains.
	Valley Confinement	More isolated valley floor systems. Valley floors confined on both sides or on one side, and typically with shallow incised channels.	
	Channel Classification	Highly varying. Sections may be diffuse whilst other portions may contain shallow channels. Channels mostly single, however occasionally multiple channels may be present.	
	Channel pattern	Where present, mostly slightly meandering with straight sections. Lower reaches may become slightly braided with a few shallow channels.	
	Length	Vary between 99 m to 2.8 km (~ 700 m)	
	Slope	~2.4% (Maximum: 30%)	
	Drainage Direction	Various directions. Drain mostly towards the larger ephemeral washes.	
	Width	Highly varying: Between 20m and 300m (~ 80 m)	
	Morphological Units	Flat sand bed, with the occasional shallow channel (single or multiple), or alluvial plane bed	
	Sediment	Shallow to somewhat deeper accumulations of fine-grained silt and occasional coarse sand along small ephemeral washes between shale plains.	

	Key plant species	*Lycium bosciifolium, Rhigozum trichotomum, Plinthus cryptocarpus, Pentzia globosa, Pentzia incana, Galenia africana, Sericocoma heterochiton, Setaria verticillata*	
Drainage Lines/Channels	Longitudinal Zone	Upper Foothill Headwater Drainage Lines	Represent linear and narrow watercourses in the form of headwater drainage lines. These drainage systems differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation. These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions. The riparian vegetation consists of a relatively sparse low shrub layer dominated by *Rhigozum trichotomum.*
	Valley Confinement	Narrowly V-shaped	
	Channel Classification	Single and straight	
	Channel pattern	Narrow drainage channels over bedrock or coarse and/or medium gravel, overlying bedrock	
	Length	~210 m (Max: 591 m and Min: 27 m)	
	Slope	~1% (Max: 2.6%)	
	Drainage Direction	Various directions	
	Width	Seldomly wider than 10m	
	Sediment	Mainly bare bedrock or bedrock covered by course and/or coarse gravel and in some locations a thin layer of gritty sand.	
	Key plant species	*Plinthus cryptocarpus, Pentzia globosa, Lycium bosciifolium, Pentzia incana, Rhigozum trichotomum*	
Depression Wetland	Size	~ 20.03 ha (Max: 45.48 ha; Min: 0.36 ha)	Fine silt and clay particles that have been layered here are fine enough to have filtered out most of the dissolved salts/minerals that have been washed off higher-lying areas. These minerals were accumulated because runoff accumulating here is not distributed or moved over larger areas, but will gradually either evaporate or infiltrate, hence the sodic content of the alluvial deposits in the pans is generally higher than in all other fluvial systems. Inundation of pans with standing water will be scarce, but thorough wetting of the soils will result in deep, 'sticky' muds. Even very shallow and short-lived surface water resulting from sufficiently large rainfall events will not only serve as surface water for fauna, but due to the higher mineral content be a breeding ground for several specially adapted invertebrates. These may then appear in very large numbers, becoming a valuable source of food to
	Slope	0.7%	
	Landscape Unit	Valley Floor	
	Outflow Drainage	No outflow (Endorheic)	
	Inflow Drainage	Via concentrated surface flow along small ephemeral washes as well as overland flow (diffuse)	
	Hydroperiod	Saturation Period: Intermittently Inundation Period: Intermittently to rarely inundated	
	Drainage Direction	Various directions	
	Sediment	Orthic A horizon overlying a loose, friable, sandy to grainy-sandy, "faded" E horizon. In some, isolated localities, this E horizon may overly a Neocutanic B horizon, however the	

		presence of this horizon was relative scarce. The dominant soil form is Fernwood, although Vilafontes were also recorded (where a Neucutanic B horizon underlies the E horizon). Typically, the orthic A horizons of the center portions of these wetland areas comprise of light reddish brown to almost pink soil which transition into soils with slightly darker hues and chromas (light brown to reddish yellow to red along the peripheries of the depression wetlands). According to the Munsell Soil Chart (Munsell Soil Chart, 2009) the hue, chroma and value of the Orthic A horizons varied, from the interior to the outer periphery, from 2.5YR//4 to 7.5YR/6/4 to 7.5YR/6/8 to 2.5YR/5/8. In some areas these top horizons may contain a low amount of silt. Underlying the Orthic A horizon are, as mentioned a paler, structureless E horizon. Soils within this horizon have undergone iron reduction with lateral flow through this horizon and have resulted in the lighter, somewhat bleached colouring. Most of the soil samples taken indicated a pink E horizon (7.5YR/8/4 or 7/4). From the reduced soil characteristic, it is clear that these depression wetlands experience occasional saturation and are regarded as ephemeral systems that are likely only saturated for short periods of time following sufficient rainfall events, and may remain dry for extended periods of time (several years).	birds and reptiles. Less saline zones on the outer edges of the pans will change into a short-lived green belt of low vegetation, which will provide mostly habitat for invertebrates to lay eggs for the next generation. The mostly spiny vegetation persisting in these pans can withstand the higher soil salinity, but this is at the cost of reduced growth, hence the apt defence against grazers to minimise damage to above-ground plant structures in a harsh environment. The contribution of these pans to grazing will only be on and around the outer edges of these pans, where seasonal higher soil moisture in less saline soils can support more palatable vegetation during periods of rainfall.
	Key plant species	*Rosenia spinescens, Salsola rabieana, Stipagrostis ciliata, Salsola tuberculata, Rosenia humilis, Monechma incanum, Lycium pumilum*	

II. Present Ecological State

The surface water resource features (wetlands, larger washes and drainage lines) have been assessed based on the three wetland driving processes (responsible for wetland formation and maintenance); Hydrology, Geomorphology and Water Quality as well as Vegetation Alteration (provides an indication of the intensity of human land use activities).

The results of the PES assessments are summarised in Tables 8 and 9 below.

Table 8: Summary results of the river IHI (Index of Habitat Integrity) assessment.

Freshwater Resource Feature	HABITAT COMPONENT		
	Instream PES Category with % Intact	Riparian PES Category with % Intact	Overall PES (weighted 60:40)
Major Ephemeral Washes	B: Largely Natural (89% intact)	B: Largely Natural (89% intact)	B: Largely Natural (89% intact)
Minor Ephemeral Washes	B: Largely Natural (86% intact)	B: Largely Natural (83% intact)	B: Largely Natural (85% intact)
Drainage Channels	A: Unmodified (94% intact)	B: Largely Natural (81% intact)	B: Largely Natural (89% intact)

Table 9: Results of Level 1 Wet-Health Assessment.

Hydro-geomorphic Unit	Hydrology	Geomorphology	Vegetation	Overall PES
Depression Wetlands: WT2, WT3, WT5, WT6, WT7	A: Natural/Unmodified (PES Score: 0)	A: Natural/Unmodified (PES Score: 0)	C: Moderately Modified (PES Score 2)	A: Natural/Unmodified (PES Score: 0.57)
Depression Wetland: WT1	D Largely Modified (PES Score: 4.5)	F Critically Modified (PES Score: 7.3)	F Critically Modified (PES Score: 6.2)	E Significantly Modified (PES Score: 6)
Depression Wetland: WT 4	C Moderately Modified (PES Score: 3.6)	D Largely Modified (PES Score: 5.2)	D Moderately Modified (PES Score: 3.3)	D Largely Modified (PES Score: 4)

Very little change has occurred to the hydrological and geomorphological characteristics of most of the freshwater resource features, appart from two wetland features which have been significantly impacted through historical cultivation (WT 1) and dam construction (WT 4). The vegetation characteristics of all of these freshwater resource features have been impacted by grazing in the past and have allowed for some encroachment of especially *Rhigozum trichotomum* within the ephemeral wash and drainage systems and *Rosenia spinescens* within some portions of the depression wetland. Some of the smaller ephemeral washes as well as the "vloere" located within the larger ephemeral washes, contain old (historical) plough lines. It is unclear if these ploughing activities were an attempt to cultivate within the deeper soil profiles or if it was an attempt to facilitate vegetation establishment. Other, "minor" impacts include twin track crossings, farm fences, soil capping and sheet erosion. A few of the ephemeral washes to the north and east are crossed by the larger gravel access route.

Subsequently, the majority of these freshwater systems are still in a mostly natural, functional condition.

