AQUATIC IMPACT ASSESSMENT REPORT

For The

PROPOSED PHASE 1 GILIMBERG RE 1, 200MW CLUSTER SOLAR PV FACILITY AND ASSOCIATED INFRASTRUCTURE IN MOGALAKWENA LOCAL MUNICIPALITY, WATERBERG DISTRICT, LIMPOPO PROVINCE.



NOVEMBER 2026

Prepared by:	**Prepared for:**
Sediba Sa Metse (Pty) Ltd 798 Gambry Avenue, Doornpoort, 0186. Pretoria E-mail: **rebotile@sedibasametse.co.za**	**Abantu Environmental Services** Eastern Cape, Gqeberha 078 207 8278

STRICTLY CONFIDENTIAL

1. Document Control

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AUTHOR (s)	**Chaba, R** (Pr. Sci. Nat. 154249) BSc. Hons. Environmental Monitoring and Modeling **Mashaba, P.N** Master of Applied Science, Nature Conservation, Plant Ecology (TUT)
First Draft Date Produced	October 2026

ASPECT INVESTIGATED	**SPECIALIST NAME**	**QUALIFICATIONS & SACNASP registration number**	**DATES OF FIELD SURVEYS**
Aquatic	Peter Nyeko, Mashaba 10 years +	Master of Applied Science, Nature Conservation, Plant Ecology (TUT) • Introduction to Wetlands • Tools for Wetland Assessments (*GroundTruth*)	30 Oct 2026
Aquatic	Chaba, Rebotile 12 years +	Honours Degree. Environmental Monitoring and Modelling and Advanced Dip. Nat. Conservation *SACNASP: 154249)* • Introduction to Wetland, Tools for Wetland Assessments (*GroundTruth*)(*GroundTruth*) and Wetland Legislation (*WetRest)*	30 Oct 2026

2. EXECUTIVE SUMMARY

Sediba Sa Metse (Pty) Ltd was appointed to undertake a Aquatic Biodiversity Impact Assessment for the proposed Phase 1 Gilimberg RE 1, 200MW Cluster Solar PV Facility and associated infrastructure, including its 2km powerline, located approximately 2km east of Mars Village in the Mogalakwena Local Municipality, Waterberg District, Limpopo Province. The assessment, at the 300ha, was conducted in accordance with relevant environmental legislation, including the National Environmental Management Act (NEMA), the National Environmental Management: Biodiversity Act (NEMBA), the National Water Act (NWA), and Environmental Impact Assessment Regulations, 2014 (Amendment G. 49028, No.3717 of July 2023 and G. 43855, No. 1150 of October 2020) as in NEMA No. 107 of 1998 as per Sections 24(5)(a) and (h) and 44, and followed applicable best-practice guidelines.

The project area is characterised as a semi-natural system, historically used for game farming and subsistence agriculture, and currently utilised for communal livestock grazing, with additional disturbances including firewood collection and localised sand mining. The assessment confirmed **two watercourse systems (**per DWS guideline) and identified as **drainage lines,** within the phase 1 project site covering 200m buffer. There are named Drainage Line 1 (on the north) and Drainage Line 2 (on the south) for the purpose of this assessment. The systems's PES is determined as **Moderate (Category C)** and not sensitive to the disturbance whilst they are important to the hydrology catchment of the wide provincial value. The proposed activity has potential to destabilises or modifies the soil structure, topography, and geomorphology, impeding the natural flow of water be within the drainage lines. This assessment recommends complete avoidance of the systems and buffer them with 100m.

The proposed mitigation in this report must be implemented to the best of ability by the applicant, and duty of care must be applied. The proposed activities may be authorised with General Authorisation from competent authorities. It is the opinion of the specialist, with field-based facts and available resources, that the proposed activities of maintenance and construction of the solar plant should be considered.

3. Indemnity

- This report is based on survey and assessment techniques, which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken.
- This report is based on a desktop and field-based investigation using available information and data related to the site to be affected, *in situ* fieldwork, surveys, assessments, and the specialist's best scientific and professional knowledge.
- The Precautionary Principle has been applied throughout this investigation.
- The findings, results, observations, conclusions, and recommendations given in this report are based on the specialist's best scientific and professional knowledge as well as information available at the time of the study.
- Additional information may become known or available during a later stage of the process for which no allowance could have been made at the time of this report.
- The specialist reserves the right to modify this report, recommendations, and conclusions at any stage should additional information become available.
- Information and recommendations in this report cannot be applied to any other area without proper investigation.
- This report, in its entirety or any portion thereof, may not be altered in any manner or form or for any purpose without the specific and written consent of the specialist as specified above.
- Acceptance of this report, in any physical or digital form, serves to confirm acknowledgment of these terms and liabilities.

Lead Specialist: Rebotile Chaba

4. Declaration of Independence

First Specialist

I, Mr Rebotile Chaba declare that:

- I am an independent specialist and registered Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP Registration No. 154249).
- I have the necessary expertise, experience, and professional competence to undertake the assessment and prepare this specialist report.
- This specialist assessment has been conducted in accordance with the requirements of the Protocol for Specialist Assessment and Minimum Report Content Requirements, promulgated in terms of Government Notice No. 320 of 20 March 2020, as amended, under the National Environmental Management Act, 1998 (Act No. 107 of 1998).
- The assessment complies with the applicable requirements of the Environmental Impact Assessment Regulations and the relevant environmental theme protocol associated with this application.
- The site sensitivity verification and specialist assessment were undertaken using accepted scientific principles, professional judgement, field observations, desktop assessments, and the best available information at the time of the study.
- The findings, results, conclusions, and recommendations presented in this report are, to the best of my knowledge, scientifically sound, accurate, objective, and based on information currently available.
- I have no business, financial, personal, or other interest in the proposed activity, application, or applicant, other than remuneration for professional services rendered in connection with this assessment.
- I will perform my duties in an objective manner and will not be influenced by the applicant, Environmental Assessment Practitioner (EAP), or any interested or affected party.
- All assumptions, limitations, uncertainties, and data gaps identified during the assessment process have been disclosed in this report.

- I am aware that a false declaration may constitute an offence in terms of applicable environmental legislation.

Undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2014, as amended.

Specialist: Rebotile Chaba
Qualification: BSc Honours (Environmental Monitoring and Modelling)
Professional Registration: SACNASP Pr.Sci.Nat.: 154249
Company: Sediba Sa Metse (Pty) Ltd

Signature: 
Date: 31 October 2026

Second Specialist

I, Mr Nyeko Mashaba declare that:

- I am an independent co-specialist.
- I have the necessary expertise, experience, and professional competence to undertake the assessment and prepare this specialist report.
- This specialist assessment has been conducted in accordance with the requirements of the Protocol for Specialist Assessment and Minimum Report Content Requirements, promulgated in terms of Government Notice No. 320 of 20 March 2020, as amended, under the National Environmental Management Act, 1998 (Act No. 107 of 1998).
- The assessment complies with the applicable requirements of the Environmental Impact Assessment Regulations and the relevant environmental theme protocol associated with this application.
- The site sensitivity verification and specialist assessment were undertaken using accepted scientific principles, professional judgement, field observations,

desktop assessments, and the best available information at the time of the study.

- The findings, results, conclusions, and recommendations presented in this report are, to the best of my knowledge, scientifically sound, accurate, objective, and based on information currently available.
- I have no business, financial, personal, or other interest in the proposed activity, application, or applicant, other than remuneration for professional services rendered in connection with this assessment.
- I will perform my duties in an objective manner and will not be influenced by the applicant, Environmental Assessment Practitioner (EAP), or any interested or affected party.
- All assumptions, limitations, uncertainties, and data gaps identified during the assessment process have been disclosed in this report.
- I am aware that a false declaration may constitute an offence in terms of applicable environmental legislation.

Undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2014, as amended.

Specialist: Nyeko Mashaba
Qualification: Master of Applied Science, Nature Conservation, Plant Ecology
Company: Sediba Sa Metse Pty Ltd

Signature: 

Date: 31 October 2026

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6. LIST OF ACRONYMS & ABBREVIATIONS

BSP	Biodiversity Sector Plan
BRP	Bioregional Plan
CMS	Convention on the Conservation of Migratory Species
CBA	Critical Biodiversity Area
DEA	Department of Environmental Affairs (National)
DEAT	former Department of Environmental Affairs and Tourism (National)
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
ECA	Environmental Conservation Act, 1989 (Act No. 73 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EI	Ecological importance
ES	Ecological sensitivity
EIP	Environmental Implementation Plan
EMF	Environmental Management Framework
EMP	Environmental Management Plan
ESA	Ecological Support Area
NFEPA	National Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
ha	Hectares
IDP	Integrated Development Plan
IUCN	International Union for Conservation of Nature
NWA	National Water Act (NWA, Act 36 of 1998)
NBA	National Biodiversity Assessment 2011
NWM5	National Wetland Maps 5
ONA	Other Natural Area
PA	Protected Area

PES	Present Ecological Status
PACA	Protected Area and Conservation Area
REMP	National River Ecostatus Monitoring Program (previously the River Health Program)
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPAD	South African Protected Area Database
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SPLUMA	Spatial Planning and Land Use Management Act (No. 6 of 2013)
QGIS	Quantum Geographic Information System
WULs	Water Use Licenses

7. INTRODUCTION

Abantu Environmental Services appointed Sediba Sa Metse (Pty) Ltd to undertake an Aquatic Biodiversity Impact Assessment for the basic assessment process for a **Phase 1 Gilimberg RE 1, 200MW Cluster Solar PV Facility** and associated infrastructure, including its 2km overhead power line connecting to the Boruto Eskom substation. **The proposed 300ha site** is located approximately 30km north of Mokopane, outside Sekuruwe village, in the Mogalakwena Local Municipality, Waterberg District, Limpopo Province. A team of specialists was dispatched to the site on 30 October 2026 to conduct a field assessment and collect the necessary data. The evaluation aimed to assess the aquatic biodiversity sensitivity, status/value and importance of the area/site. The assessment used a desktop (including a literature review) and a field survey.

This assessment study was undertaken in line with the Department of Water and Sanitation (DWS) Best Practice Guideline for Impact Prediction and is guided by following legislative requirements: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment Regulations, 2014 (Amendment G. 49028, No.3717 of July 2023 and G. 43855, No. 1150 of October 2020, as in NEMA, Sections 24(5)(a) and (h) and 44; Regulation 636 under the National Environmental Management: Waste Act; National Water Act (Act 36 of 1998) (NWA); and NWA amendment of Regulation 704 (GN R 704) of 1999.

Terms of Reference

The terms of reference for this study were set and are as follows:

- Determine the present ecological status of the project site (Gilimberg Phase 1) to assist with the EA application process
- Provide the evaluation of the area's conservation importance and significance
- Compile a detailed report with maps and recommendations.

Scope of Work

The following tasks were undertaken in fulfillment of the terms of reference for this assessment:

- Conduct an aquatic desktop and field-based assessment for the proposed study
- Identify, assess, and delineate any aquatic significance of sites, areas, or features in and around the project site
- Determine sensitivity areas (maps) around the site.
- Assess current impacts and suggest mitigation measures for minimising impacts

- Produce a detailed report with findings and recommendations.

Project Area of Influence (PAOI)

The **Project Area of Influence (PAOI)** includes all areas that may be affected directly or indirectly by the proposed development.

For the **Phase 1 Gilimberg Solar Farm**, the PAOI includes:

- The development footprint, including solar panels, inverters, and associated infrastructure;
- All access roads, cabling routes, and powerline connections;
    - Areas affected by indirect impacts, including:
    - Dust generation
    - Noise disturbance
    - Soil erosion and runoff
    - Alteration of natural drainage patterns

The PAOI was used to assess ecological receptors, including vegetation communities, fauna, and SCC, in line with the Species Environmental Assessment Guideline

Protocol Compliance Statement

This Aquatic Biodiversity Impact Assessment has been conducted in accordance with:

- DFFE Aquatic Biodiversity Assessment Protocol (GN 320 of 2020)
    - DFEE Screening Tool
    - Site assessment and verification
- Wetland Delineation and Classification Guidelines
- Environmental Assessment Guideline for Ecosystems (SANBI, Version 2, 2023);
- The Species Environmental Assessment Guideline (2022);
- SANBI Freshwater Biodiversity Planning Tools
- DWS Updated Manual for Identification and Delineation of Wetlands and Riparian Areas, 2008;
- National Biodiversity Assessment 2018 (SANBI 2019).
- National Wetland Management Framework for South Africa, 2021
- Wetland Management Guidelines (Eco – Pulse, 2018).

The assessment included:

- Use of the Environmental Screening Tool and verification of sensitivity;
- A desktop assessment using national biodiversity datasets;

- including utilisation of the National Wetland Map, NFEPA data, Freshwater Ecosystem Priority Areas, Critical Biodiversity Areas, habitat integrity assessments, and applicable freshwater ecological indices such as SASS5, MIRAI, FRAI, VEGRAI and/or PES methodologies;
- Evaluation of ecological sensitivity, impacts, and mitigation measures in accordance with protocol requirements.

8. APPLICABLE LEGISLATIVE AND ADMINISTRATIVE FRAMEWORK

The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996) – Section 24.

