PROPOSED BATTERY ENERGY STORAGE SYSTEM (BESS) AND ASSOCIATED INFRASTRUCTURE AT PULIDA SOLAR PV ENERGY FACILITY, FREE STATE PROVINCE

FRESHWATER IMPACT ASSESSMENT

PREPARED BY:

Environmental Services

PREPARED FOR:

Green Power

DATED:
13 September 2022

AUTHOR:

Craig Burne *Pr.Sci.Nat.*

T · 021 702 2884

E · craigb@ncc-group.co.za

DOCUMENT CONTROL

PROJECT TITLE:	Proposed Battery Energy Storage System (BESS) and associated infrastructure at Pulida Solar PV Energy Facility, Free State Province
REPORT TITLE:	Freshwater Impact Assessment
LOCATION:	Letsemeng Local Municipality, Xhariep District Municipality, Free State
CLIENT:	Enel Green Power
CONSULTANT:	NCC Environmental Services (Pty) Ltd
REVISION:	05
DATE:	13/09/2022

TABLE OF CONTENTS

DECLARATION OF INDEPENDENCE

Specialist Name	Craig Burne *Pr.Sci.Nat.*
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 amended Environmental Impact Assessment (EIA) Regulations, that: • I act as an independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations, and all other applicable legislation • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	Burne
Date	13 September 2022
SACNASP No	115213
Company	NCC Environmental Services (Pty) Ltd
Position	Senior Environmental Consultant

DOCUMENT GUIDE

The table below outlines the gazetted NEMA procedures published in GN320 dated 20 March 2020 (Government Gazette 43110) which relates to the specialist assessment and minimum report content requirements for environmental impacts on aquatic biodiversity for activities requiring environmental authorisation.

No.	Criteria/requirements for the assessment and reporting of impacts on aquatic biodiversity for activities requiring environmental authorisation	Page/Section in this report
2. Site sensitivity verification and minimum report content requirements		
2.1	A site sensitivity verification must be undertaken by an Environmental Assessment Practitioner or a specialist.	**This report**
2.2	The sensitivity verification must be undertaken through the use of: a. A desktop analyses, using satellite imagery; b. A preliminary on-site inspection; and Any other available and relevant information.	
2.3	The outcome of the site sensitivity verification must be recorded in the form of a report that: a. Confirms or disputes the current use of the land and the environmental sensitivity as identified by the screening tool, such as new developments or infrastructures, the change in vegetation cover status etc.;	
	b. Contains a motivation and evidence (e.g. photographs) of either the verified or different use of the land and environmental sensitivity; and	
	c. Is submitted together with the relevant assessment report prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.	
2. Specialist assessment and minimum report content requirements		
2.3.1	A description of the aquatic biodiversity and ecosystems on the site, including; a. aquatic ecosystem types; and b. presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	**Section 8** & **Annexure A**
2.3.2	The threat status of the ecosystem and species as identified by the screening tool;	**Section 8.1**
2.3.3	An indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status (i.e. if the site includes a wetland or a river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area);	**Section 8.7**
2.3.4	A description of the ecological importance and sensitivity of the aquatic ecosystem including: a. the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and b. the historic ecological condition (reference) as well as present ecological state of rivers (in- stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	**Sections 8.6 and 8.7**
2.4	The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.	**Section 10**
2.5	Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:	**Section 10**
2.5.1	Is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	**Yes**
2.5.2	Is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	**Yes**