III. Wetland Ecological Importance and Sensitivity (EIS)

"*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 10 below (also refer to Figures 8) and indicates the following:

» Depression Wetlands
  - This depression wetland is considered to be ecologically important and sensitive.
  - Ecosystem functions include:
    - Depression wetlands capture runoff due to their inward draining nature, reducing the volume of surface water that would either simply disappear into the soil or exit the area via drainage and stream channels.
    - This collection and retention of water, following rainfall events play an important role in the maintenance of biodiversity and the creation of special niche habitats.
    - Furthermore, temporary to ephemeral wet pans provide the opportunity for the precipitation of minerals including phosphate minerals because of the concentrating effects of evaporation. Additionally, Nitrogen recycling is also an important function of these wetlands.
  - Such depression wetlands are known to contain important/unique invertebrate populations like branchiopods, crustaceans, and dipterans. These invertebrates can lay dormant (cysts/eggs) for many years and will hatch during periods of

flooding providing, along reactivated algae, a valuable source of food for various faunal species, especially migrating and water birds, including Lesser Flamingos (*Phoeniconaias minor*) which is regarded as Near Threatened.
- As mentioned above such depression wetlands may provide important feeding sites for local and migrating faunal species.
- The contribution of these pans to grazing will only be on and around the outer edges of these pans, where seasonal higher soil moisture in less saline soils can support more palatable vegetation during periods of rainfall.
- The ephemeral nature of the wetlands mean that the wetlands will be fairly sensitive to further reductions and changes in the natural hydrological regime. This may have a significant impact on the floral composition of these areas and may result in a reduction in water supply and a collapse in invertebrate populations.

» Major Ephemeral Streams/Washes
- All major ephemeral streams/washes are considered to be ecologically important and sensitive.
- The braided channel network and "vloere" of most of the washes contribute slightly to diversity in vegetation and geomorphological structure but more significantly to patchiness.
- Furthermore, deeper pools within these systems may contain important/unique invertebrate populations like branchiopods, crustaceans, and dipterans. These invertebrates can lay dormant (cysts/eggs) for many years and will hatch during periods of flooding providing, along reactivated algae, a valuable source of food for various faunal species, especially migrating and water birds.
- The morphological heterogeneity of these features and their associated vegetation contribute to habitat diversity within the region and valuable resources, not only for faunal species associated with these habitats, but for faunal species in general.
  - The softer sand of the floodplains is preferred by burrowing species such as Bat-eared Fox, Cape Porcupine, Aardvark, Aardwolf and small rodents etc.
  - The patches of taller shrubs attract and provide nesting and feeding site for numerous avifaunal species and provide shelter and browsing for antelope species such as Kudu, Steenbok and Common Duiker
- Dry watercourses are known to serve as important migration routes and corridors, especially the more extensive habitats.
- These systems provide inter alia the following ecosystem services
  - Convey floodwaters.
  - Help ameliorate flood damage.
  - Maintain water quality and quantity.
  - Provide habitat for plants, aquatic organisms, and wildlife; and determine the physical characteristics and biological productivity of downstream environments.

» Smaller Ephemeral Washes/Streams and Drainage Features

- All smaller ephemeral washes and drainage channels are considered to be of moderate ecologically importance and sensitivity.
- These smaller, valley floor and drainage systems in general were found to be more prone to degradation – often visible by the formation of smaller washes and/or occasional dense encroachment by spiny high shrubs, most notably of *Rhigozum trichotomum*. It was then also quite significant that these smaller valley floor systems had a much lower apparent utilisation by livestock and game, although the presence of smaller fauna (birds, rodents) still seemed higher than on surrounding rocky plains.
- These systems convey floodwater into and out of the ecologically important and sensitive larger washes and subsequently play an important role in the maintenance of these, more important, system.
- Furthermore, the vegetation of these drainage lines help reduces flood damage to downstream habitats and subsequently contribute to the maintenance of biological productivity of downstream environments.

Table 10: Score sheet for determining the ecological importance and sensitivity for the identified surface water resource features.

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS			
		Major Ephemeral Washes	**Minor Ephemeral Washes**	**Ephemeral Drainage Lines**	**Depression Wetland**
PRIMARY DETERMINANTS	Rare & Endangered Species	1	1	0	1
	Populations of Unique Species	2	1	0	2
	Species/taxon Richness	2	1	1	1
	Diversity of Habitat Types or Features	4	2	1	2
	Migration route/breeding and feeding site for wetland species	4	2	2	4
	Sensitivity to Changes in the Natural Hydrological Regime	3	2	3	3
	Sensitivity to Water Quality Changes	2	3	2	3
	Flood Storage, Energy Dissipation & Particulate/Element Removal	3	3	3	3
MODIFYING DETERMINANTS	Protected Status	1	1	1	1
	Ecological Integrity	4	3	4	4
TOTAL		26	19	17	24
MEDIAN		2.5	2	1.5	2.5
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**B High**	**C Moderate**	**C Moderate**	**B High**

According to the current layout of the development footprint, some medium sensitivity minor washes and drainage lines as well as some high sensitivity larger washes will be directly impacted by the development. The high sensitivity areas along with their 30m buffers are considered as no-go areas for all infrastructure apart access roads. The medium sensitive minor washes and drainage lines are not considered no-go areas. However, development within these areas shall be subjected to strict mitigation measures including the management of surface water runoff, erosion monitoring and mitigation as well as constraints regarding the clearing of vegetation within these areas.

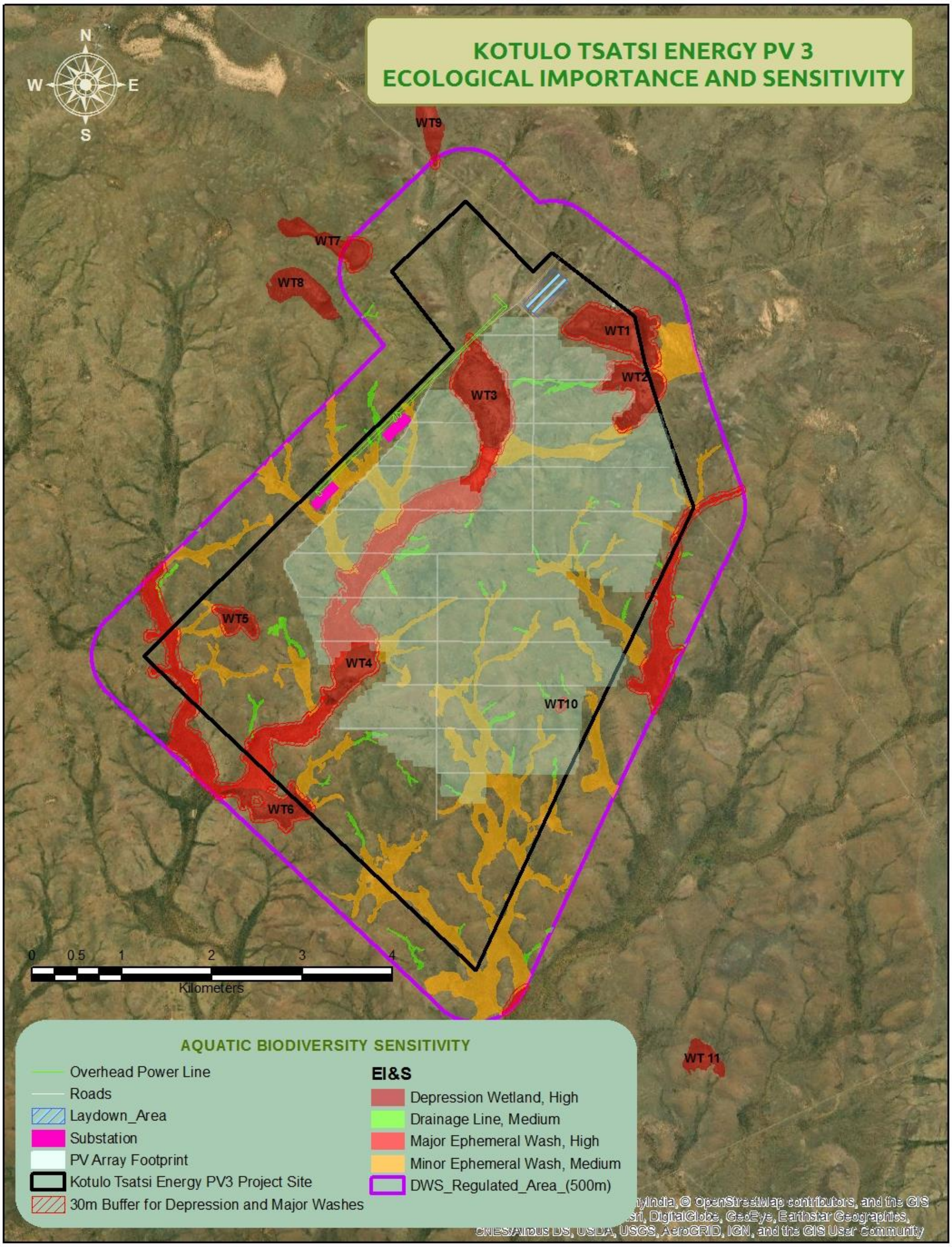

Figure 8: Ecological Importance and Sensitivity Map with recommended buffers.

IV. Wetland Buffer Zones

Buffers represent zones in which construction or habitat degradation would risk direct or indirect impacts on aquatic features and local hydrology. The main objective of the establishment and protection of buffers around aquatic features is to ensure that these features are protected from direct and indirect impacts.

The national Preliminary Guideline for the Determination of Buffer Zones for River, Wetlands and Estuaries (MacFarlane *et al.,* 2014) was used to determine a desktop-level buffer width, which was based on the types of impacts associated with above-ground construction and operation of power infrastructure. The generic buffer for this type of activity is **55 m** for all aquatic ecosystems located in an area with low rainfall and with low rainfall intensity (MacFarlane *et al.,* 2014).