The Constitution is South Africa's overarching law. It prescribes minimum standards with which existing and new laws must comply. Chapter 2 of the Constitution contains the Bill of Rights in which basic human rights are enshrined. The government's commitment to give effect to the environmental rights enshrined in the Constitution is evident from the enactment of various pieces of environmental legislation since 1996, including the NWA, the NEMA, etc.

National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), as amended.

NEMA replaces a number of provisions of the Environment Conservation Act, 1989 (Act No. 73 of 1989) (ECA). The Act provides for cooperative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for coordinating environmental functions. The principles enshrined in NEMA guide the interpretation, administration and implementation of the Act with regard to the protection and/ or management of the environment. These principles serve as a framework within which environmental management must be formulated. Section 2(4) specifies that "sustainable development requires the consideration of all relevant factors, including aspects specifically relevant to biodiversity".

National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA).

NEMBA provides for the management and conservation of biological diversity and components thereof; the use of indigenous biological resources in a sustainable manner; the fair and equitable sharing of benefits arising from bio-prospecting of biological resources; and cooperative governance in biodiversity management and conservation within the framework of NEMA.

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

The NWA is a legal framework for the effective and sustainable management of water resources in South Africa. Central to the NWA is the recognition that water is a scarce resource in the country, which belongs to all the people of South Africa and needs to be managed sustainably to benefit all members of society. The NWA places a strong emphasis on the protection of water resources in South Africa, especially against its exploitation, and the assurance that there is water for social and economic development in the country for present and future generations.

The NWA requires any development to secure Water Use Licenses (WULs) for the following activities that are applicable to this project:

Section 21 (c) and (i) use, i.e., river or wetland crossings, which include any drainage lines by any infrastructure. In terms of the definitions provided, activities included under Sections 21(c) and (i) are (amongst others) for the construction of roads, bridges, pipelines, culverts, and structures for slope stabilisation and erosion protection.

General Authorisation in terms of section 39 of the NWA

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

The General Authorisations for Section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA have recently been revised (Government Notice R509 of 2016). Determining if a WUL is required for these water uses is now associated with the risk of degrading the ecological status of a watercourse. A low risk of impact could be authorised in terms of General Authorisations (GA).

Government Notice 509 of 2016

Authorisations related to wetlands are regulated by Government Notice 509 of 2016 regarding Section 21(c) and (i). This notice grants General Authorisation (GA) for water-related uses under certain conditions, such as that all water uses should be regulated and registered with the relevant authority. The Notice sets out the conditions and considerations which should be taken. For instance, the user of the water must ensure that the selection of a site for establishing any impeding or diverting the flow or altering the bed, banks, course or characteristics of the

watercourse works: (i) is not located on a bend in the watercourse; (ii) avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps.

Convention on the Conservation of Migratory Species (CMS)

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, aquatic, and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 117 (as of 1 June 2012) Parties from Africa, Central and South America, Asia, Europe and Oceania. South Africa is a signatory to this convention.

Biodiversity Sector Plan, 2014

This is the provincial biodiversity master plan, which is part of a wider set of national biodiversity planning tools and initiatives that are designed for national legislation and policy. One of its intentions is to aim for the conservation of the species during land use and development. It guides the development planning, environmental assessments and regulation as well as the management of the natural resources (NRM).

Limpopo Environmental Management Act (LEMA)

LEMA is provincial legislation that aims to conserve biodiversity and manage natural resources in Limpopo Province. It addresses matters such as the protection of provincial nature reserves, management of protected species, and regulation of environmental activities within sensitive areas, including Critical Biodiversity Areas (CBAs). The project area falls within both CBA 1 and CBA 2, making LEMA provisions particularly relevant to development planning and biodiversity protection in this case.

Other Relevant Guidelines

The “Biodiversity Offset” in its simple terms and meaning is “*the measurable results or outcomes that are implemented to compensate nature for unavoidable impacts from development after the mitigation hierarchy measures have been exhausted*”. After the Hierarchy Mitigation (*Avoidance, Minimise, Restore and* ***Offset)*** is explored, the Offset is the last resort. These guidelines must be read together with other pieces of legislation, such as EIA (2014), NEMA (107 of 1998), and others.

9. Assumptions and Limitations

The following assumptions and limitations apply to this report:

- The site sensitivity verification and field-assessment exercise was undertaken in the dry season of October 2026.
- The site assessment focused and assessed systems within the 200m buff from the proposed site area.
- This investigation was a once-off desktop and field-based assessment, in one day period.
- The assessment was based on available and relevant information/data and assumed to be accurate and reliable.
- Secondary data and information (e.g., SANBI) are trusted to be accurate and reliable.
- Additional information may be available after the completion of this assessment, and therefore, Sediba Sa Metse (pty) Ltd. can at any given time, amend and modify the content of such information.
- Anticipated that some vegetation may have been missed due to timing, however, by satisfactory and reasonable facts, the findings are true reflection of the site.
- Sediba Sa Metse (Pty) Ltd exercises reasonable skill, care, and diligence in the provision of services. However, it accepts no liability or consequential liability for the use of the supplied project deliverables (in part or whole) and any information or material contained therein. The client, including their agents, by receiving these deliverables, indemnifies Sediba Sa Metse (Pty) Ltd (including its members, employees, and sub-consultants) against any actions, claims, demands, losses, liabilities, costs, damages, and expenses arising directly or indirectly from or in connection with services rendered, directly or indirectly.
- The project deliverables, including the reported results, comments, recommendations, and conclusions, are based on the author/s professional knowledge as well as available information. The study is based on assessment techniques and investigations that are limited by time and budgetary constraints applicable to the type and level of survey undertaken. Sediba Sa Metse (Pty) Ltd, therefore, reserves the right to modify aspects of the project deliverables if and when new/additional information becomes available from research or further work in the applicable field of practice or about this study.
- All copyrights are reserved.

10. Project Locality

The **proposed 300ha project site for phase 1** is located at (23°54'5.85" S and 29° 1'2.35" E), approximately 2.5 km west of Mars village, about 7km east of N11, and 30km north of Mokopane town, in the Mogalakwena Local Municipality, Waterberg District, Limpopo (Figure 1).

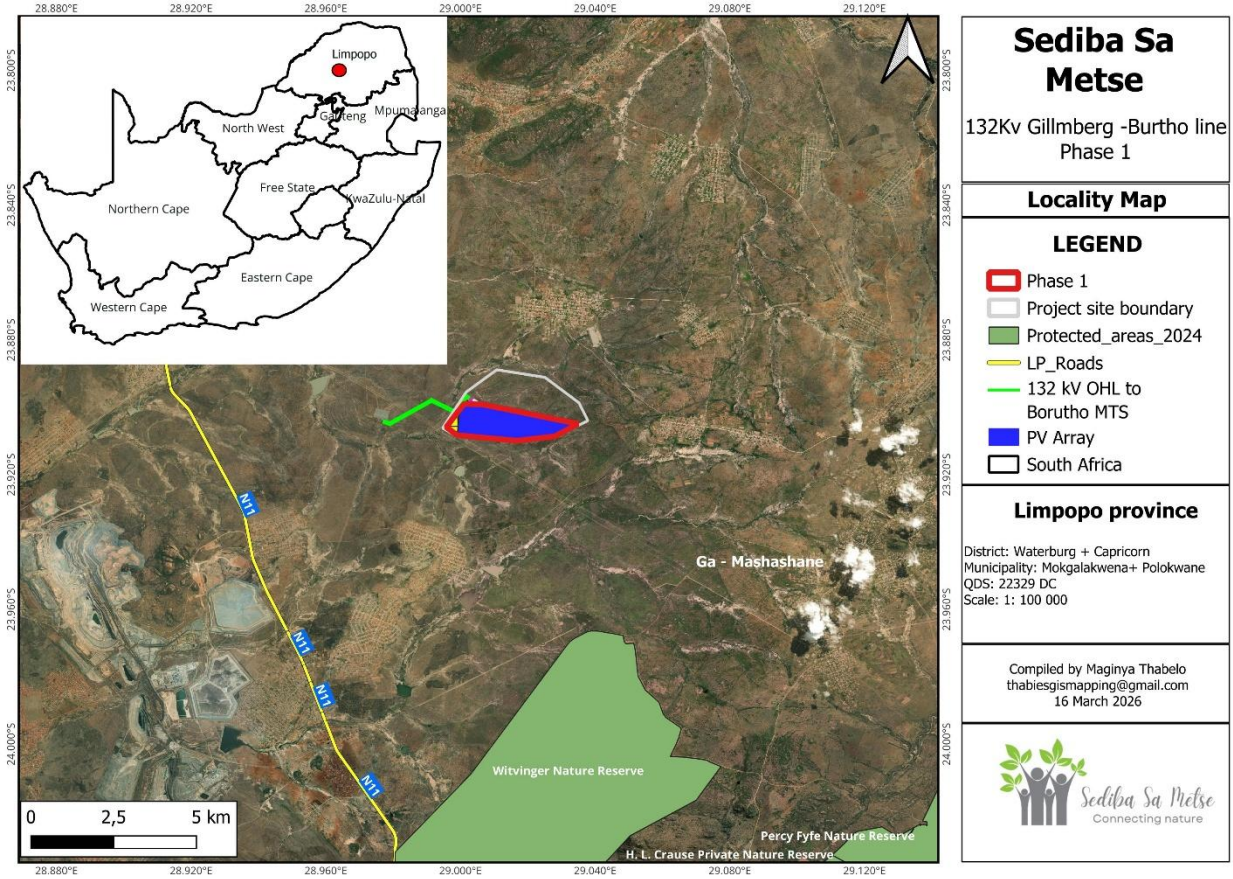


Figure 1: Locality map of the Phase 1 Gilimberg Solar PV farm.

11. RECEIVING ENVIRONMENT

The study area was assessed through a desktop review of available environmental data, supplemented by field surveys conducted on **30 October 2026**. The survey assessed the aquatic biodiversity conditions within project site and Project Area of Influence (PAOI), with results considered sufficient to inform habitat suitability, ecological sensitivity and present ecological status (PES).

Climate

Summer rainfall with very dry winters. MAP from about 400 mm in the northwest to about 600 mm where it borders on the foot of mountains to the east and south. Frost is fairly infrequent. Mean monthly maximum and minimum temperatures for Polokwane are 33.2°C and 0.6°C for October and June, respectively (Mucina and Rutherford, 2006).

Vegetation types and biophysical descriptions

Vegetation units are broadly classed and may include several distinct vegetation communities within a unit (Mucina and Rutherford, 2006). The vegetation type found on the study site is Makhado Sweet Bushveld and Polokwane Plateau Bushveld (Figure 2).

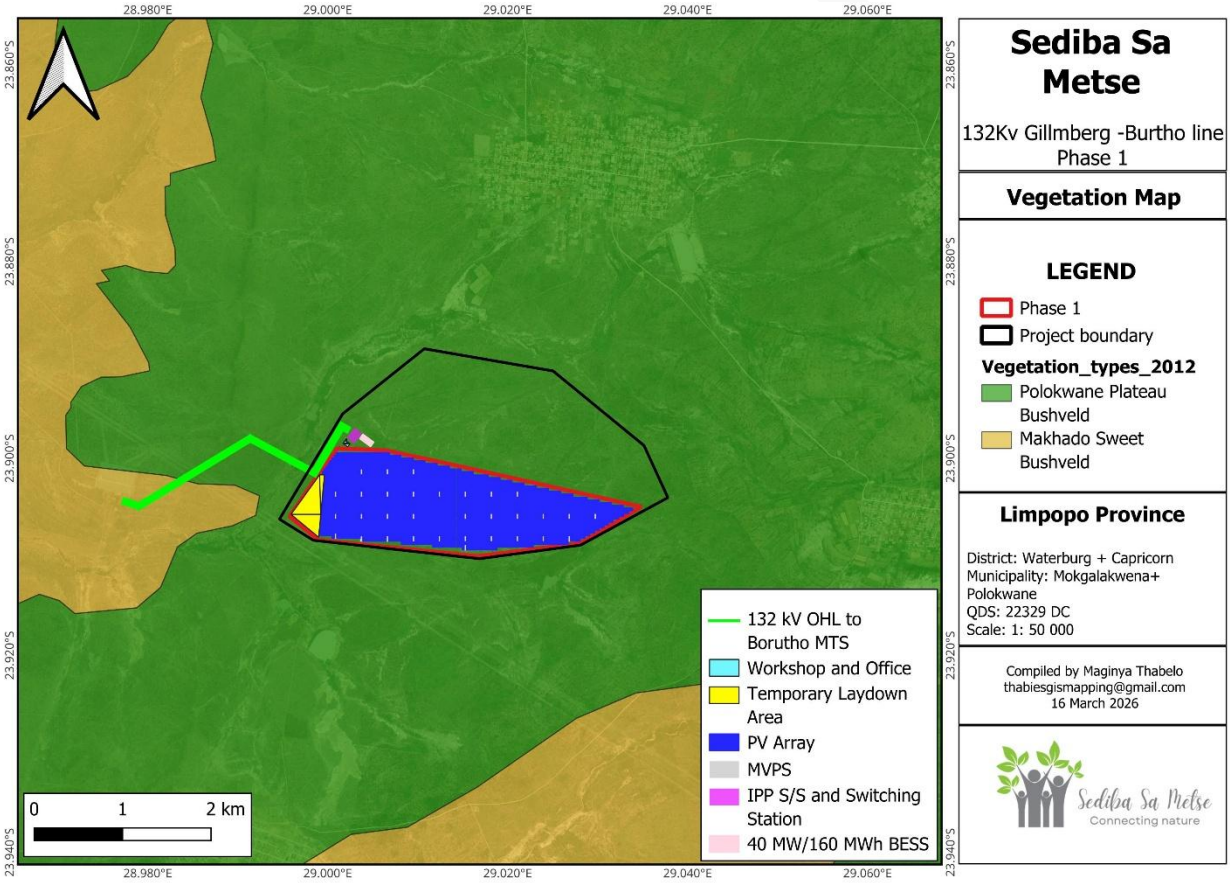


Figure 2: Vegetation Map for the Phase 1 Gilimberg Solar PV Farm.

Makhado Sweet Bushveld

Distribution

Limpopo Province: Straddling the Tropic of Capricorn, it occurs on the plains south of the Soutpansberg, east of the Waterberg, and on the apron surrounding the Blouberg and Lerataupje Mountains, and north of the Polokwane Plateau and west of the escarpment, with extensions to Mokopane to the south and to the north near Vivo. Altitude about 850–1 200 m.

Vegetation & Landscape Features

Slightly to moderately undulating plains sloping generally down to the north, with some hills in the southwest. Short and shrubby bushveld with a poorly developed grass layer.

Conservation

Vulnerable. Target 19%. About 1% statutorily conserved, mainly in the Bellevue Nature Reserve. Some 27% transformed, mainly by cultivation, with some urban and built-up areas. The southwestern half of the unit is home to densely populated rural communities. Erosion is low to high.

Polokwane Plateau Bushveld

Distribution

Limpopo Province: The higher-lying plains around Polokwane, north of the Strydpoort Mountains and south of the Makhado Sweet Bushveld. Altitude about 1,100– 1,500 m.

Vegetation & Landscape Features

Moderately undulating plains with short open tree layer with a well-developed grass layer to grass plains with occasional trees at higher altitudes (for example, the Mashashane area in the southwest and the southeastern watershed of the Sand River catchment, such as around Eersteling). Hills and low mountains of the Mamabolo Mountain Bushveld are embedded within this unit.c

Conservation

Least threatened according to remote sensing sources, but with over one-third of the remaining vegetation regarded as degraded, it would probably be regarded as susceptible. Target 19%.

Less than 2% statutorily conserved mainly in the Percy Fyfe and Kuschke Nature Reserves. In addition, 0.7% conserved in other reserves, for example, the Polokwane Game Reserve. Some 17% transformed, including about 10% cultivated and 6% urban and built-up. A dense concentration of rural human settlements is found particularly in the eastern and northwestern parts of the unit. In some regions, scattered populations of alien *Agave*, *Jacaranda mimosifolia*, *Melia azedarach*, *Opuntia ficus-indica,* and *Ricinus communis* are of concern. Erosion is high to moderate.

12. CONSERVATION STATUS

South Africa, through its various pieces of legislation, protects all biodiversity and aquatic systems. For instance, the conservation target for freshwater is at least 20%. This proposes and emphasizes that, for each freshwater ecosystem (including wetlands), at least 20% of its entire system, including its features (catchment), must be protected or conserved. Furthermore, provinces and municipalities also have their regulations, guidelines, and frameworks to conserve biodiversity ecosystems within their boundaries.

Critical Biodiversity Areas (CBAs) are terrestrial and aquatic areas of the landscape that must be maintained in a natural or near-natural state to ensure the continued existence and functioning of species and ecosystems, and the delivery of ecosystem services. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses. It is highly recommended that this Conservation Plan serve as a primary reference for biodiversity considerations in Environmental Impact Assessments.

Criteria for Identifying CBA

Together with protected areas, the portfolio of CBAs identified in a biodiversity plan must collectively meet biodiversity targets for the representation of ecosystem types and species of special concern. These areas may also meet biodiversity targets for some ecological processes (Ecological Support Areas, ESAs) that are not essential for meeting biodiversity representation targets (thresholds), but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas. The areas may provide ecosystem services that support socio-economic development, such as water provision, flood mitigation, or carbon sequestration (e.g., wetlands). The degree or extent of restriction on land use and resource use in these areas may be lower than that recommended for CBAs.

Criteria for Identifying ESAs

An ESA is an area that must remain in at least fair ecological condition to meet biodiversity targets for environmental processes that have not been met in CBAs or protected areas; meet biodiversity targets for the representation of ecosystem types or species of special concern when it is not possible to meet them in CBAs; support ecological functioning of a protected area or CBA (e.g. protected area buffers); or a combination of these.

ESAs can meet biodiversity targets for terrestrial, aquatic, or both. All ecological processes necessary for the long-term persistence of ecosystems and species should be adequately included in the portfolio of protected areas, CBAs, and ESAs. Sites selected to form part of an ESA could be in good, fair, or even severely modified ecological conditions, as long as the current environmental conditions are compatible with fulfilling the purpose for which the ESA has been selected. The desired state/management objective for most ESAs is to maintain them in at least fair ecological condition. For severely modified ESAs, the management objective is to prevent further deterioration of the current ecological condition.

Limpopo Conservation Plan v2 (2013)

This section of the assessment describes the biodiversity planning framework relevant to the project area, with specific reference to the Limpopo Conservation Plan version 2 (LCPv2). The Limpopo Conservation Plan v2 is the provincial biodiversity sector plan developed by the Limpopo Department of Economic Development, Environment and Tourism (LEDET) to guide biodiversity conservation and inform land-use planning and environmental decision-making within Limpopo Province.

The primary purpose of the Limpopo Conservation Plan v2 is to develop the spatial component of a bioregional plan by identifying Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), together with associated land-use management guidelines. These spatial priorities represent the minimum areas required to ensure the persistence of biodiversity patterns and ecological processes in the province. The plan is intended to inform environmental impact assessments, spatial development frameworks, environmental management frameworks, and other land-use planning tools, thereby supporting sustainable development and biodiversity conservation.

Objectives of the Limpopo Conservation Plan v2

The objectives of the Limpopo Conservation Plan v2 are to:

- Identify and map Critical Biodiversity Areas and Ecological Support Areas within Limpopo Province.
- Ensure that biodiversity targets for terrestrial and aquatic ecosystems are achieved.

- Conserve representative samples of biodiversity patterns, including threatened ecosystems and endemic vegetation types.
- Maintain ecological and evolutionary processes required for long-term ecosystem functioning.
- Provide spatial biodiversity priorities and land-use management guidelines to inform planning, environmental authorisations, and resource management decisions

The conservation planning process applied a systematic, target-driven spatial biodiversity planning approach based on the best available biodiversity and spatial data, aligned with national bioregional planning guidelines.

Critical Biodiversity Areas and Ecological Support Areas

The Limpopo Conservation Plan v2 identifies biodiversity priority areas using two main spatial categories:

- Critical Biodiversity Areas (CBAs)
- Ecological Support Areas (ESAs)

Approximately 40% of Limpopo Province has been identified as Critical Biodiversity Areas, while a further 22% has been identified as Ecological Support Areas, highlighting the importance of these areas for maintaining biodiversity and ecological processes within the province

Table 1: Definitions of CBA and ESA categories used in Limpopo Province

Category	Description	Management Objective
CBA 1 (Critical Biodiversity Area 1)	Natural or near-natural areas that are considered irreplaceable for meeting biodiversity targets and ensuring the persistence of ecosystems, species, and ecological processes. These areas are essential for achieving conservation goals.	Maintain in a natural state. No habitat loss should occur.
CBA 2 (Critical Biodiversity Area 2)	Natural or near-natural areas are required to meet biodiversity targets but are considered replaceable under certain conditions. These areas contribute to achieving biodiversity targets and maintaining ecological functioning.	Maintain in a natural or near-natural state. Limited and carefully managed development may be considered, subject to environmental assessment.
ESA 1 (Ecological Support Area 1)	Natural or near-natural areas that support the functioning of CBAs and ecological processes such as water flow, species movement, and ecosystem resilience.	Maintain ecological function and connectivity. Limited disturbance may be acceptable if ecological functioning is maintained.

ESA 2 (Ecological Support Area 2)	Degraded or modified areas that are still important for supporting ecological processes or maintaining connectivity between biodiversity priority areas. These areas may require rehabilitation or careful management.	Maintain or restore ecological functioning where possible.
Protected Areas	Legally protected areas such as national parks, nature reserves, and protected environments that form part of the formal conservation network.	Maintain in accordance with conservation legislation and management plans.
Other Natural Areas (ONA)	Natural or near-natural areas that are not classified as CBAs or ESAs but still retain biodiversity value.	Avoid unnecessary habitat loss and maintain ecological integrity where possible.
No Natural Remaining Areas (NNR)	Areas that have been transformed by development, agriculture, or infrastructure and no longer retain natural habitat.	Limited biodiversity value. Restoration may be possible in some areas.

Application of the Limpopo Conservation Plan v2 to the Project Area

The Limpopo Conservation Plan v2 provides a spatial framework to guide land-use planning and biodiversity conservation within Limpopo Province. It identifies areas essential to meeting biodiversity targets and maintaining ecological processes.

Where development is proposed within areas classified as CBA 1, CBA 2, or ESA, these areas are considered environmentally sensitive and require careful management to avoid or minimise impacts on biodiversity. The presence of CBAs or ESAs within or adjacent to the proposed Citrus Farm Extension indicates that biodiversity considerations must be incorporated into project planning, design, and implementation.

The Limpopo Conservation Plan v2 is designed to inform environmental impact assessments and land-use decision-making, but it does not replace the need for site-specific ecological assessments. Detailed field verification is required to confirm the site's ecological condition and sensitivity and to guide appropriate mitigation measures. According to the Limpopo Conservation Plan version 2 (LCPv2) (2013), the study area is classified as CBA2 (Figure 3).

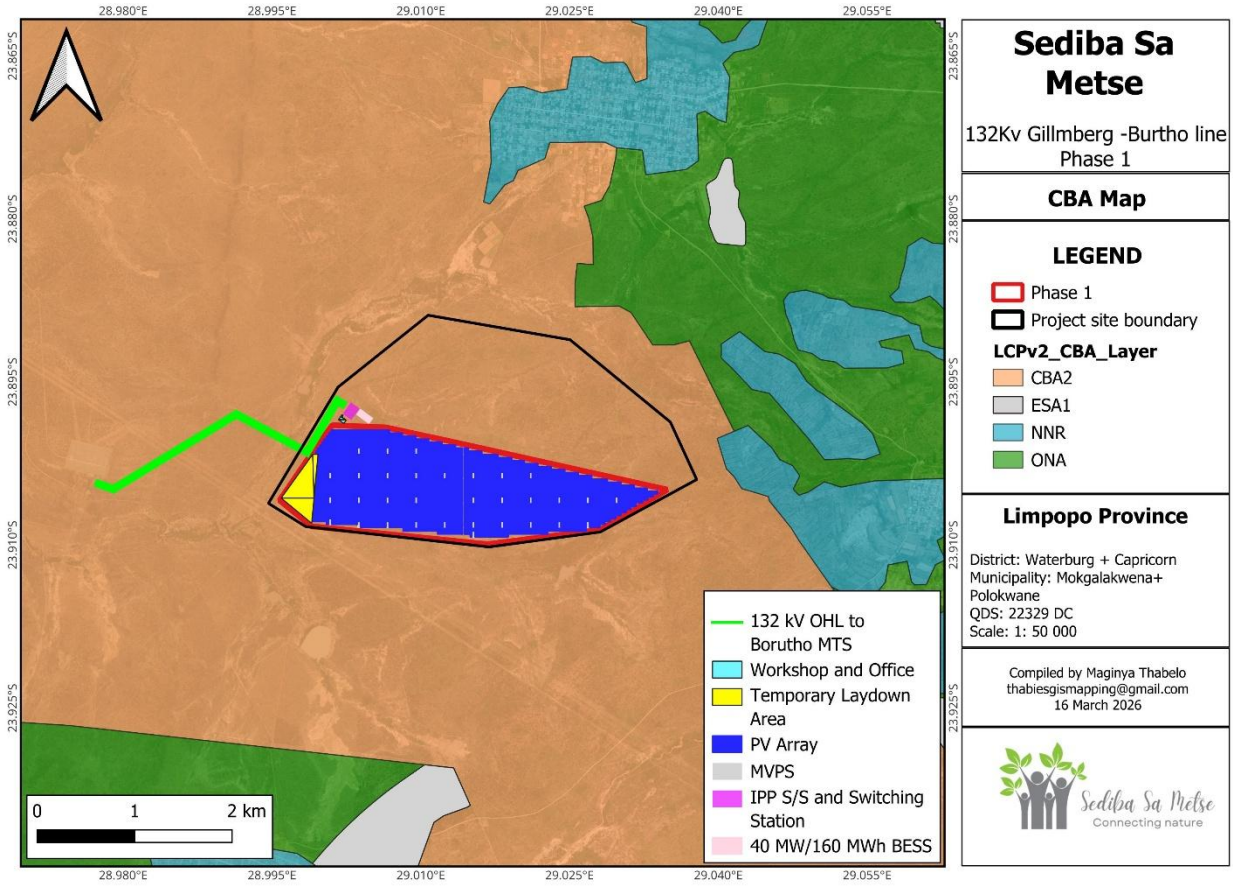


Figure 3: Conservation map for the Phase 1 Gilimberg Solar PV Farm.