It is recommended that this generic buffer be reduced to the following, specifically due to the flat terrain (i.e. a flatter slope will mean that water flowing across the buffer will flow slowly, thus increasing the chance of sediment and pollutants settling out, and increasing the effectiveness of the buffer):

- » Aquatic features of high sensitivity: 30m buffer

5. ASSESSMENT OF PROPOSED IMPACTS

Identification of Potential Impacts and Associated Activities

According to the current layout, construction, operation and decommission will lead to direct and potential indirect loss of / or damage to freshwater resources. This will lead to localised loss of freshwater resources and may 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 wetlands can have an impact on the functioning of those wetlands. Consequences may include:

- » increased loss of soil;
- » loss of/or disturbance to indigenous wetland vegetation;
- » loss of sensitive wetland habitats;
- » loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- » fragmentation of sensitive habitats;

- impairment of wetland function;
- change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- reduction in water quality in wetlands downstream.

Assessment of Impacts

Impact 1: *Loss of riparian systems and disturbance of the alluvial water courses during the construction, operation and decommissioning phase*

Impact Nature: This refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of geomorphological profiles (including stream beds and banks). Possible ecological consequences associated with this impact 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 the current layout includes some freshwater resource features including high sensitive larger ephemeral washes, this impact is likely to occur on-site. The placement of PV panels or any hard surface within the riparian habitat will result in the direct disturbance/replacement/loss of the of riparian zones and alluvial watercourses, being replaced by hard engineered surfaces.

Furthermore, the physical removal of the riparian zones and disturbance of any alluvial watercourses by new road crossings or upgrades of existing roads, as well as by cable crossings are likely within the watercourses within the site.

These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in loss and/or damaged vegetation.

	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**High (70)**	**Medium (55)**
Status	Negative	Negative
Reversibility	Low – Destruction of riparian vegetation will not be remedied easily.	Low – Destruction of riparian vegetation will not be remedied easily.
Irreplaceable loss of resources	Local loss of resources	Very limited loss of resources

Can impacts be mitigated?	To some degree, mainly through avoidance of highly sensitive areas and associated buffers.
Mitigation:	» The highly sensitive major ephemeral washes and their associated buffer areas should be regarded as No-Go areas for all construction activities apart from road construction/upgrading and lying of cables, and only where the use of existing access roads is not an option. » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation within the medium sensitive freshwater resource features should be allowed to persist as far as possible, with only the larger shrubs being trimmed. » Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared. » Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off. » Avoid placing any construction camps, laydown areas, substation or any buildings or storage facilities within the medium sensitive features. Construction of PV panels, access roads and underground cables are acceptable with the implementation of the mentioned mitigation measures. » 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). » As mentioned, existing roads should be used as far as possible within the high sensitive features, with new crossings being avoided as far as possible. Where no existing crossings are available the construction of new crossings can be considered: ▪ Where new water course 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 vegetation (reduce footprint as much as possible). ▪ 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, ▪ Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated to reduce the disturbance of the area within the river beds. » For construction within the smaller ephemeral washes and drainage features (medium sensitive freshwater resource features): ▪ During the construction and operational /decommissioning phase, monitor these drainage features to see if erosion issues arise and if any erosion control is required. ▪ 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. ▪ During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible. ▪ Disturbed areas may need to be rehabilitated and revegetated. ▪ Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required
Cumulative Impacts	Increase in surface run-off velocities, reduction in the potential for groundwater infiltration and the spread of erosion into downstream freshwater resource features.
Residual Impacts	» Locally altered vegetation structure, » Without the implementation of mitigation measures, possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Impact 2: *Impact on riparian systems through the increase in surface runoff on riparian form and function during the operational and decommissioning phases*

Impact Nature: The proposed PV Power Project will involve the addition of hardened areas through the establishment of solar panel foundations while some compaction of soils may occur due to site works. Service roads have the potential to further increase areas of hardening as do the temporary construction area. The substation and additional support buildings will increase hardened surfaces. The aforementioned will increase the runoff generated on site due to the addition of areas of hard surfaces and could lead to increased flood peaks downstream with increased flood risk and erosion risk, potentially reducing or disturbing important/sensitive downstream riparian habitats.		
	Without Mitigation	**With Mitigation**
Extent	Local & downstream (3)	Local (2)
Duration	Long-term (4)	Medium-term (3)
Magnitude	Moderate (7)	Moderate (6)
Probability	Definite (5)	Probable (3)
Significance	**High (70)**	**Medium (33)**
Status	Negative	Negative
Reversibility	Low – Destruction of riparian vegetation will not be remedied easily.	Low – Destruction of riparian vegetation will not be remedied easily.
Irreplaceable loss of resources	Local and downstream loss of resources	Limited loss of local resources
Can impacts be mitigated?	To some degree, mainly through avoidance of highly sensitive areas and associated buffers and through the implementation of an effective storm water management plan.	
Mitigation:	» The highly sensitive major ephemeral washes and their associated buffer areas should be regarded as No-Go areas for all construction activated	

	apart from road construction/upgrading and lying of cables, and only where the use of existing access roads is not an option. » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared. » Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off. » Vegetation within the medium sensitive freshwater resource features should be allowed to persist as far as possible, with only the larger shrubs being trimmed. » Infrastructure footprint and associated area of disturbance should be minimised as far as practically possible » Any storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Stormwater from hard stand areas, buildings and substation must be managed using appropriate channels and swales when located within steeper areas. » The runoff should be dissipated over a broad area covered by natural vegetation or managed using appropriate channels and swales. » 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. » The existing road infrastructure should be utilised as far as possible to minimise the overall disturbance » Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated in order to reduce total area of hardened, bare areas within the property. » 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.
Cumulative Impacts	Downstream alteration of hydrological regimes due to the increased run-off from the area. However due to low mean annual runoff within the region this is not anticipated due to the nature of the development.
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.

Impact 3: *Increase in sedimentation and erosion during the construction, operational and decommissioning phase*

Impact Nature: For the construction and decommissioning phases 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 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 The proposed development will require clearing of existing vegetation and disturbance of soils, specifically for the installation of foundations for PV modules, access roads, electrical cabling, substation, buildings and laydown areas. The solar panels will increase shading of the surface and may result in a decrease in vegetation cover.

Disturbed or exposed soils will increase the likelihood of soil erosion and subsequent potential sedimentation of downstream water courses during significant rainfall events. The study by Cook and McCuen (2013) found that the runoff from individual solar panels resulted in greater kinetic energy which increased potential soil erosion below panels (this potential erosion may be enhanced by panel maintenance which includes regular washing). The site is, however, located in a low rainfall area of South Africa which will reduce the potential impact with the mild topography also reducing the erosivity of runoff.		
	Without Mitigation	**With Mitigation**
Extent	Local & downstream (3)	Local (1)
Duration	Long-term (4)	Very Short Duration (1)
Magnitude	Moderate (7)	Moderate (6)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (56)**	**Low (24)**
Status	Negative	Slightly negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Local and potential loss of downstream resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation:	» The highly sensitive major ephemeral washes and their associated buffer areas should be regarded as No-Go areas for all construction activated apart from road construction/upgrading and lying of cables, and only where the use of existing access roads is not an option. » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared. » Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off. » Vegetation within the medium sensitive freshwater resource features should be allowed to persist as far as possible, with only the larger shrubs being trimmed. » 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. » 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 » 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 storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Stormwater from hard stand areas, buildings and substation must be managed using appropriate channels and swales when located within steep areas.	

	» 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 shrubland 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. » The existing road infrastructure should be utilised as far as possible to minimise the overall disturbance created by the proposed Solar PV Facility. » Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas. » Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » 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. » Containers carrying batteries (if present) should be regularly checked for leaks. If leaks are found, these containers should be repaired, replaced immediately with leaked chemicals cleaned up as soon as possible. » Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage using impermeable floors with appropriate bunding, sumps and roofing. » Handle hydrocarbons carefully to limit spillage. » Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited. » Designate a single location for refuelling and maintenance, outside of any freshwater resource features. » Keep a spill kit on site to deal with any hydrocarbon leaks. » Remove soil from the site which has been contaminated by hydrocarbon spillage.
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However due to low mean annual runoff within the region this is not anticipated due to the nature of the development together with the proposed layout.
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.

Cumulative Impacts

All existing (authorised) renewable energy projects located within an approximate radius of the 30km of the Kotulo Tsatsi Energy PV3 were taken into account (Figure 9).

Cumulative Impact 1: *Compromise ecological processes as well as ecological functioning of important freshwater resource habitats*

Impact Nature: Transformation of intact freshwater resource habitat could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to habitat fragmentation and potentially 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 and Downstream areas (3)
Duration	Long Term (4)	Long Term (4)
Magnitude	Minor (4)	Moderate (6)
Probability	Improbable (2)	Probable (3)
Significance	**Low (18)**	**Medium (39)**
Status	Negative	Negative
Reversibility	Moderate to Low	Moderate to Low
Irreplaceable loss of resources	No	Limited loss of local resources
Can impacts be mitigated?	Yes	
Mitigation	» All highly sensitive major ephemeral washes and their associated buffer areas should be regarded as No-Go areas for all construction activities apart from road construction/upgrading and lying of cables, and only where the use of existing access roads is not an option. » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. » Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared. » The potential stormwater impacts of the proposed developments areas should be mitigated on-site to address any erosion or water quality impacts. » Good housekeeping measures as stipulated in the EMPr for the project should be in place where construction activities take place to prevent contamination of any freshwater features. » Where possible, infrastructure should coincide with existing infrastructure or areas of disturbance (such as existing roads). » Disturbed areas should be rehabilitated through reshaping of the surface to resemble that prior to the disturbance and vegetated with suitable local indigenous vegetation.	

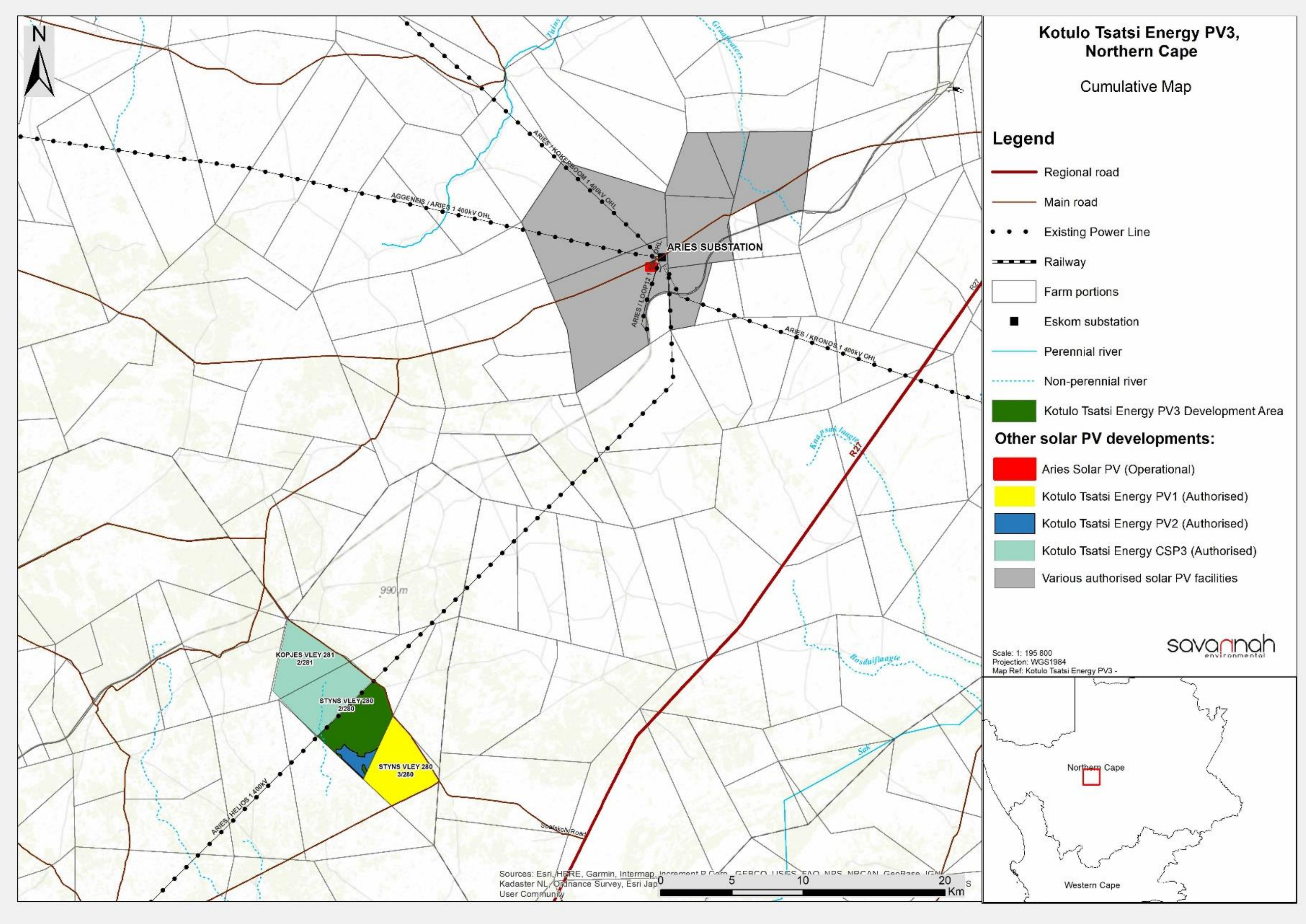

Figure 9: The location of the Kotulo Tsatsi Energy PV3 in relation to other renewable energy projects within a radius of 30km from the Kotulo Tsatsi Energy PV3 (Map provided by Savannah Environmental).

6. CONCLUSION

Nkurenkuru Ecology and Biodiversity was appointed by Savannah Environmental (Pty) Ltd to undertake freshwater resource and biodiversity study and assessment for the proposed Kotulo Tsatsi Energy PV3. The proposed PV energy facility cover an area of approximately 1200 ha and will have a generating capacity of up to 480MW. The proposed facility will be located within Portion 2 of the farm Styns Vley 280. The affected property is located approximately 70km (south-west) from the town of Kenhardt and 60km (north) of the town of Brandvlei within the Hantam Local Municipality and the Namakwa District Municipality in the Northern Cape Province.

This study has been commissioned to meet the requirements of the BA process in the form of a Basic Assessment (BA) 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.

On the Kotulo Tsatsi Energy PV2 project site, there are a number of rivers running across the site, all of which ultimately confluence with the Grootvloer / Brandvlei pan/depression system to the south. The Sak River also flows into these extensive depression features around Brandvlei, and then into the Grootvloer pan/depression just to the north, which only flows out northwards during periods of high flow, flowing into the Hartbees River and then the Orange River.

- » A total of 134 freshwater resource features were identified and delineated and include:
  - Seven (7) Depression Wetland (located outside of the proposed development footprint);
  - Three (3) large primary/major ephemeral washes;
  - Thirty-eight (38) minor ephemeral washes;
  - one hundred and seven (107) drainage channels.

Very little change has occurred to the hydrological and geomorphological characteristics of most of the freshwater resource features, appart from two wetland features which have been significantly impacted through historical cultivation (WT 1) and dam construction (WT 4). The vegetation characteristics of all of these freshwater resource features have been impacted by grazing in the past and have allowed for some encroachment of especially

Rhigozum trichotomum within the ephemeral wash and drainage systems and *Rosenia spinescens* within some portions of the depression wetland. Some of the smaller ephemeral washes as well as the "vloere" located within the larger ephemeral washes, contain old (historical) plough lines. It is unclear if these ploughing activities were an attempt to cultivate within the deeper soil profiles or if it was an attempt to facilitate vegetation establishment. Other, "minor" impacts include twin track crossings, farm fences, soil capping and sheet erosion. A few of the ephemeral washes to the north and east are crossed by the larger gravel access route.

Subsequently, the majority of these freshwater systems are still in a mostly natural, functional condition.

Catchment Context (Regional Hydrological Setting):

» The project site is located within the Lower Orange Water Management Area (WMA) and within the DWS Quaternary catchment D57D and is primarily drained by the Sak River and its associated tributaries.
» The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge et al., 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers.
» A review of the NFEPA as well as the CBA coverage for the for the study area revealed that three depression wetland features were located within project site, although all of these features were located outside of the proposed development footprint. These depression wetlands are regarded as FEPAs and is classified as CBA1 features. Each CBA1 feature is furthermore surrounded by a buffer area classified as CBA2. Desktop and infield delineation of freshwater resource features within the potential area of influence, confirmed the presence of these depression wetland feature along with an additional four other depression wetlands. Due to the current layout of the proposed PV facility, these FEPA/CBA wetlands will not be significantly impacted.
» A fairly short watercourse that flows through the south-western corner of the project site has been captured by the NFEPA and NC CBA spatial data and has been classified as an Upstream Management River (NFEPA) as well as an Ecological Support Area (NC CBA Map). Furthermore, a buffer area of 500m around this watercourse have also been classified as an ESA. This watercourse is however excluded from the proposed development footprint.

- Furthermore, the entire project site is located within a sub-quaternary catchment classified as an "Upstream Management Area". These UMA 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 (Driver et al., 2011).

Assessment of Depression Wetland Feature

- Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of seven depression wetlands units within the project site, with one wetland feature located within the proposed development footprint.
- The findings of the baseline wetland assessment suggest that most of the depression wetlands are still in a Natural/Unmodified condition (PES: A). However, the vegetation has been moderately modified as a result of historical grazing.
- WT 1, however have been historically cultivated and have subsequently been significantly modified (PES: E); whilst a portion of WT 4 have been impacted by a dam that have been constructed just at the edge of the downslope boundary of the wetland feature and has resulted in this wetland being largely modified (PES: D)
- Following the Ecological Importance and Sensitivity (EIS) assessment, it was found that all of these wetland habitats, no matter the extent these features have been impacted, are still considered to be ecologically important and sensitive (Class B: High EI&S)
- According to the DWA Buffer Tool a buffer zone of 30m for this wetland feature is recommended.
- This wetland features as well as its associated buffer are is regarded as a No-Go area for all activities, and must be maintained in a similar condition.