13. KEY BIODIVERSITY AREAS

Site-based management efforts are among the most effective means to reduce global biodiversity loss. Therefore, it is crucial to identify sites with globally significant biodiversity, so that we can prioritise where and how to act most effectively. Key Biodiversity Areas are the most important places in the world for species and their habitats. Through the Key Biodiversity Area (KBA) programme in South Africa, we identify, map, monitor, and conserve these high-priority areas to help safeguard the most critical sites for nature.

SANBI and BirdLife South Africa lead this important initiative in South Africa in collaboration with several other partners.

What are Key Biodiversity Areas, and why are they important?

Key Biodiversity Areas (KBAs) are ‘sites that contribute significantly to the global persistence of biodiversity’, which means they are the most important places in the world for species and their habitats, whether these be in terrestrial, freshwater, estuarine, or marine ecosystems. The aim is to help prevent the rapid loss of biodiversity by supporting nationally led efforts to identify places

worldwide that are critical for the survival of unique plants and animals and the ecological communities they comprise. KBAs provide a global currency for identifying the most biologically significant sites, thereby focusing our collective efforts on conserving the places that matter most. Sites qualify as global KBAs if they meet the specific standardised criteria and quantitative thresholds focused on one or more of the five trigger aspects (Table 2):

Table 2: According to the South African KBAs (2024), the project area does not fall within any KBA

Threatened biodiversity	Sites that support significant populations of species or ecosystems at risk of extinction.
Geographically restricted biodiversity	Sites that hold species or ecosystems with limited global ranges or extent.
Ecological integrity	Sites with intact ecological communities that maintain natural processes and have low human impact.
Biological processes	Locations critical for key life-cycle events such as breeding aggregations, refuges, or recruitment sources.
Irreplaceability	Sites essential for achieving conservation goals, where loss would significantly reduce options for biodiversity protection.

14. HYDROLOGY AND AQUATIC

Aquatic systems will consist of the biotic and abiotic (physical and chemical) components, and their ecological processes within the habitats/areas such as wetlands, rivers, lakes, marshes, etc. These ecosystems are critically important to biodiversity as they maintain very unique and diverse vegetation and fauna communities (Cherry, 2011). The vegetation of these areas is very unique and normally lusher than that of the surrounding terrestrial vegetation. They play an important role in channeling water, retention of water and release of water to adjacent ecosystems (Edwards, *et al.,* 2018) and provide various benefits to biodiversity and human life, (Kotze *et al.,* 2005)

In South Africa, around 50% of wetlands have been lost or severely degraded (Dini, 2004). Globally, wetlands are recognized as one of the ecosystems declining at a rapid rate, at an estimated rate of 50%, (De Klerk, *et al.,* 2016). The most and top threats affecting these systems are anthropogenic or human-induced activities such as unsustainable economic development for agriculture, industries, mining, overgrazing by livestock, water abstraction and the discharge or disposal of sewage waste (DWAF, 2004). The outcomes of these activities in one way or another transform most of these wetlands to more dire and unrecoverable conditions.

The importance of wetlands is key to natural life and maintaining/providing ecological processes and functions to support unique ecosystems (Richards, 2001). Countries such as South Africa developed various pieces of legislation, protocols, and guidelines to guide development and maintain biodiversity. It is critically important for these guidelines to strive to balance both economic and ecological needs while sustaining human life (Pickett & Cadenasso, 2008). During the planning and decision-making stage of any sort of project development, it is imperative to consider the ecological systems and how they will be impacted. Assessment tools (e.g., Wet-Ecoservices and Wet-Health by Kotze *et al*., 2020) have been developed using the latest wetland knowledge and adopted (e.g., by DWS) for assessing different wetland units or types. These were used during this wetland assessment.

This assessment aims to determine the PES of the wetland systems. In compliance with the legislation (NWA), it is required that, before commencement of any development, a specialist (aquatic) assessment to verify or dispute the existence of the wetland within the 500m regulated zone around the proposed development boundary/edges must be conducted. The results (report) of this assessment, which include the anticipated and potential impacts

(negative/positive), with their proposed mitigation measures, are therefore to be submitted to the competent authority (e.g., DWS) to make an informed decision whether the development is considered/accepted/approved or not (Macfarlane *et al*., 2020).

This process allows the landowner, developers, land users, and government institutions to fully take responsibility for protecting these threatened ecological systems. The assessment was conducted to ensure that the integrity, health, and functions of the wetlands are maintained, rehabilitated, sustained, and protected for the benefit of future generations, (Kotze *et al*., 2020).

What are wetlands

Section 1 of the National Water Act (NWA, Act 36 of 1998), of South Africa, describes wetlands 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 typically adapted to life in saturated soil.*"

Wetlands are characterised by unique soils and vegetation that distinguish them from adjacent terrestrial and fully aquatic systems (Skowno, et al., 2019). By nature, they include a variety of ecosystems, such as seeps, pans/depressions, mangroves, marshes, estuaries, valley bottoms, and floodplains (see Figure 4 and Table 3). From various scientific sources, a wetland can be described and summarised as a unique area on the land, which is transitional (ecotone) between the aquatic (water) and terrestrial (soil) ecosystems. They further state that the water table of these areas (i.e. wetland) is closer to or above the soil surface and characterised by (unique) saturated soil and hydrophytic vegetation types, and able to serve or provide habitat to very distinctive organisms, (Edwards, *et al.,* 2018).

Edwards (2018) also described a wetland as an ecosystem that is formed as a result of an anaerobic process. The anaerobic process occurs on the earth's surface, in the soil (hydric) of no oxygen content, favoring and supporting specific, unique vegetation (hydrophytes). The hydric soil of the wetland is distinctive and characterised by redoximorphic and/or gleying conditions.

This type of soil formation is capable of providing a foundation and home to a unique vegetation, which is often termed 'obligate' vegetation species that differ from one zone to another in a wetland system, Figure 5. In South Africa, wetland attracts and home unique fauna/animals from insects to birds (e.g., African Grass Owl). Wetlands can be divided or categorized into various types and forms considering their characteristics and development

formations (topography, geology, etc.). Those types of systems are such as pan, hillslope or valley bottom.

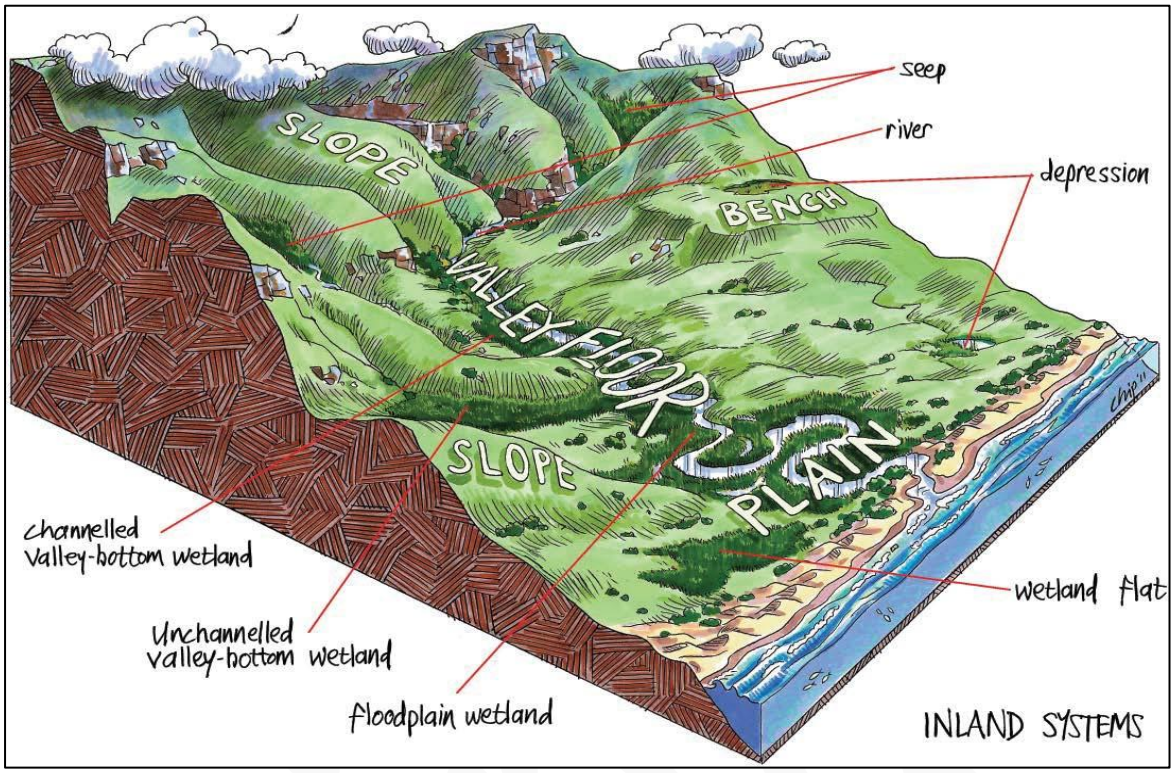


Figure 4: Wetland HGM units with their landscape settings (Ollis, et al., 2013)

RAMSAR Convention, however, defines wetlands broadly, 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 meters*", under its Article 1.1.
- RAMSAR further says, that for the purpose of protecting coherent sites, it "*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands*" as a wetland, under its Article 2.1.

The importance of wetlands is widely recorded and noted. Hahn (2013) suggests that wetlands play a vital regulatory role in hydrology by absorbing and storing freshwater, as well as maintaining and moderating the flow of rivers. Wetlands are also known to promote, improve and maintain ecological and structural integrity.

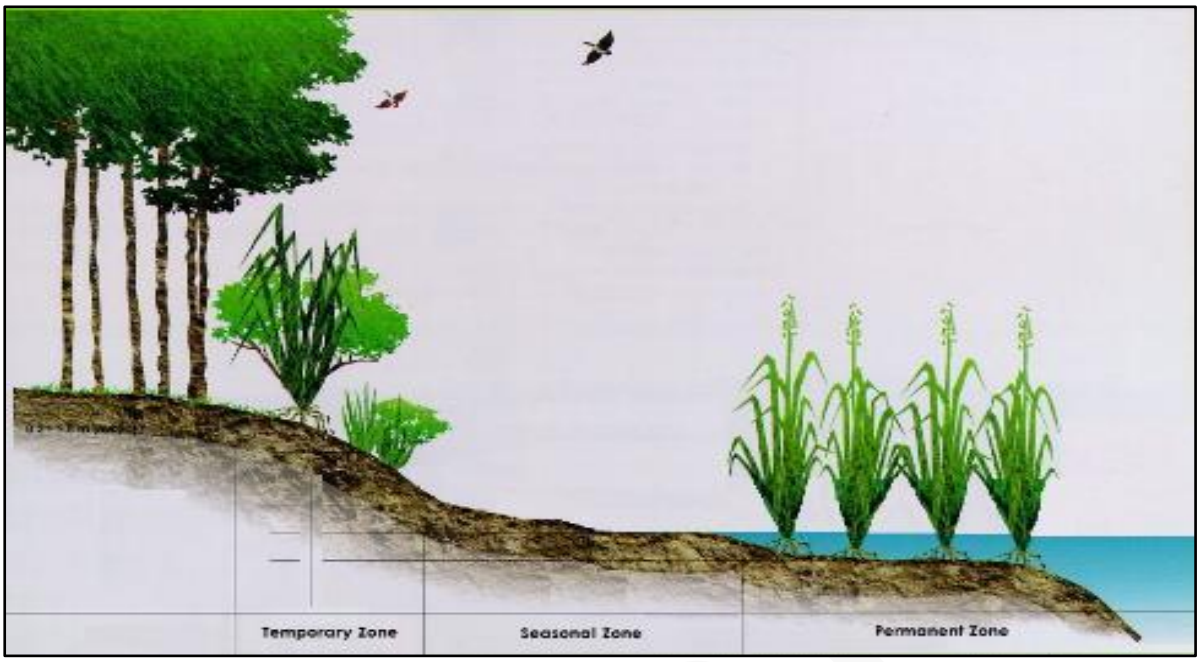


Figure 5: Wetland diagram showing the different zones (Kotze, 2007 and Ollis, 2013).

Table 3: Different types of inland wetlands in the description

Hydro-geomorphic types	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Floodplain	Valley bottom areas with a well-defined stream channel, gently sloped & characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from the main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from the main channel (when channel banks overspill) and from adjacent slopes.	***	*/***
Valley bottom without a channel	Valley bottom areas with no clearly defined stream channel are usually gently sloped and characterised by alluvial sediment deposition, generally leading to the accumulation of sediment. Water inputs mainly from channels entering the wetland and also from adjacent slopes.	***	*/***
Hillslope seep with the stream channel	Slopes on hillsides, are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Isolated hillslope seepage	Slopes on hillsides, are characterised by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***

Hydro-geomorphic types	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Depression (includes pans)	A basin-shaped area with a closed elevation contour that allows for accumulation of surface water (i.e., it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/***	*/***

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

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

Final

Multiple ephemeral drainage lines are mapped during the study, which form part of the catchment feeding into the broader river systems outside the development footprint (Figure 6). And no permanent wetlands are identified within the 500m regulated zone of the site.