Assessment of Major Ephemeral Streams/Watercourses

- According to the baseline assessment three primary/major ephemeral washes, were assessed.
- These delineated features mostly represent larger and wider watercourses that include broad watercourses that lack distinct channel development
- These washes are classified as Lower Foothill Rivers.
- Most of the washes lacked distinct channel features and are either diffuse or display braided channel configuration referred to as *bar and swale* topography
- The findings of the Index of Habitat Integrity assessment suggest that these major ephemeral washes are still in a Natural/Unmodified condition (PES: A). Similarly, to the wetland features, as well as most of the smaller ephemeral washes, the vegetation

structure has been slightly impacted through long term, historical grazing. However, the vegetation structure and composition are still regarded to be Largely Natural.

- All of these major ephemeral washes are regarded as of High Ecological Significance and Importance due to the functions and services provided by these features.
- According to the DWA Buffer Tool a buffer zone of 30m for this wetland feature is recommended.
- These major ephemeral washes along with their buffer areas are regarded as No-Go Areas for all activities associated with the PV development apart from unavoidable road crossings.
- According to the current layout, some portions of these high sensitive features fall within the proposed development footprint. These areas should however be excluded from the development footprint and should be maintained in a similar condition.

Assessment of Minor Ephemeral Streams/Watercourses

- These smaller washes are typically found within smaller valley floor areas, indicating that these smaller valley floors do not have the same flood-buffering capacities as the larger ephemeral washes. Generally, the steeper the surrounding undulating low slopes, the larger the drainage lines with a more pronounced and deeper sand-bed in the centre, resulting from many centuries of accumulation of sands.
- These smaller, more isolated valley floor systems in general were found to be more prone to degradation – often visible by the formation of smaller washes and/or occasional dense encroachment by spiny high shrubs, most notably of *Rhigozum trichotomum*. It was then also quite significant that these smaller valley floor systems had a much lower apparent utilisation by livestock and game, although the presence of smaller fauna (birds, rodents) still seemed higher than on surrounding rocky plains.
- Even though being more prone to degradation, these features were still in a Largely Natural Condition.
- These smaller ephemeral washes were determined to be of Medium Ecological Sensitivity and Importance.
- The medium sensitive minor washes are not considered no-go areas. However, development within these areas shall be subjected to strict mitigation measures including the management of surface water runoff, erosion monitoring and mitigation as well as constraints regarding the clearing of vegetation within these areas.

Assessment of Smaller Ephemeral Drainage Lines/Channels

- According to the baseline assessment a total of one-hundred and seven (107) smaller ephemeral drainage lines were identified, delineated and assessed,
- These "lines" are marginal in nature with moderately developed channel structures
- No hydromorphic (wetland soil) or hydrophyte (wetland plant) indicators were recorded in these watercourses.

- These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions.
- The findings of the baseline wetland assessment suggest that these drainage lines are all in an unmodified condition,
- Following the Ecological Importance and Sensitivity (EIS) assessment, it was found that these drainage lines were of moderate ecological importance and sensitivity (Class C: Moderate EI&S)
- These medium sensitive drainage lines are not considered no-go areas. However, development within these areas shall be subjected to strict mitigation measures including the management of surface water runoff, erosion monitoring and mitigation as well as constraints regarding the clearing of vegetation within these areas.

Proposed Optimised Layout

- The client has since adjusted the layout of the SEF in order to address some of the constraints (refer to Figure 23 for an illustration of the new optimised layout).
- The new layout is deemed an improvement from an aquatic perspective, however still not completely satisfactory.
- The layout can and should still be refined in order to completely avoid all high sensitive aquatic features.

Recommendations

- The depression wetland feature along with its associated 30m buffer is regarded as a No-Go Area and should be excluded from all activities associated with the PV development. This wetland feature should be maintained a similar natural condition.
- The major ephemeral ashes along with their 30m buffers is regarded as No-Go Areas for all activities apart from road construction/upgrading and lying of cables, and only where the use of existing access roads is not an option.
    - As portions of these larger ephemeral washes are located within the current development footprint, it is recommended that this development footprint is adjusted in order to avoid these sensitive features.
    - Where no existing crossings are available the construction of new crossings can be considered:
        - Where new water course 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 vegetation (reduce footprint as much as possible).
        - 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,

- Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated to reduce the disturbance of the area within the river beds.

» The minor ephemeral washes and drainage lines located within the current development footprint is NOT regarded as No-Go Areas for the Solar PV field, roads and underground cables.
  - However, laydown areas, site camps, offices, facility substations or any building infrastructure may not be located within any of these features;
  - Vegetation within the medium sensitive freshwater resource features should be allowed to persist as far as possible, with only the larger shrubs being trimmed.
  - Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off.
  - These areas' natural morphology should be maintained.
  - Where deemed necessary erosion control measures should be installed along these ephemeral features and may include silt fences etc.
  - During the construction and operational /decommissioning phase, monitor these drainage features to see if erosion issues arise and if any erosion control is required.
  - 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.
  - Any storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities, especially along these smaller ephemeral features as these systems feed into the larger ephemeral washes.
  - 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, especially along these ephemeral systems.

With these recommendations and mitigation measures in place, impacts on the surface water resource integrity and functioning can be potentially reduced to a sufficiently low level. 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 Kotulo Tsatsi Energy PV1 project detailed in this report could be authorised from a surface water resource perspective.

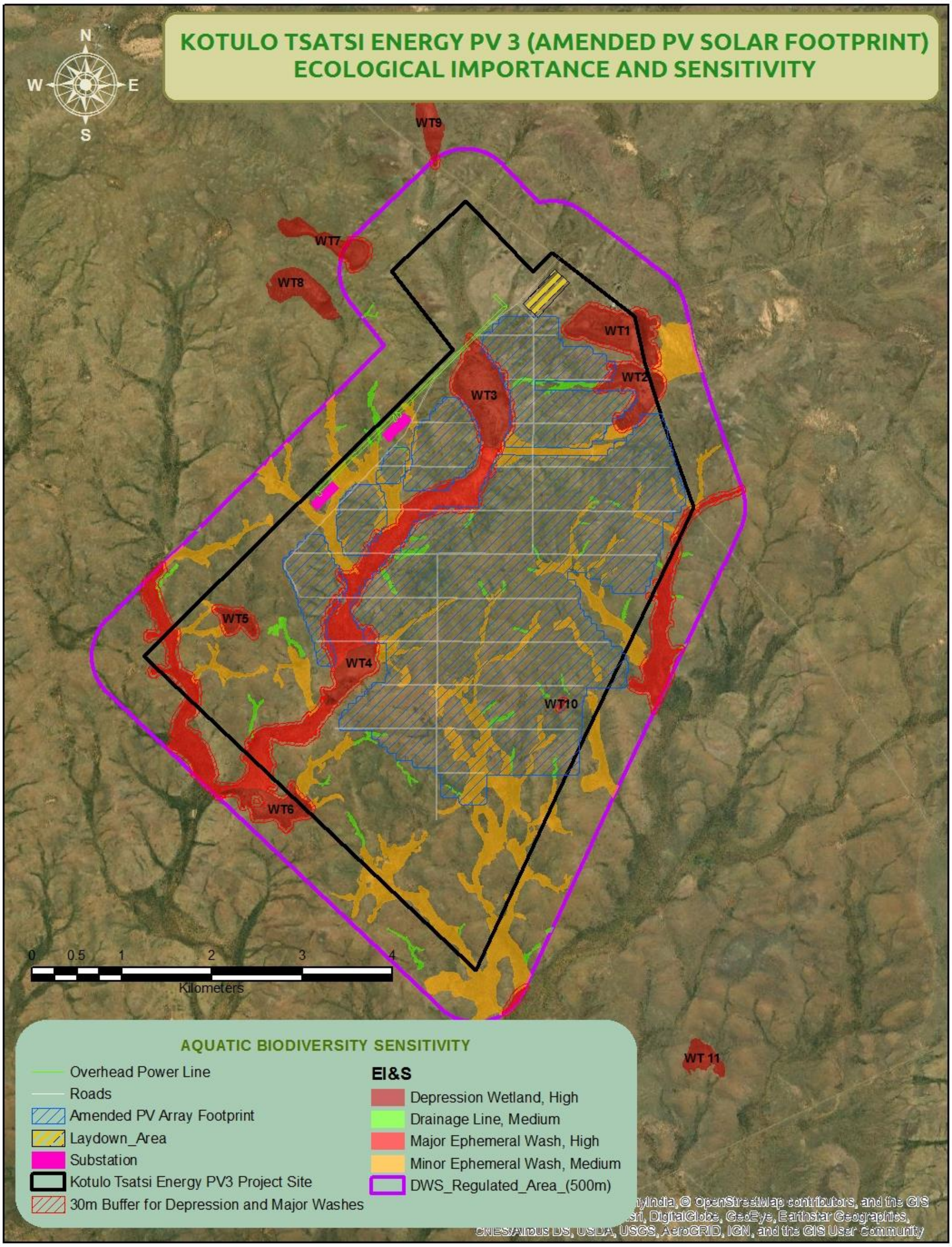

Figure 10: Proposed adjusted layout.