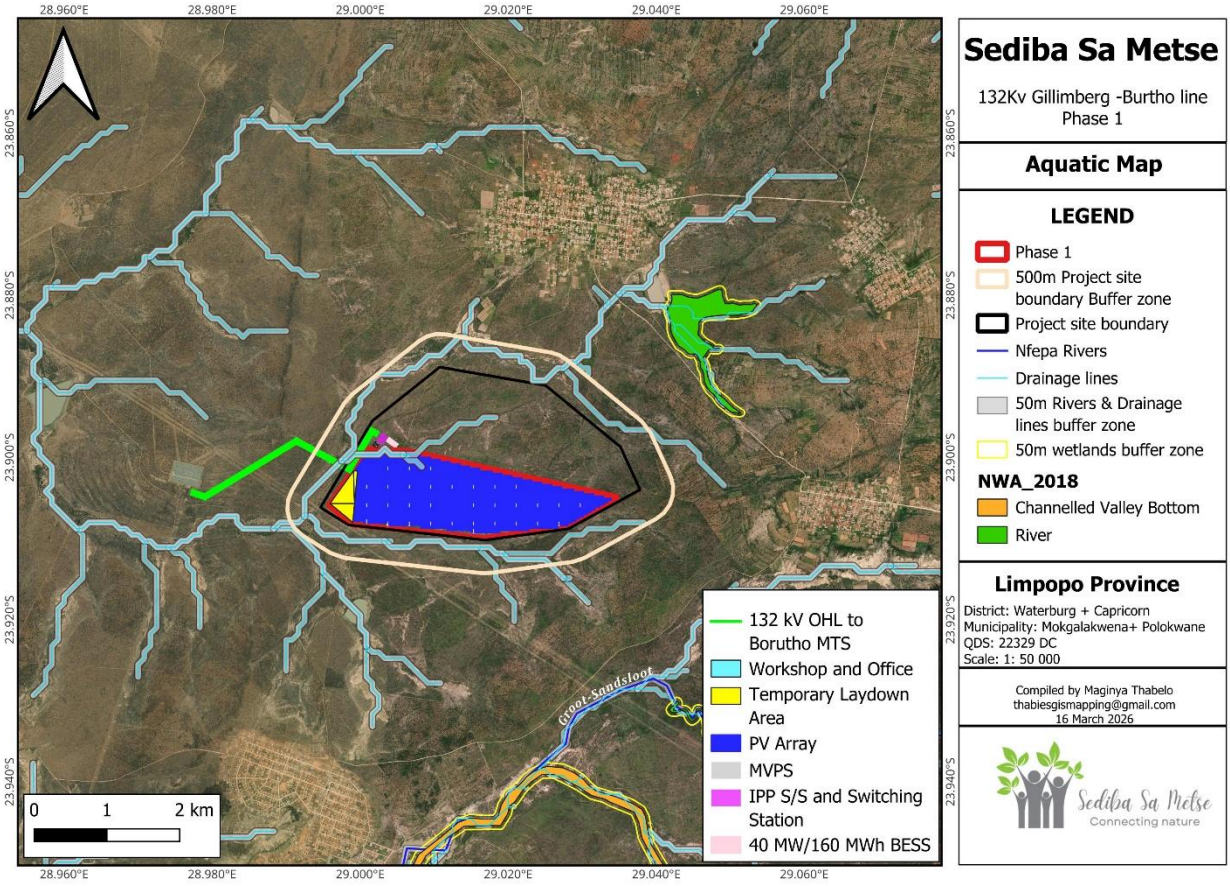


Figure 6: Aquatic features for the Phase 1 Gilimberg Solar Farm.

15. METHODOLOGY AND ASSESSMENT APPROACH

The aim of this assessment is to:

- Identify and delineate the wetland ecosystems found within the project site.
- Determine, assess and measure the potential impacts and risks associated with the proposed development.

There are two methodology approaches deployed during this assessment, that is:

- Desktop Assessment:
  - Level 1A and 1B Wet-tool assessment
- Field-based Assessment
  - Level 2 – field-based assessment of collecting data from the wetland

Desktop Assessment

A desktop study was undertaken by consulting relevant data from the South African National Biodiversity Institute (SANBI) Biodiversity Geographic Information System (BGIS) website, Freshwater Ecosystem Priority Areas (FEPA) (Nel, *et al.,* 2011) and the National Biodiversity Assessment 2018 (SANBI, 2019) dataset to verify the occurrence of wetland. The data relevant to the study area were loaded into computer programs such as Quantum Geographic Information Systems (QGIS, 3.34.7-Prizren) and Google Earth Pro (Version 3).

Wetland Identification and Mapping

it is required that, before commencement of any development, a specialist (aquatic) assessment to verify or dispute the existence of the wetland within the 500m regulated zone around the proposed development boundary/edges must be conducted. The National Biodiversity Assessment 2018 National Wetland Map 5 provides desktop-level wetlands already classified into their Hydrogeomorphic Unit (HGM) as well as associated rivers. HGM is the level 4 in the classification system of inland aquatic systems and are distinguished primarily on the basis of landform, hydrological traits and hydrodynamics (Ollis, *et al.,* 2013).

Through the use of Quantum Geographic Information Systems (QGIS, 3.34.7-Prizren) and Google Earth Pro (Version 3) of National Freshwater Ecosystem Priority Areas (NFEPA) project (CSIR, 2011; Nel, *et al.,* 2011) and National Biodiversity Assessment 2018 (SANBI, 2019) dataset did **not identify the permanent wetland or rivers** but only the **drainage line systems (**see Figure 6 above).

Infield Assessment

The infield sampling and delineation focused on the visual characteristics of the drainage lines, within and covering the 50-100m buffer. A site visit was undertaken on the 30th of October 2026 to collect relevant data identified through the desktop assessment. The specialists paced slowly through the identified wetland and the project site to visually collect data. The following wetland modules or components were considered during the field assessment:

- Geomorphology,
- Vegetation,
- Factors affecting water quality,
- Hydrological traits,
- And any onsite disturbances and land uses.

Wetland Delineation

Delineation of wetlands in South Africa is following adopted guidelines such as one from the Department of Water Affairs and Forestry (now the Department of Water and Sanitation). The following are the guidelines applied during the delineation process;

- Updated manual for identification and delineation of wetlands and riparian areas (DWAF, 2008);
- Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems, (Ollis, *et al,* 2013).

The wetland's outer edge (buffer zone) was determined during the delineation process. This involves determining the boundary between the wetland and the terrestrial land and other various zones within the wetland system.

During this delineation process, the following aspects of the wetland system were noted;

- The soil formation, presence, and type,
- landscape position (e.g., seepage, hilltop, midslope, valley bottom, floodplain),
- vegetation (hydrophilic vegetation) and
- redoxymorphic features (e.g. the presence of water – the extent of saturation/inundation).

A soil auger was used to sample the first 50-100cm of the soil profile during the delineation process to determine these zones. Reasonable attempts were made to sample soil from multiple areas within the wetland, starting from the centre of the wetland (where the surface

water is seen or there is high moisture presence) and moving towards the outer drier edge of the wetland, at an interval of 5m apart from one point to another, Figure 7

It should be noted that although vegetation is a primary indicator of a wetland according to NWA, this is only the case under normal conditions where the system is not in any way disturbed by anthropogenic activities. However, other indicators such as soil wetness, soil form and the associated redoxymorphic features are permanent and most often used to confirm the presence of wetlands. The reliance on other indicators more than vegetation is due to the response of vegetation to moisture variability, disturbance regimes and management rendering vegetation unreliable to confirm the presence of wetlands.

During this assessment, the geomorphological and topography aspects were the key factors over soil and vegetation due to the system types (drainage lines), which exhibit terrestrial features in general context.

Final



Figure 7: Soil augering during field assessment

Aquatic Ecological Health

In South Africa, few approaches have been developed and are adopted to assess and determine the wetland's health, hereafter referred to as the Present Ecological State (PES). These include:

- Present Ecological Status (PES) method, for floodplain and other palustrine wetlands (Kleynhans, 1996 & 1999; Duthie, 1999b) included in the Resource Directed Measures (RDM-99 method) Manual for Wetland Ecosystems (DWAF, 1999c),
- Wetland Index of Habitat Integrity (IHI) (Kleynhans, *et al.,* 2009),

- WET-Health Version 1 (Macfarlane, *et al.,* 2009),
- WET-Health Version 2 (Macfarlane, *et al.,* 2020),

These were developed in line with the objectives of the National Water Act, Act 36 of 1998 to provide for the regulation, management and protection of water resources and their associated systems.

Wetland-IHI and WET-Health assessment approaches are the most reliable, preferred and recommended methods used to assess the PES of rivers and wetlands, ecological importance (EI) and ecological sensitivity (ES) of the wetlands in southern Africa. For the purpose of this assessment, WET-Health Version 2 (Macfarlane, *et al.*, 2020) is used to assess this wetland. This tool is the updated version of the original tool by Macfarlane, et al. (2009) and therefore, as a result of the refinement and improvements in this tool, it was deemed suitable for use in these assessment units.

WET-Health is a tool developed to assess the present ecological state (PES) or health of wetlands of different hydrogeomorphic types at three levels of resolution (Macfarlane *et al.,* 2020). The method is designed to assess the PES of an identified wetland by scoring the wetland against the perceived deviation from a reference condition i.e. natural reference condition unimpacted by anthropogenic activities (Macfarlane *et al.,* 2020). Three levels of resolution that can be employed during a WET-Health assessment are as follows:

- Level 1A assessment – Desktop-based tool of low resolution, which uses predefined landcover data to assess wetland health. Usually applied at regional and national scales.
- Level 1B assessment – Desktop-based tool using higher resolution landcover data in conjunction with aerial imagery analysis of the study areas and limited in-field assessment.
- Level 2 assessment – A field-based rapid assessment tool which incorporates a Level 1B assessment and refines this assessment through the rapid evaluation of a set of field indicators.

Wetlands are driven by three integrated drivers, namely hydrology, geomorphology and water quality. The fourth driver, vegetation, is a response to the three drivers and to the activities associated with wetlands. These drivers are also referred to as components of wetlands health (Macfarlane *et al.,* 2020). The PES of a wetland is then assessed by evaluating the extent to which human-induced activities have modified wetland traits across four components of wetland health.

During this assessment, some of the activities or impacts have been observed, such as those shown in Figure 8. Integral to WET-Health is the characterization of different Hydrogeomorphic Units (HGM) which have been distinguished and defined on the basis of landform, hydrological characteristics and hydrodynamics (Ollis *et al.,* 2013; Macfarlane *et al.,* 2020).

For this project, a Level 1B assessment resolution was undertaken as it is sufficient to provide the PES required for the purpose of this study. The PES is determined according to Table 4.

Table 4 - Ecological and impact categories used for PES interpretation (Macfarlane et al., 2020)

ECOLOGICAL CATEGORY	DESCRIPTION	Impact Category	PES SCORE (%)
A	Unmodified, natural.	None	90-100
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	Small	80-89
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	Moderate	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	Large	40-59
E	Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	Serious	20-39
F	Critically modified. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	Critical	0-19



Figure 8: Activities in the drainage line that affect the Wet-Health.

Wetland Functional Assessment

Wetlands are one of the most threatened, important, unique and productive ecosystems in the world (Edwards, *et al.*, 2018; SANBI, 2019). According to Zedler and Kercher (2005), wetlands provide up to 40% of the world's ecosystem services. Wetlands represent what is called ecological infrastructure, which provides important ecosystem services contributing to human needs and biodiversity, which ultimately feeds into the government's mandate to have the environment protected at the national scale and with international collaborations (Kotze *et al*., 2020). As a result of the valued importance of these ecosystems, there was a need to assess and compare wetlands in terms of the ecosystem services they provide. This led to the development of the first version of the WET-EcoServices to be developed by Kotze *et al,* (2008). This tool has been recently updated and refined into WET-EcoServices version 2, which now includes riparian areas and explicit separation of ecosystem service supply and demand (Kotze *et al.,* 2020).

According to Kotze *et al,* (2020), WET-EcoServices aims to "…assist decision makers, Government officials, planners, consultants and educators in undertaking rapid assessments

of individual wetlands and riparian areas in order to reveal the importance of the ecosystem services which the individual wetland/riparian areas provide.”. The tool assesses 16 different ecosystem services (Kotze *et al.*, 2020) according to the categorization of ecosystem services by MEA (2005):

Regulating and Supporting Services

- Flood attenuation
- Streamflow regulation
- Sediment trapping
- Phosphate assimilation
- Nitrate assimilation
- Toxicant assimilation
- Erosion control
- Carbon storage
- Biodiversity maintenance

Provisioning services

- Provision of water for human use
- Provision of harvestable resources
- Food for livestock
- Provision of cultivated foods

Cultural services

- Cultural and spiritual experience
- Tourism and recreation
- Education and research

The tool uses supply and demand to assess the potential of a wetland to provide ecosystem services. Supply is the capacity of a wetland to produce a service while demand refers to the societal demands for a service (Kotze *et al.*, 2020). The demand and supply scores for each of the 16 wetland ecosystem services are calculated, then integrated to provide the overall importance score Table 5.

Table 5 - Ecosystem importance categories from integrated demand and supply scores (Kotze *et al.*, 2020)

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

Ecological Importance and Sensitivity

The methodology provided by Rountree et al. (2013) is used for the determination of the Ecological Importance and Sensitivity of the assessment for the wetlands identified. The method incorporates the PES score from WET-Health (Macfarlane et al., 2020) and the functionality scores from WET-EcoServices (Kotze et al., 2020) to determine the most representative EIS category for the wetland.

The methodology provides a series of aspects to be assessed on a scale of 0 to 4, where 0 represents no importance and 4 represents very high importance. The mean of the assessed aspects is used to allocate the EIS category as shown in Table 6 below:

Table 6 – EIS Categories, Class and Definition

Ecological Importance and Sensitivity Categories	Range of EIS Score	EIS Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a	4	**A**

major role in moderating the quantity and quality of water of major rivers.		
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quality and quantity of water in major rivers.	>3 and <4	**B**
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river.	>2 and </=3	**C**
Low/Marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>1 and </=2	**D**
None: Wetlands that are rarely sensitive to changes in water quality/hydrological regime.	>0 and </=1	**E**

Recommended Ecological Category

The evaluation of water resources and the provision of recommendations for future management classes, often referred to as the Recommended Ecological Category, the following considerations according to NWA are required:

- Ecological Importance (ecosystems and biodiversity);
- Ecological functions, and
- Basic human needs (especially for rural people who rely directly on ecosystem goods and services for their livelihoods and wellbeing).

According to Rountree *et al.* (2013) "… Water resources which have high values for one or more of these criteria may thus be justifiably managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), their hydrological functional importance (where water resources provide critical functions upon which people may be dependent) or their role in providing direct human benefits (such as meeting some of the basic needs of rural people who depend directly on the water resource)".

The scores obtained from WET-Health, WET-EcoServices and Ecological Importance and Sensitivity assessments will be used to determine the Recommended Ecological Category (REC). Four classes are used to describe and assign the REC (Table 7). Water resources that have PES categories in an E or F ecological category are deemed unsustainable by the DWS. In such cases, the REC must automatically be increased to a D. In the case where EIS is high, but PES cannot be improved, the PES score must be used for the REC. Where the PES score is moderate, and the EIS is high, the REC must be assigned one category above the current PES category.

Table 7 - Description of REC Classes

Category	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

Buffer Zones

The consolidated report by the WRC (Macfarlane & Bredin, 2017) is one of the available guidelines used to determine and calculate the aquatic buffer zones. Generally, the guideline is developed as a tool to calculate the best-suited buffer for each wetland or section of a wetland based on numerous on-site observations. The guideline also considers the extent of the development's impact or risk to the ecosystem.

Various buffer zone categories were developed and suggested to be applicable, see Table 8 for different development stages. Together with other publications, the following definitions are drawn:

- **Buffer zone**: A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.

- **Aquatic impact buffer zone**: A zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels.

The guideline emphasizes that, the buffer zones shall be tailored around the risk that the aquatic resource may face. This criterion recognizes the importance of using risk as a basis for establishing an appropriate buffer width (size). Where risk or uncertainty is high, ecologically conservative buffers should be established, whereas less conservative buffers are appropriate for low-risk situations. Several key risk factors have been identified for possible inclusion in the approach. These include:

(i) Risks posed by adjacent land uses or activities;

(ii) The importance and sensitivity of the water resource;

(iii) The conservation status (risk of extinction) of aquatic and semi-aquatic species;

(iv) Characteristics of the buffer that affect the functionality of the buffer; and

(v) Mitigation measures that may be applied to reduce risks.

The extent of the buffer zone is calculated from the:

(i) Edge of the active channel (Rivers and streams);

(ii) Edge of the temporary zone (Wetlands).

The method of calculating the extent of the buffer is designed for site-based assessments and includes a detailed evaluation of risks and consideration of site-specific factors that can affect the buffer requirements. Such an approach is designed to inform any detailed development planning and provide an appropriate level of information for authorisation purposes (including compliance). Table 8 and Table 9 below shows calculated buffers for different phases of the project's life and the stepwise methodology to be applied.

Table 8 – Applicable buffer zones for different HGM and phases of development (Macfarlane, *et al.*, 2015)

Wetland	Construction Phase	Operational Phase
Seepage Wetlands	50 m	79 m
Depressional Pan Wetlands	42 m	80 m
Unchannelled Valley Bottom Wetlands	58 m	92 m

Channelled Valley Bottom Wetlands	62 m	98 m

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Table 9 - Stepwise tasks for buffer recommendation (Macfarlane, *et al.*, 2015)

Step	Task	Scope
1	Define objectives and scope to determine the most appropriate level of assessment	**Desktop assessment:** This assessment is designed to characterize risks at a desktop level to red-flag land located adjacent to water resources that should potentially be set aside and managed to limit impacts on water resources. **Site-based assessment:** This assessment is designed for site-based assessments and includes a more detailed evaluation of risks and consideration of site-specific factors that can affect buffer requirements.
2	Map and categorize water resources	The assessor is required to generate a map delineating the boundaries of the water resources potentially affected by proposed developments within the study area.
2.1	Classify the watercourse	E.g., Wetland, spring or river and subcategories: Ephemeral drainage line and type of channel (albeit with or without active channel).
2.2	Map the line from which aquatic impact buffer zones will be delineated (Edge of active channel)	• Rivers and streams – the outer edge of the active channel; • Wetlands – the edge of the temporary zone.
2.3	Identify the water resource type	Desktop: Level 3: Sub-system/landscape unit. Site-based: Level 4: Hydromorphic unit.
3	Management objectives	Use appropriate references and methods (below) to formulate management objectives for the watercourse.

Step	Task	Scope
3.1	Determine the Present Ecological State	Desktop or site-based assessment depending on requirements from regulating authority.
3.2	Determine the Importance and sensitivity	In order to determine the overall importance and sensitivity of a water resource, the ecological, social and economic importance should be considered.
4	Risk assessment of water resources	Undertake a risk assessment to assess the potential impacts of planned activities on water resources.
5	Risk assessment for the protection of biodiversity	Assess risks posed by the proposed development on biodiversity and identify management zones
6	Delineate and demarcate recommended setback requirements	Finalize and delineate setback requirements on a layout plan and in the field. In doing so, it is also important to ensure that setback requirements also cater to a range of other potentially important management, functional and legal requirements.
7	Document management measures necessary to maintain the effectiveness of setback areas	Key aspects of the setback requirements will include: • An aquatic impact buffer zone; • Possible core habitat requirements; • Possible corridor requirements; • Any additional aspects requiring consideration to ensure effective management of setback areas.

16. Evaluation of Impacts and Risks

The impact assessment methodology used to assess the impact of the proposed activities development on the receiving wetlands is based on impact assessment guidelines provided by NEMA regulations (2014) as amended. The potential risks of the proposed development will also be assessed using the latest Risk Assessment Matrix for section 21(c) and (i) Water Use Activities (version 2.0).

The impacts will be ranked according to the methodology described below. Where possible, mitigation measures will be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria, as discussed below.

Direct, Indirect & Cumulative

Impacts can either be direct impact, indirect impacts or cumulative impacts. Impact type descriptors are defined in Table 10 below.

Table 10 – Impact type descriptors

Descriptor	Definition
Direct Impact	Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
Indirect Impact	Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
Cumulative Impact	Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

Impact Direction

Impact direction can either be a positive impact, a negative impact or a neutral impact. Impact direction descriptors are defined in Table 11 below.

Table 11 – Impact Direction Descriptors

Descriptor	Definition
Positive	The environment overall will benefit from the impact/risk
Negative	The environment overall will be adversely affected by the impact/risk
Neutral	The environment overall will not be affected

Spatial Extent of Impact

Spatial extent aims to assess the impact footprint. The larger the footprint, the higher the impact rating will be. Table 12 below provides the descriptors and criteria for assessment.

Table 12 - Criteria for the assessment of the extent of the impact

Extent Descriptor	Definition	Rating
Site	Impact footprint remains within the boundary of the site.	1
Local	Impact footprint extends beyond the boundary of the site to the adjacent surrounding areas.	2
Regional	Impact footprint includes the greater surrounds and may include an entire municipal or provincial jurisdiction.	3
National	The scale of the impact is applicable to the Republic of South Africa.	4
Global	The impact has global implications	5

Duration of Impact

The duration of the impact is the period of time that the impact will manifest on the receiving environment, Table 13. The concept of reversibility is linked to some degree to the duration rating. The longer the impact endures, the less likely it is to be reversible. provides the criteria for rating the duration of impacts.

Table 13: Duration Ratings and Description

Duration descriptor	Definition	Rating
Construction / Decommissioning phase only	The impact endures for only as long as the construction or the decommissioning period of the project activity. This implies that the impact is fully reversible.	1
Short term	The impact continues to manifest for a period of between 3 and 5 years beyond construction or decommissioning. The impact is still reversible.	2
Medium term	The impact continues between 6 and 15 years beyond the construction or decommissioning phase. The impact is still reversible with relevant and applicable mitigation and management actions.	3
Long term	The impact continues for a period in excess of 15 years beyond construction or decommissioning. The impact is only reversible with considerable effort in implementation of rigorous mitigation actions.	4
Permanent	The impact will continue indefinitely and is not reversible.	5

Potential Intensity of Impact

The concept of the potential intensity of an impact is the acknowledgement at the outset of the project of the potential significance of the impact on the receiving environment. For example, SO2 emissions have the potential to result in significant adverse human health effects, and this potential intensity must be accommodated within the significance rating. The importance of the potential intensity must be emphasised within the rating methodology to indicate that, for an adverse impact on human health, even a limited extent and duration will still yield a significant impact. See Table 14 and Table 15 below.

Table 14 - Criteria for the impact rating of the potential intensity of a negative impact

Potential Intensity Descriptor	Definition of negative impact	Rating
Low	Negative change with no associated consequences.	1
Moderate-Low	Nuisance impact	2

Moderate	Substantial alteration and/or reduction in environmental quality/loss of habitat/loss of heritage/loss of welfare amenity	4
Moderate-High	Severe alteration to faunal or floral populations/loss of livelihoods/individual economic loss.	8
High	Extreme alteration to human health linked to mortality/loss of a species/endemic habitat.	16

Table 15 – Criteria for the impact rating of the potential intensity of a positive impact

Potential Intensity Descriptor	Definition of positive impact	Rating
Low	Positive change with no other consequences.	1
Moderate-Low	Economic development	2
Moderate	Improved environmental quality/improved individual livelihoods	4
Moderate-High	Net improvement in human welfare	8

It must be noted that there is no HIGH rating for positive impacts under potential intensity, as it must be understood that no positive spinoff of an activity can possibly raise a similar significance rating to a negative impact that affects human health or causes the irreplaceable loss of a species.

Probability / Likelihood of Impact

This is the likelihood of the impact potential intensity manifesting. This is not the likelihood of the activity occurring. If an impact is unlikely to manifest, then the likelihood rating will reduce the overall significance. Table 16 provides the rating methodology for likelihood.

The rating for likelihood is provided in fractions in order to indicate percentage probability, although it is noted that mathematical connotation cannot be implied to numbers utilised for ratings.

Table 16 - Criteria for the rating of the likelihood of the impact occurring

Likelihood Descriptor	Definition	Rating
Improbable	The possibility of the impact occurring is negligible and only under exceptional circumstances.	0.1

Very Unlikely	The possibility of the impact occurring is low with a less than 30% chance of occurring.	0.2
Unlikely	The impact has a 30% to 50% chance of occurring.	0.5
Likely	The impact has a 51% to 90% chance of occurring.	0.75
Definite	The impact has a >90% chance of occurring regardless of preventative measures.	1

Cumulative Impacts

In order to assess any impact on the environment, cumulative impacts must be considered in order to determine an accurate significance. Impacts cannot be assessed in isolation. An integrated approach requires that cumulative impacts be included in the assessment of individual impacts.

The nature of the impact should be described in such a way as to detail the potential cumulative impact of the activity.

Significant Rating Scale

The significance assessment assigns numbers to rate impacts in order to provide a more quantitative description of impacts for purposes of decision-making. Significance is an expression of the risk of damage to the environment, should the proposed activity be authorised.

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus, the total value of the impact is described as the function of significance, which takes cognisance of extent, duration, potential intensity and likelihood. Table 17 provides the resulting significance rating of the impact as defined by the equation as above.

Impact Significance = (extent + duration + potential intensity) x likelihood

Table 17 – Significance rating table

Score	Implications for Decision-making	Rating
< 3	The risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures and will not have an influence on decision-making. The	Low

	project can be authorised with low risk of environmental degradation	
3 - 9	The risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures and will only have an influence on the decision-making if not mitigated. Project can be authorised but with conditions and routine inspections. Mitigation measures must be implemented.	Moderate
10 - 20	The risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making. Project can be authorised but with strict conditions and high levels of compliance and enforcement. Monitoring and mitigation are essential.	High
21 - 26	The risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making. The project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating.	Fatally Flawed

Reversibility of the Impacts

The reversibility of an impact refers to the extent to which the impacts/risks are reversible, assuming that the project has reached the end of its life cycle (decommissioning phase). Reversibility descriptors are provided in Table 18.

Table 18 - Reversibility descriptors and definitions

Descriptor	Definition
High reversibility	Impact is highly reversible at end of project life.
Moderate reversibility	Moderate reversibility of impacts.
Low reversibility	Low reversibility of impacts.
Impacts are non-reversible	The impact is permanent, i.e., this is the least favourable assessment for the environment.