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8. APPENDICES

Appendix 1 Methodology: Freshwater Resource

Survey methods

The assessment was initiated with a survey of the pertinent literature, past reports, and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

The desktop delineation of all surface water resources (i.e. rivers, streams, and wetlands) within 500m of the proposed development (i.e. the DWS regulated area for Water Use in terms of Section 21 of the National Water Act) was undertaken by analysing available contour data and colour aerial photography, supplemented by Google EarthTM imagery where applicable. Digitization and mapping were undertaken using ArcMap GIS software. All of the mapped watercourses were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems/habitat) based on professional experience, topographical setting, and drainage patterns. Following the mapping of water resource units within 500m of the proposed development, the risk posed by the development to freshwater ecosystems was screened at a desktop level and ascribed a qualitative risk rating. The potential risks were also identified based on the nature of the proposed development and professional experience with similar developments, as well as based on ground-truthing of mapped watercourses in the field.

A two-day site visit was then conducted to ground-truth the above findings, thus allowing critical comments of the development when assessing the possible impacts and delineating the freshwater resource areas.

» The following equipment was utilized during fieldwork.
- Canon EOS 450D Camera
- Garmin Etrex Legend GPS Receiver
- Soil Auger
- Munsell Soil Colour Chart (2000)
- Braun-Blanquet Data Form (for vegetation recording and general environmental recordings).

Freshwater resource areas were then assessed on the following basis:

- Identification and delineation of wetlands and riparian areas according to the procedures specified by DWAF (2005a).
- Vegetation type – verification of type and its state or condition-based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended), and the South African Biodiversity Information Facility (SABIF) database.
- Plant species were further categorised as follows:
    - Terrestrial/Upland: species are rarely found within the riparian zone (<25% probability) and characterize the terrestrial landscape that borders the riparian zones. Upland species usually occur naturally in the upper parts of the riparian zone, but with low relative abundance (DWAF, 2008).
    - Facultative riparian: species may occur in either riparian zones or the upland (25>% probability of occurrence in the riparian zone). They can habituate to more mesic conditions with a high probability of survival, or can tolerate higher levels of flooding disturbance or soil moisture. They are not good national indicators, but rather circumstantial indicators good for particular regions (DWAF, 2008).
    - Preferential riparian: these area species that are preferentially, but not exclusively, found in the riparian zone (>75% probability). They may be found in non-riparian areas as indicators of wetness. Where they do occur in the upland, they show progressive reductions in abundance, statue, and vigour farther from the riparian zone. Preferential riparian species may harden to drought conditions, but will always indicate sites with increased moisture availability, and are therefore consistent indicators across geographic boundaries (DWAF, 2008).
    - Obligate: these species occur almost exclusively in the riparian zone (>90% probability). They are seldom found in non-riparian areas, but where they are outside of riparian areas, they still indicate wetness. They are not likely to occur in the upland. Obligate riparian species are conservative as such i.e. an obligate will remain obligate throughout all geographic regions (DWAF, 2008).
- Assessment of the freshwater resources based on the method discussed below and the required buffers.
- Mitigation or recommendations required.

Classification System for Wetlands and other Aquatic Ecosystems in South Africa System (SANBI, 2013)

Since the late 1960’s, wetland (including other freshwater ecosystems) classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith et al., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with several specialists and stakeholders developed in 2010 the newly revised accepted National Wetland Classification Systems (NWCS, 2010). In 2013 however, this classification system (National Wetland Classification System) underwent a name change to now be known as the 'Classification System for Wetlands and other Aquatic Ecosystems in South Africa'. This was done to avoid confusion around the term 'wetland' which is defined differently by the RAMSAR Convention and the South Africa National Water Act (Act No. 36 of 1998). The scope of the Classification System has not been changed, however, in that it still includes all ecosystems that the RAMSAR Convention is concerned with.

This classification system includes and distinguishes between three broad types of inland aquatic/freshwater systems namely:

» Rivers, which are 'lotic' aquatic ecosystems with flowing water concentrated within a distinct channel, either permanently or periodically.
» Open water bodies, which are permanently inundated 'lentic' aquatic ecosystems where standing water is the principal medium within which the dominant biota live. In this system, open water bodies with a maximum depth of greater than 2m are called limnetic (lake-like) systems.
» Wetlands are transitional between aquatic and terrestrial systems and are generally characterised by (permanently to temporarily) saturated soils and hydrophytic vegetation. These areas are, in some cases, periodically covered by shallow water and/or may lack vegetation.

The basis upon which this classification system is based on is the principles of the Hydrogeomorphic (HGM) approach at higher levels, including structural features at the finer or lower levels of classification (SANBI, 2013) (Table 11).

Table 11: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and sub-categories at Levels 4B to 4C.

Level 4: Hydrogeomorphic (HGM) Units		
HGM Type	**Longitudinal zonation/Landform/Outflow drainage**	**Landform/Inflow drainage**
River	Mountain headwater stream	Active channel
		Riparian Zone
	Mountain Stream	Active channel
		Riparian Zone
	Transitional	Active channel
		Riparian Zone
	Upper foothills	Active channel
		Riparian Zone
	Lower foothills	Active channel
		Riparian Zone
	Lowland river	Active channel
		Riparian Zone

	Rejuvenated bedrock fall	Active channel
		Riparian Zone
	Rejuvenated foothills	Active channel
		Riparian Zone
	Upland floodplain	Active channel
		Riparian Zone
Channeled valley-bottom wetland	N/A	N/A
Unchanneled valley-bottom wetland	N/A	N/A
Floodplain	Floodplain depression	N/A
	Floodplain flat	N/A
Depression	Exorheic	With channeled inflow
		Without channeled inflow
	Endorheic	With channeled inflow
		Without channeled inflow
	Dammed	With channeled inflow
		Without channeled inflow
Seep	With channeled outflow	N/A
	Without channeled outflow	N/A
Wetland Flat	N/A	N/A

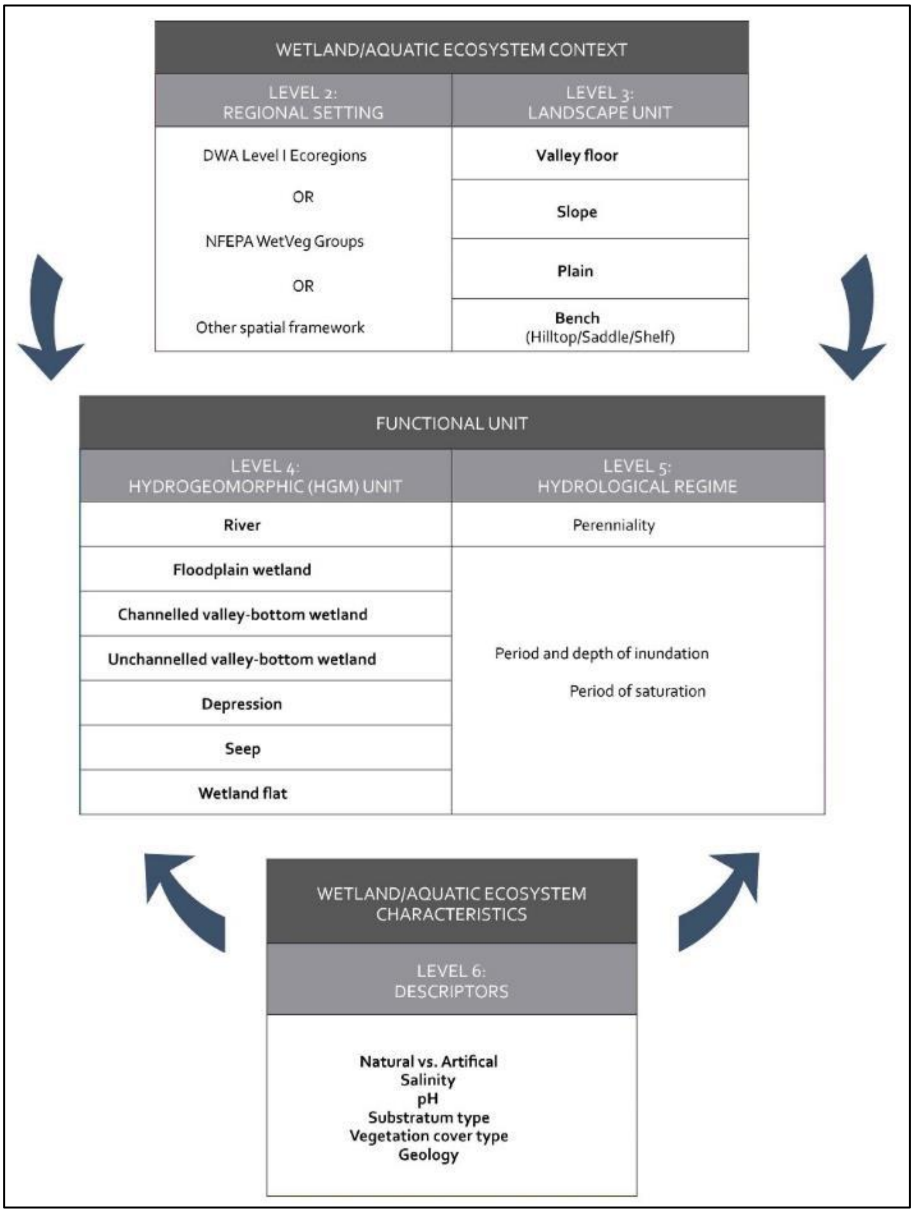

Figure 11: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

It is widely accepted that hydrology (i.e. the presence or movement of water) and geomorphology (i.e. landform characteristics and processes) are the two fundamental features that determine the way in which an inland aquatic ecosystem functions, regardless of climate, soils, vegetation or origin. Subsequently, it is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs.