Irreplaceability of Receiving Environment or Resource Loss caused by impacts or risks

Irreplaceability of an impact refers to the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase). Irreplaceability descriptors are provided in Table 19.

Table 19 - Irreplaceability descriptors and definitions

Descriptor	Definition
High irreplaceability	The project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment
Moderate irreplaceability	Moderate irreplaceability of resources
Low irreplaceability	Low irreplaceability of resources.
Resources are replaceable	The affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment.

Confidence

Confidence refers to the degree of confidence in predictions based on available information and specialist knowledge. Confidence descriptors are provided in Table 20.

Table 20 - Confidence descriptors and definitions

Descriptor	Definition
Low	A specialist has low confidence in the assessment due to significant limitations, such as the unavailability of data or information
Medium	The specialist has medium confidence in the assessment due to some limitations, such as the unavailability of data or information
High	The specialist has high confidence in the assessment.

17. Risk Assessment

In the case of a risk assessment matrix, unlike the assessment of significant impacts as per EIA guidelines. The risk to the water resource is considered with proposed mitigation measures assumed to be in place. Wetland systems that are identified are further identified using the 'likelihood of impact' guidelines, as shown in Table 21 below. The likelihood of impact for the proposed construction of the solar farm is **Definite without mitigation.**

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Table 21 - Qualitative 'likelihood of impact' ratings and descriptions

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

Likely / Possible	intensity and development area. This is generally resources located downstream within the following parameters: ○ within 32m downstream of a low-risk development; ○ within 100m downstream of a moderate risk development; and/or ○ within 500m downstream of a high-risk development (note that the extent of the affected area downstream could be greater than 500m for high-risk developments or developments that have extensive water quality and flow impacts e.g. dams/abstraction and treatment plants).
Likelihood of Impact Rating	**Description of Rating Guidelines**
Unlikely	These resources are unlikely to require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or ➢ resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: ○ greater than 32m downstream of a low-risk development; ○ greater than 100m downstream of a moderate-risk development; and/or

	○ greater than 500m downstream of a high-risk development (note that the extent of the affected area downstream could be greater than 500m for high-risk developments or developments that have extensive water quality and flow impacts e.g. dams/abstraction and treatment plants).
None	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located within another adjacent sub-catchment, and which will not be impacted by the development in any way, shape or form.

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18. DATA ANALYSIS

Any large-scale development within a natural system inevitably exerts pressure on the environment, often with negative ecological consequences if not carefully managed. It is therefore critical during the planning and environmental authorisation phase to identify potential impacts and design effective mitigation measures. Best practice requires that such developments be located in already modified or fragmented areas wherever possible (Edwards et al., 2018).

Assumptions and Limitations

The findings of this assessment are subject to the following assumptions and limitations:

- It is assumed that all third-party data sources (e.g., SANBI BGIS, Limpopo Conservation Plan shapefiles, Google Earth imagery) used in this assessment are accurate and up to date;
- Evidence of fauna was determined through both direct observations and indirect signs (e.g., tracks, scats, nests, burrows, and shed skins). Some species may remain undetected due to cryptic behaviour, low densities, or nocturnal activity patterns;
- It is acknowledged that additional biodiversity records may become available after completion of this report through ongoing databases such as SANBI and citizen science platforms (e.g., iNaturalist);
- The project site is located within a semi-natural landscape surrounded by villages, agricultural activities, and grazing areas, which may influence species composition and distribution;
- The survey was limited to a single 1-day field assessment, which may restrict the detection of some species and reduce overall sampling completeness;
- Survey conditions were predominantly sunny

Despite these limitations, the integration of desktop analysis, field observations, and specialist expertise provides a robust and reliable assessment of the ecological sensitivity, biodiversity value, and potential impacts associated with the proposed development.

19. RESULTS

The assessment confirms at least, **two drainage lines** within the project site and its 200m buffer zone. The aquatic systems identified the only **drainage lines** which are less sensitive and exhibit general conditions of terrestrial system, (Figure 9). The drainage lines are cut crossing or flowing from east to west. **Drainage Line 1** cut across inside the site on the northern area, and **Drainage Line 2** cut across on the southern boarder edge, outside the site



Figure 9: The overall condition of the drainage line

Table 22: Drainage Lines within Phase 1 Site.

Watercourse System	Where	Position/Project Site	Buffer Zone Size	GPS Coordinates	Recommendation
Drainage Line 1	Inside the project site	Cutting across the site from the west to the east	100 m	Start: -23.902631°, 29.022770° Middle: -23.903865°, 29.013574° End: -23.898647°, 29.001490°	No activities within the system. Avoid the system and buffer 100m around. Clearly mark the buffer with visible marker during the construction and operational phase.
Drainage Line 2	Outside, on the edge/boarder	Outside south boarder of the site. On the edge, from west to east	100 m	Start: -23.908527°, 29.031428° Middle: -23.911594°, 29.014383° End: -23.909650°, 29.000954°	Shift the southern board of the proposed site outsider the 100m buffer zone. No activities within the system. Avoid the system and buffer 100m around. Clearly mark the buffer with visible marker during the construction and operational phase.

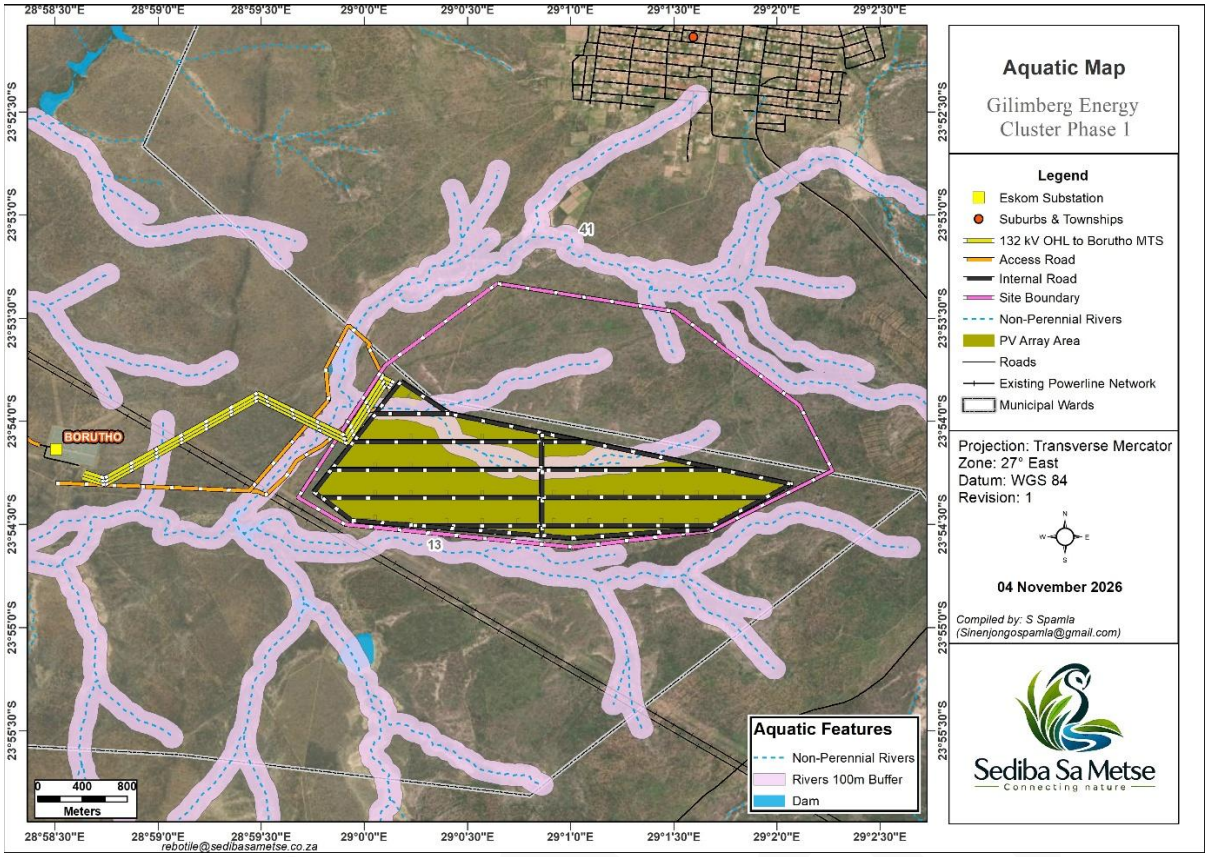


Figure 10: The Drainage Lines within Phase 1 Site



Soil sampled from the drainage line



Drainage Line

Figure 11: The Drainage Line condition on site

Ecological Health – Present Ecological Status (PES)

A Level 1B Wet-Health wetland assessment was undertaken for the system in an effort to determine its PES. Four wetland modules or wetland components were assessed, namely

Hydrology, Geomorphology, Water Quality and Vegetation. All three wetlands' PES were determined.

Both Drainage Lines 1 and 2 – PES

The systems are experiencing the similar pressure and threats or challenges. They are important for its hydrological catchment aspect. It collects and transport the run off waters during rainfall into the downstream river feeding into wider provincial water sources. The germorphology and vegetation have been modified by the existing activities such as overgrazing, wood cutting, fires and enchroachment by invasive plants and Sickle Bush Tree. The **Combined Ecological Category is C: Status – Moderately modified**. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.

Drainage Lines' Functional Assessment

The general ecosystem services were assessed using the WET-Ecoservices by Kotze et al. (2020). This involved assessing the potential of the systems to supply ecosystem services that are in demand by local users of the wetlands, thus providing an Importance Score for each ecosystem service assessed.

Both Drainage Lines.

The Regulating and Support Services of the systems are moderate .This is mainly due to its locality setting as a major receiver of the local waters down to major rivers of the province. Whilst the Provision and Cultural Services are Low on both supply and demand.

Ecological Sensitivity and Importance

The Wetland Ecological Sensitivity and Importance (EIS) was undertaken as a system. The scores obtained from the WET-Health and WET-EcoServices assessments were used to assess the EIS. EIS categories are provided in Table 6 above.

For **both drainage lines**, the EIS for this system is **Moderate:** *Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river*, (EIS Class: C),

Recommended Ecological Category (REC)

Both systems, provide moderate ecosystem services with the PES and REC category : C as per the guidelines provided by Rountree et al. (2013). Recommended mitigation measures for the current impacts and disturbances, as well as potential impacts from the proposed activities, are provided below to assist with maintaining and even improving the current PES, EIS, and REC

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20. Impact Description, Assessment, and Mitigations

Two drainage lines are moderately to heavily disturbed, impacted, and degraded by existing activities. They are exposed to varying degrees of impacts and disturbances and pressure, including and associated with agricultural activities. The vegetation clearance, livestock trampling and harvesting of local firewood compromise the systems including their 200m buffer catchment. Current impacts on the identified system were identified during the in-field assessment. These, together with relevant impacts from the proposed solar plant, were subjected to a prescribed impact assessment methodology.

Current Impacts

The drainage lines to some its geomorphological characteristics and vegetation compromised. During the infield assessment, the current impacts were identified and are provided below:

- Modification/rerouting of the systems.
- Agricultural ploughing activities within the portion of the system.
- Heavy tree cutting
- Livestock trampling and grazing
- Presence of alien and invasive species as well as encroachment

Anticipated Potential Impacts

Below are the anticipated potential impacts associated with the proposed activities. The common and major impact is the **habitat loss and site clearance,** and fragmentation of corridor for local avifaunal or/and fauna.

Construction Phase

- Potential impacts on the wetlands
    - The clearing of vegetation for site establishment and preparation for construction will expose the soil to erosion, where the carried sediment will be deposited downstream.
    - Deep excavation will destruct and destabilise the soil profile that may lead to lose of natural nutrients and soil life.
    - Compaction of the surrounding area by driving in and around the site with heavy vehicles that may lead to short-term gullies/trails.
    - Removal of vegetation within this area will remove a portion of local ecological support area essential for biological maintenance.

- Incorrect planning and placement of stormwater infrastructure during construction will lead to sedimentation and toxicant enrichment of the downstream, thus impacting water quality in the wide water system.
- Establishment and increase of alien and invasive species.
- Modification of the system by displacement and destabilisation of the hydrological aspect that may lead to slowing down of water flow or velocity.
- Possible soil erosion if the ground is left bare for over time.
- Impediment of the water flows during infrastructure placement and digging of the foundation/lay hole

Operational phase

- Maintenance activities may lead to land pollution into the drainages
- Poor planning and placement of the structure/panels and associated structures may lead to constant maintenance or replacement before they reach their lifespan
- Establishment and increase of alien and invasive species is probable.
- Leakage of toxic substances form the substations or others, may be leached into the soil.

Progressive Rehabilitation

Recommended that this drainage system must not be impacted or tempered with but be buffered with 100m and avoided

21. Assessment of Significance

The assessment of the significance of the potential impacts was considered and is summarised below. Table 23 provides the assessment of significance on the potential impacts during **construction**, while the assessment of significance on the potential impacts from the **operational phase** of the development is provided in Table 24

Table 23 - Assessment of significance pre and post-mitigation (Construction Phase)

Impact Description		Impact type	Extent (E)	Duration (D)	Potential Intensity (P)	Likelihood (L)	Impact Rating & Significance (IR&S)
Impact	Indirect Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	1	2	0,5	3 - MOD
Aspect:	Geomorphology and Vegetation	Project Impact	2	1	4	2	14 - MOD
Potential Impact:		**Significance with Mitigation**					
The clearing of vegetation for site establishment and preparation for construction will expose the soil to erosion, where the carried sediment will be deposited downstream		Residual Impact	2	2	2	1	6- LOW
		Reversibility	Low reversibility				
		Irreplaceability	High irreplaceability				
		Cumulative Impact					
		Cumulative Impact	2	2	4	1	8 - MOD
		Confidence	High				
Description of Cumulative Impact							
There is a need for more solar plant development and associated infrastructure as the population continues to grow. Projects of the same nature will put the surrounding wetland systems under pressure and threatens their biodiversity and functions.							
Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Indirect Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	1	2	0,5	3 - MOD
Aspect:	Geomorphology and Hydrology	Project Impact	2	2	4	0,75	6 - MOD
Potential Impact:		**Significance with Mitigation**					
Compaction of the surrounding area by driving in and around the site with heavy vehicles that may lead to short term gullies/trails.		Residual Impact	1	1	2	0,2	1 - LOW
		Reversibility	High reversibility				

	Irreplaceability	Resources are replaceable				
	Cumulative Impact					
	Cumulative Impact	2	2	2	0,5	3 - MOD
	Confidence	Medium				
Description of Cumulative Impact						
The driving in and over the drainage is probable. Growing demand of solar plant is probable and this appears to continue into the future as more land for such development is in demand.						
Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Direct Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	2	2	0,75	5 - MOD
Aspect:	Vegetation and Wetland	Project Impact	2	4	4	1	10 - HIGH
Potential Impact:		**Significance with Mitigation**					
Removal of vegetation within this area will remove a portion of an ecological support area essential for the maintenance of drainsages in the area.		Residual Impact	1	4	2	1	7 - MOD
		Reversibility	Impacts are non-reversible				
		Irreplaceability	High irreplaceability				
		Cumulative Impact					
		Cumulative Impact	2	4	4	1	10 - HIGH
		Confidence	High				
Description of Cumulative Impact							
Both approved and unapproved developments are encroaching on CBAs at an unprecedented rate. More watercourse systems are likely to be impacted upon and removed by these kinds of land uses.							
Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Indirect Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	2	2	1	6 - MOD
Aspect:	Hydrology, Water quality and Vegetation	Project Impact	2	4	4	1	10 - HIGH
Potential Impact:		**Significance with Mitigation**					

The lack of vegetated land due to the development will increase surface runoff to downstream and decrease the infiltration rate required to sustain draiange with slow subsurface flow during dry periods.	Residual Impact	2	2	2	0,5	3 - MOD
	Reversibility	Low reversibility				
	Irreplaceability	Moderate irreplaceability				
	Cumulative Impact					
	Cumulative Impact	2	3	4	1	9 - MOD
	Confidence	High				
Description of Cumulative Impact						
The area is prone to future sola plant development and activity likely to permanently destroy the systems..						

Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Direct Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	2	2	0,5	3 - MOD
Aspect:	Water quality	Project Impact	2	3	4	0,75	7 - MOD
Potential Impact:		**Significance with Mitigation**					
Chemicals, toxicants, and hydrocarbons spill and leaks will be carried by runoff to the downstream of the draiange.		Residual Impact	1	1	2	0,2	1 - LOW
		Reversibility	Low reversibility				
		Irreplaceability	High irreplaceability				
		Cumulative Impact					
		Cumulative Impact	3	2	4	1	9 - MOD
		Confidence	High				
Description of Cumulative Impact							
The drainage prone to the leaching of the toxicants. And mechanisms to prevent the spill must be in place for future							

Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Direct Impact:	**Significance without Mitigation**					

Impact Direction:	Negative	Existing Impact	3	3	3	1	9 - MOD
Aspect:	Water quality	Project Impact	2	4	3	1	9 - MOD
Potential Impact:		**Significance with Mitigation**					
Modification of the system by displacement and destabilisation of the hydrological aspect that may lead to slow down of the natural systems of the drainage line		Residual Impact	2	2	2	0,5	3 - MOD
		Reversibility	Low reversibility				
		Irreplaceability	Moderately irreplaceability				
		Cumulative Impact					
		Cumulative Impact	3	4	4	1	11 - HIGH
		Confidence	High				
Description of Cumulative Impact							
The area is prone to sola plant development. Unplanned and planned development and infrastructure will have future disturbance to the remaining natural systems including the wetlands							

Table 24 - Assessment of significance pre and post-mitigation for the operational phase.

Impact Description		Impact type	Extent (E)	Duration (D)	Potential Intensity (P)	Likelihood (L)	Impact Rating & Significance (IR&S)
Impact	Direct Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	3	2	0,75	5 - MOD
Aspect:	Hydrology and Geomorphology	Project Impact	3	5	4	1	12 - HIGH
Potential Impact:		**Significance with Mitigation**					
Poor planning and placement of the infrastructure may lead to constant maintenance or replacement of the solar plant before it reach its lifespan		Residual Impact	1	1	1	0,5	1 - LOW
		Reversibility	High reversibility				
		Irreplaceability	Low irreplaceability				

	Cumulative Impact					
	Cumulative Impact	3	3	4	0,75	8 - MOD
	Confidence	High				
Description of Cumulative Impact						
This impact is likely to persist if mitigation measures are not implemented (proper planning)						

Impact Description		**Impact type**	**E**	**D**	**P**	**L**	**IR&S**
Impact	Direct Impact:	**Significance without Mitigation**					
Impact Direction:	Negative	Existing Impact	2	2	2	0,75	5 - MOD
Aspect:	Hydrology and geomorphology	Project Impact	3	2	4	1	9 - MOD
Potential Impact:		**Significance with Mitigation**					
Establishment and increase of alien and invasive species is probable		Residual Impact	1	2	2	0,5	3 - MOD
		Reversibility	Impacts are non-reversible				
		Irreplaceability	Moderately irreplaceability				
		Cumulative Impact					
		Cumulative Impact	3	3	4	0,75	8 - MOD
		Confidence	High				
Description of Cumulative Impact							
The area is prone to infestation of the invasive alien plants soon after soil disturbance.							

22. Assessment of Significance Results

From the above summary of the assessment of significance for different potential impacts during the **construction and operational phase**. The overall significant rating is **Moderate to high** at the receiving environment without mitigation. Due to its **permanent** habitat destruction and **long-term** impact as well as **limited to site** footprints. With applicable mitigation measures, the impacts are likely to be mitigated and rated as **Low for** aquatic theme (avoid the systems). Assessment of significance for the operational phase will be **very Low** with a probability of **invasive alien plants** manifesting.

Mitigation Measures

Mitigation measures aim to reduce the significance of potential impacts. The following mitigation measures are suggested. However, it should be noted that the list is not exhaustive but specifies the assessed potential impacts. Therefore, more mitigation measures can be added should more impacts be identified during the project.

- A rule and principle of the Mitigation Hierarchy must be applied. This means:
  - **Avoid** unnecessary destruction of the wetlands
  - **Minimise** the impact and limit it to the site and footprint
  - **Rehabilitate** the areas impacted where mitigation is unavoidable (e.g. revegetate the areas cleared during digging)
  - **Offset** is not probable as the project is capable of achieving the above three.
- The impacts are **definite** (i.e., happening within the draiange), therefore, the **General Use** authorisation must be obtained from the local competent authority.
- The proposed activities must be outside the **drainage lines and its buffer** as provided in the map and sensitivity file.
- In the EMPr, the emphasis is on how to manage the:
  - Management of alien and invasive plants,
  - Management of soil erosion control and sedimentation during the rainy period.
- The deep excavation for infrastructure placement will disturb the soil structure/profile adjacent to the systems. No sedimentation or erosion must take place into the systems
- The drainage systems must not be used as **refuge site, parking areas, ablution facilities or any other means.**
- Mark the drainage buffer with clearly visible markers and communicate their extend to all workers
- No infilling of any infrastructure into the wetland.

- No clearance of vegetation around the wetland.
- If during the rainy period, the risk of erosion is detected by the environmental officer, attempts must be made to stop and prevent erosion.
- Erosion breakers, such as heaps built of soil materials and grass seeds (of wetland species) must be developed on areas of steep slopes, at the gully cuts, and along the edge
- Rehabilitation of the areas affected is recommended.
- During progressive rehabilitation, re-vegetation of disturbed areas must be undertaken with indigenous species from the surrounding area, either sourced locally with the permission of the Environmental Control Officer (ECO) or commercially.
- No hunting or harvesting of fauna and flora in and around the site

Final

23. Conclusion

The assessment confirmed **two watercourse systems (**per DWS guideline) and identified as **drainage lines,** within the phase 1 project site covering 200m buffer. There are named Drainage Line 1 (on the north) and Drainage Line 2 (on the south) for the purpose of this assessment. The systems's PES is determined as **Moderate (Category C)** and not sensitive to the disturbance whilst they are important to the hydrology catchment of the wide provincial value. There are currently experience similar pressure and threats emanating from agricultural activities and human presence.

The proposed activity has potential to destabilises or modifies the soil structure, topography, and geomorphology, impeding the natural flow of water be within the drainage lines. This assessment recommends complete avoidance of the systems and buffer them with 100m.

The proposed mitigation in this report must be implemented to the best of ability by the applicant, and duty of care must be applied. The proposed activities may be authorised with General Authorisation from competent authorities. It is the opinion of the specialist, with field-based facts and available resources, that the proposed activities of maintenance and construction of the solar plant should be considered.

Final

Assumptions and Limitation

The following limitations and assumptions apply to this assessment:

- Although all watercourses occurring within 500m of the proposed activities were mapped at a desktop level, field investigations were confined to the ones within the 200m zone of the proposed site. Only two were within the scope and assessed during this project.
- **Sampling** by its nature means that not all parts of the study area were visited but reasonable and representative data was collected to be analysed.
- The assessment findings are thus only applicable to these three wetland systems.
- A Soil Munsell Colour Chart was used to determine the soil matrix colour of the soil sampled. However, it is important to note that the recording of the colours using the soil chart is highly subjective and varies significantly depending on soil moisture and the prevailing light conditions. In this case, all the soils sampled were moist to wet and sampling was undertaken in sunny conditions.
- Soil wetness indicators (i.e., soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality does not influence the delineation of wetland areas. This assessment was conducted in October 2026.
- Vegetation are the first responder to the soil and hydrological modification, therefore cannot entirely be relied on during the determination of the wetland assessment unless only determining the degree of water quality and hydrology impact.
- Although every effort was made to correctly identify the plant species encountered onsite, wetland plants, particularly the Cyperaceae (sedge) family, are notoriously difficult to identify to species level. Every effort as made to accurately identify plant species but where identification to species level could not be determined, such species were only identified to genus level.
- Seasonality can also influence the species of flora encountered at the site, with the flowering time of many species often posing a challenge in species identification.

24. REFERENCES

Brownlie, S., Botha, M., Helme, N., Holness, S., Rebelo, T., and Wessels, K., 2009. *Guidelines for Incorporating Biodiversity into Environmental Impact Assessment Processes*. Pretoria: South African National Biodiversity Institute (SANBI).

Department of Environmental Affairs (DEA), 2016. *National Protected Area Expansion Strategy (NPAES)*. Pretoria: DEA.

Driver, A., Sink, K., Nel, J., Holness, S., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P., Harris, L., and Maze, K., 2011. *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems*. Pretoria: SANBI.

Driver, A., Sink, K.J., Nel, J.L., et al., 2012. *National Biodiversity Assessment 2011: Technical Report*. Pretoria: SANBI.

Edwards, D., et al., 2018. *Best practice guidelines for biodiversity-inclusive impact assessment*. Pretoria: SANBI.

Friedmann, Y. and Daly, B. (eds.), 2004. *Red Data Book of the Mammals of South Africa: A Conservation Assessment*. Pretoria: CBSG Southern Africa.

Mucina, L. and Rutherford, M.C. (eds.), 2006. *The Vegetation of South Africa, Lesotho and Swaziland*. Pretoria: SANBI.

Nel, J.L. and Driver, A., 2014. *National Biodiversity Assessment: Freshwater Component*. Pretoria: SANBI.

Republic of South Africa, 1996. *Constitution of the Republic of South Africa (Act No. 108 of 1996)*. Pretoria: Government Printer.

Republic of South Africa, 1998. *National Environmental Management Act (Act No. 107 of 1998)*. Pretoria: Government Printer.

Republic of South Africa, 1998. *National Water Act (Act No. 36 of 1998)*. Pretoria: Government Printer.

Republic of South Africa, 2004. *National Environmental Management: Biodiversity Act (Act No. 10 of 2004)*. Pretoria: Government Printer.

SANBI (South African National Biodiversity Institute), 2010. *Red List of South African Plants*. Pretoria: SANBI.

SANBI, 2019. *National Biodiversity Assessment 2018: Synthesis Report*. Pretoria: SANBI.

SANBI, 2024. *Protected Areas Database*. Pretoria: South African National Biodiversity Institute.

Skinner, J.D. and Chimimba, C.T., 2005. *The Mammals of the Southern African Subregion*. Cambridge: Cambridge University Press.

25. Appendix C: Photos from the site