In summary, the overall structure of this classification system comprises six tiers. This tiered structure is summarised in Figure 11 with Level 4 tier (HGM Units), as mentioned, forming the focal point of this system together with Level 5 tier (hydrological regime).

Some of the terms and definitions used in this document are present below:

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form) but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as "**areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres**" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard et al., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten meters. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are 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 supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a watercourse (SANBI, 2009). The DWA is however reconsidering this position concerning the management of estuaries due to the ecological needs of these systems concerning water allocation. Table 12 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open water bodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must, therefore, have one or more of the following attributes to meet the above definition (DWAF, 2005):

» A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
» Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
» The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water-loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 12: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describe as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[3]	NO

[3] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act.

Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[4] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES3
Riparian areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[5]

Rivers: a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow (unidirectional) of water. A river is taken to include both the active channel and the riparian zone as a unit (SANBI, 2013).

Dominant water sources for rivers include concentrated surface flow from upstream channels and tributaries. Other inputs can include diffuse surface or subsurface flow (e.g. from an upstream seepage wetland), interflow (e.g. from an upstream seepage wetland), interflow (e.g. from valley side-slopes), and/or groundwater inflow (e.g. from springs). Water moves through the system, at least periodically, as concentrated flow and usually exits as such, except where there is a sudden decrease in gradient causing the outflow to become diffuse (in which case the river would grade into one of the wetland types). Other water outputs from a river include evapotranspiration and infiltration (SANBI, 2013) (refer to Figure 12).

[4] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[5] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

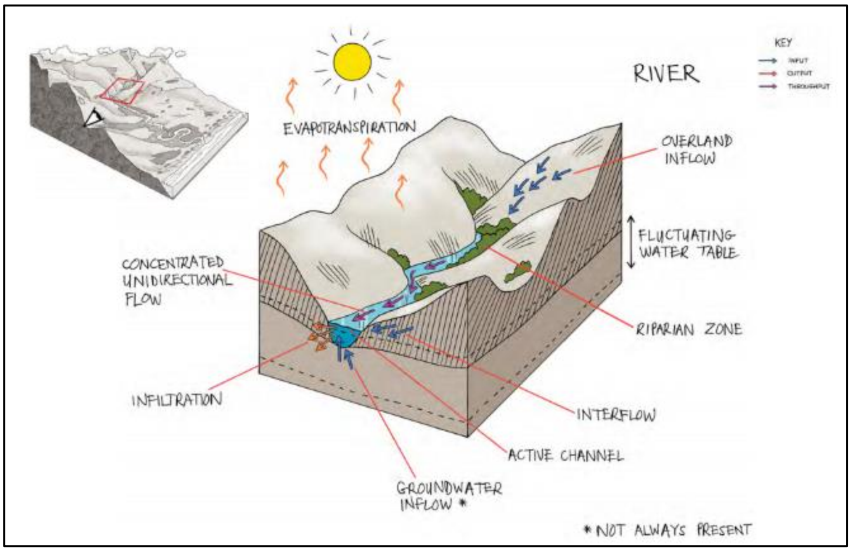

Figure 12: A conceptual illustration of a river as provided by SANBI, 2013.

Riparian zone: According to the definition provided by DWAF (2008), a riparian zone can be described as:

"*the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas*"

Furthermore, DWAF (2008) states that:

"*unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel*."

Riparian vegetation may be associated with both perennial and non-perennial watercourses/rivers. Riparian areas furthermore represent the transitional area between aquatic and terrestrial habitats. The vegetation associated with riparian zones typically require ample water and are adapted to shallow water table conditions as well as periodical flooding. Due to water availability and rich alluvial soils, riparian areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush in comparison to the upland terrestrial vegetation (refer to Figure 13).

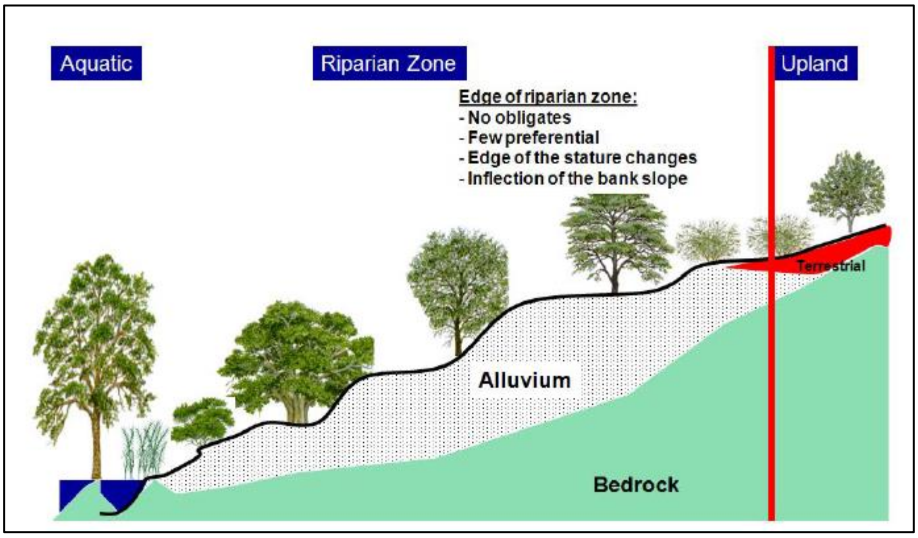

Figure 13: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river (DWAF, 2008).

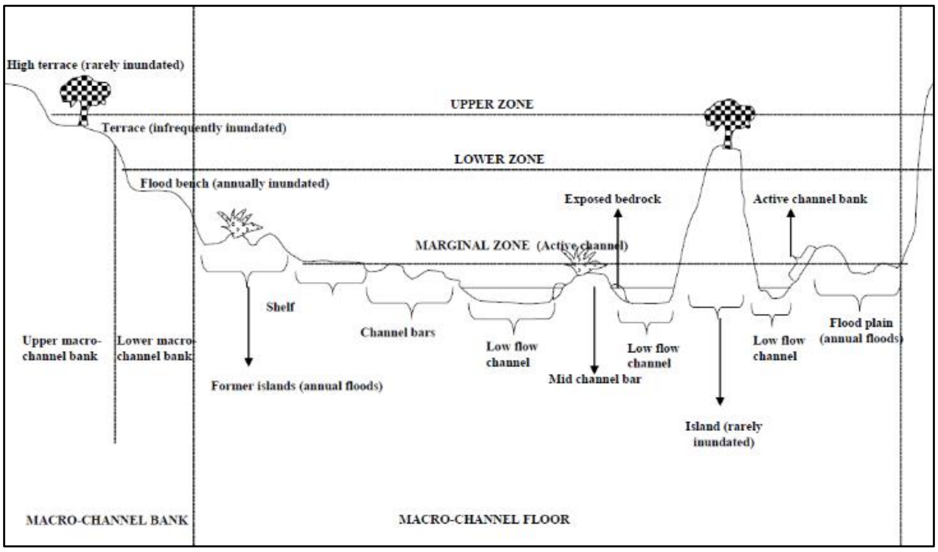

Figure 14: A schematic diagram illustrating (example) the different riparian zones relative to the different geomorphic zones typically associated with a river (Kleynhans *et al*., 2008).

The structure and dynamics of riparian zones are highly variable and are mostly an expression of the hydrological and geomorphological nature of watercourse (Figure 14 and Table 12). As such DWAF (2008) has recommended that the type of river or stream channel with which the riparian zone is associated be considered (Table 14).

Indicators of riparian areas include:

- Landscape position:
  - Riparian areas are associated with valley bottom landscape units (i.e. adjacent to the river/stream channel and floodplains).
- Alluvial soils and recently deposited material:
  - Alluvial soils are soils derived from material deposited by flowing water.

- » Alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas but it can be used to confirm the topographical and vegetative indicators.
- » Topography:
  - » The National Water Act definition of riparian zones refers to the structure of the banks and likely the presence of alluvium.
  - » A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised "macro-channels" which are typical of many of southern Africa's eastern seaboard rivers.
  - » Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus, the likely presence of wetlands.
- » Vegetation:
  - » The identification of riparian areas relies heavily on vegetative indicators (Unlike wetland delineation which relies on redoximorphic features in soil).
  - » Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs:
    - in species composition relative to the adjacent terrestrial area; and
    - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure, and/or numbers of individual plants.
  - » In addition to indicators of structural differences in vegetation, indicator species themselves can be used to denote riparian areas (e.g. Obligate-, Preferential- and Facultative riparian species).

Table 13: Geomorphological longitudinal river zones for South African rivers as characterized by Rowtree & Wadeson (2000) (SANBI, 2013).

Longitudinal Zone (and zone class)	Characteristic gradient	Diagnostic channel characteristics
Zonation associated with a normal profile		
Source zone	Not specified	Low-gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	>0.1	A very steep-gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	0.040-0.099	Steep-gradient steam dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, plane bed. Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	0.020-0.039	Moderately steep stream dominated by bedrock or boulders. Reach types include plane bed, pool-rapid, or pool-riffle. Confident or semi-confined valley floor with limited floodplain development.
Upper foothills	0.005-0.019	Moderately steep cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool-riffle reach types. Length of

		pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
Lower foothills	0.001-0.005	Lower gradient, mixed-bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock-controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of a significantly greater extent than rapids or riffles. Floodplain often present.
Lowland River	0.0001-0.0010	Low-gradient, alluvial sand-bed channel, typically regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increase in silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile		
Rejuvenated bedrock fall/cascades	>0.02	Moderate to steep gradient, often confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
Rejuvenated foothills	0.001-0.020	Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge; characteristic similar to foothills (gravel/cobble-bed rivers with pool-riffle/pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a micro-channel activated only during infrequent flood events. A floodplain may be present between the active and macro-channel.
Upland floodplain	<0.005	An upland low-gradient channel, often associated with uplifted plateau areas as occurring beneath the eastern escarpment.

Table 14: A description of the different riparian vegetation zones typically associated with a river/stream system (Kleynhans *et al*., 2008).

	Marginal	Lower	Upper
Alternative Description	Active features (Wet bank)	Seasonal features (Wet bank)	Ephemeral features (Dry bank)
Extends from	Water level at low flow	Marginal Zone	Lower Zone
Extends to	Geomorphic features/substrates that are hydrologically activated (inundated or moistened) for the greater part of the year	Usually a marked increase in lateral elevation.	Usually a marked decrease in lateral elevation
Characterized by	See above; Moist substrates next to water's edge; water loving-species usually vigorous due to near-permanent access to soil moisture	Geomorphic features that are hydrologically activated (inundated or moistened) on a seasonal basis. May have different species than marginal zone	Geomorphic features that are hydrological activated (inundated or moistened) on an ephemeral basis. Presence of riparian and terrestrial species with increased stature.

Importance and functions of riparian areas

Riparian areas perform a variety of functions that are of value to society, especially the protection and enhancement of water resources, and the provision of habitat for plant and animal species.

Riparian areas can variously:

» store water and help reduce flood peaks;
» stabilize stream banks;
» improve water quality by trapping sediment and nutrients;
» maintain natural water temperature through shading for aquatic species;
» provide shelter, food and migration corridors for the movement of both aquatic and terrestrial species;
» act as a buffer between aquatic ecosystems and adjacent upslope land uses;
» can be used as recreational sites; and
» provide material for building, muti, crafts, and curios.

However, as mentioned, the structure and dynamics of riparian zones are highly variable and as such not all riparian areas are capable of fulfilling all of these functions or to the same extent.

Habitat Integrity and Condition of the Affected Freshwater Resources:

To assess the Present Ecological State (PES) or condition of the observed wetlands, a modified Wetland Index of Habitat Integrity (DWAF, 2007) was used. The Wetland Index of Habitat Integrity (WETLAND-IHI) is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The output scores from the WETLAND-IHI model are presented in the standard DWAF A-F ecological categories (Table 13), and provide a score of the Present Ecological State of the habitat integrity of the wetland system being examined. The author has included additional criteria into the model-based system to include additional wetland types. This system is preferred when compared to systems such as WET-Health – wetland management series (WRC 2009), as WET-Health (Level 1) was developed with wetland rehabilitation in mind, and is not always suitable for impact assessments. This coupled to the degraded state of the wetlands in the study area, a complex study approach was not warranted, i.e. conduct a Wet-Health Level 2 and WET-Ecosystems Services study required for an impact assessment.

Table 15: Description of A – F ecological categories based on Kleynhans et al., (2005).

ECOLOGICAL CATEGORY	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A	Unmodified, natural.	Protected systems; relatively untouched by human hands; no discharges or impoundments allowed
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	Some human-related disturbance, but mostly of low impact potential
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	

The WETLAND-IHI model is composed of four modules. The "Hydrology", "Geomorphology" and "Water Quality" modules all assess the contemporary driving processes behind wetland formation and maintenance. The last module, "Vegetation Alteration", provides an indication of the intensity of human land use activities on the wetland surface itself and how these may have modified the condition of the wetland. The integration of the scores from these 4 modules provides an overall Present Ecological State (PES) score for the wetland system being examined. The WETLAND-IHI model is an MS Excel-based model, and the data required for the assessment are generated during a rapid site visit.

Additional data may be obtained from remotely sensed imagery (aerial photos; maps and/or satellite imagery) to assist with the assessment. The interface of the WETLAND-IHI has been developed in a format that is similar to DWAF's River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Conservation importance of the individual wetlands was based on the following criteria:

- Habitat uniqueness
- Species of conservation concern
- Habitat fragmentation concerning ecological corridors
- Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near-natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a species of conservation concern were observed (HIGH). Any systems that were highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating.

Wetland Ecological Importance and Sensitivity (EIS)

The outcomes of the wetland functional assessment were used to inform an assessment of the importance and sensitivity of wetland systems using the Wetland EIS (Ecological Importance and Sensitivity) assessment tool. The Wetland EIS tool includes an assessment of three components:

- Biodiversity support;
- Landscape-scale importance;
- Sensitivity of the wetland to floods and water quality changes.

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 16.

Table 16: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
None, Rating=0	Rarely sensitive to changes in water quality/hydrological regime.
Low, Rating=1	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate, Rating=2	Some elements sensitive to changes in water quality/hydrological regime.
High, Rating=3	Many elements sensitive to changes in water, quality/hydrological regime.
Very High, Rating=4	Vary many elements sensitive to changes in water quality/hydrological regime.

Appendix 2: Methodology: Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

- The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.

- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional,

Immediate area	1
Whole site (entire surface right)	2
Neighboring areas	3
Regional	4
Global (Impact beyond provincial boundary and even beyond SA boundary)	5

» The **duration**, wherein it was indicated whether:

Lifetime of the impact will be of a very short duration (0 – 1 year)	1
The lifetime of the impact will be of a short duration (2 – 5 years)	2
Medium-term (5 -15 years)	3
Long term (> 15 years)	4
Permanent	5

» The **magnitude**, quantified on a scale from 0 – 10,

small and will have no effect on the environment	2
minor and will not result in an impact on processes	4
moderate and will result in processes continuing but in a modified way	6
high (processes are altered to the extent that they temporarily cease)	8
very high and results in complete destruction of patterns and permanent cessation of processes	10

» The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5,

very improbable (probably will not happen)	1
improbable (some possibility, but low likelihood)	2
probable (distinct possibility)	3
highly probable (most likely)	4
definite (impact will occur regardless of any prevention measures)	5

» The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as;
   » **LOW**,
   » **MEDIUM** or
   » **HIGH**;

» the **status**, which was described as either positive, negative or neutral.
» the degree of which the impact can be reversed,
» the degree to which the impact may cause irreplaceable loss of resources,
» the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

» S = Significance weighting
» E = Extent

- » D = Duration
- » M = Magnitude
- » P = Probability

The significance weightings for each potential impact are as follows;

Table 17: Rating table used to rate level of significance.

RATING	CLASS	MANAGEMENT DESCRIPTION
< 30	**Low (L)**	Where the impact would not have a direct influence on the decision to develop the area.
30 - 60	**Medium (M)**	Where the impact could influence the decision to develop in the area unless it is effectively mitigated.
> High	**High (H)**	Where the impact must have an influence on the decision process to develop in the area.

Appendix 2. Specialist CV.

CURRICULUM VITAE:

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
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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. 10st 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 3. Specialist's 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).

Appendix 4. SACNASP CERTIFICATE

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Gerhardus Alfred Botha

Registration number: 400502/14

is registered as a

Professional Natural Scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule I of the Act)

Ecological Science	**28 January 2015**
Botanical Science	**19 November 2014**

COSTOS SCIENTIARUM NATURALIUM

28 January 2015		
Pretoria	President	Executive Director