2.5.3	How will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:	**Minimally, refer below:**
	(a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes);	**Sections 8.6**
	b. will the proposed development change the sediment regime of the aquatic ecosystem and its sub -catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns);	**Unlikely** (BESS Alt 2 highly unlikely)
	c. what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.); and	**Minor/low** (BESS Alt 2)
	d. to what extent will the risks associated with water uses and related activities change;	**Minimally**
2.5.4	How will the proposed development impact on the functioning of the aquatic feature? This must include:	**Refer below:**
	a. base flows (e.g. too little or too much water in terms of characteristics and requirements of the system);	**Minimally** (BESS Alt 2)
	b. quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over - abstraction or instream or off stream impoundment of a wetland or river);	**Minimally** (BESS Alt 2)
	c. change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchanneled valley-bottom wetland to a channelled valley-bottom wetland);	**Unlikely** (BESS Alt 2)
	d. quality of water (e.g. due to increased sediment load, contamination by chemical and / or organic effluent, and / or eutrophication);	**Minimally** (BESS Alt 2)
	e. fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and	**Annexure B**
	f. the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.)	**None**
2.5.5	How will the proposed development impact on key ecosystems regulating and supporting services especially: a. flood attenuation; b. streamflow regulation; c. sediment trapping; d. phosphate assimilation; e. nitrate assimilation; f. toxicant assimilation; g. erosion control; and h. carbon storage?	**Annexure B** (Minimal for BESS Alternative 2 compared to Alternative 1)
2.5.6	How will the proposed development impact community composition (numbers and density of species) and integrity (condition, viability, predator - prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	**Minimally** (BESS Alt 2)
2.6	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: (a) size of the estuary; (b) availability of sediment; (c) wave action in the mouth; (d) protection of the mouth; (e) beach slope; (f) volume of mean annual runoff; and (g) extent of saline intrusion (especially relevant to permanently open systems).	**n/a**
The compliance statement / assessment must be prepared by a suitably qualified specialist registered with the SACNASP, with expertise in the field of aquatic sciences.		**Noted**
The compliance statement / assessment must: be applicable to the preferred site and the proposed development footprint;		**Noted**
2.7	The findings of the specialist assessment must be written up in an Aquatic Biodiversity	**Refer below:**

	Specialist Assessment Report that contains, as a minimum, the following information:	
2.7.1	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	**Page 1 & 5**
2.7.2	A signed statement of independence by the specialist;	**Page 5**
2.7.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	**Sections 7 & 12**
2.7.4	The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	**Section 7**
2.7.5	A description of the assumptions made, any uncertainties or gaps in knowledge or data;	**Section 6**
2.7.6	The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant;	**Section 11, 12 & 13**
2.7.7	Additional environmental impacts expected from the proposed development;	**Section 10**
2.7.8	Any direct, indirect and cumulative impacts of the proposed development on site;	**Section 10**
2.7.9	The degree to which impacts and risks can be mitigated;	**Section 10 & Annexure B**
2.7.10	The degree to which the impacts and risks can be reversed;	**Section 10 & Annexure B**
2.7.11	The degree to which the impacts and risks can cause loss of irreplaceable resources;	**Section 10 & Annexure B**
2.7.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies;	**N/A to access road and cable trench** **32m for BESS**
2.7.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr);	**Annexures B, D & E**
2.7.14	A motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate;	**Section 9, pg 39**
2.7.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not; and	**Section 13**
2.7.16	Any conditions to which this statement is subjected.	**Section 13, obtain an EA**

ABBREVIATIONS

BESS	Battery Energy Storage System
CBA	Critical Biodiversity Area
CDNGI	Chief Directorate National Geospatial Information
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EC	Ecological Category
EGP	Enel Green Power
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
ESA	Ecological Support Area
FBIS	Freshwater Biodiversity Information System
FSA	Fish Support Area
GN	Government Notice
IAP	Invasive Alien Plant
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
PES	Present Ecological State
PV	Photovoltaic
SANBI	South African National Biodiversity Institute
SS	Substation
WMA	Water Management Area
WRC	Water Research Commission
WUA	Water Use Authorisation

GLOSSARY OF TERMS AND DEFINTIONS

Altering the bed, banks, course and characteristics of a watercourse
Any change affecting the resource quality within the riparian habitat or 1:100-year floodline.

Aquatic
Associated with and dependent on water e.g. aquatic vegetation.

Aquatic ecosystem
The abiotic (physical and chemical) and biotic components, habitats and ecological processes contained within rivers and their riparian zones and reservoirs, lakes, wetlands and their fringing vegetation.

Biodiversity
The diversity of genes, species and ecosystems on Earth, and the ecological and evolutionary processes that maintain this diversity.

Catchment
In relation to a watercourse, watercourses or part of a watercourse means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points.

Critical Biodiversity Area
Areas required to meet biodiversity targets for ecosystems, species or ecological processes, as identified in a systematic biodiversity plan. May be terrestrial or aquatic.

Ecological Support Area
An area that is not essential for meeting biodiversity targets but plays an important role in supporting the ecological functioning of one or more Critical Biodiversity Areas or in delivering ecosystem services. May be terrestrial or aquatic.

Invasive Alien
A species whose natural range occurs outside of South Africa and which were transported to their current location by humans; where they are able to reproduce, spread and typically cause negative ecological impact

In-stream habitat
The physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse.

Pollution
The direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it -
a) less fit for any beneficial purpose for which it may reasonably be expected to be used; or
b) harmful or potentially harmful -
i. to the welfare, health or safety of human beings;
ii. to any aquatic or non-aquatic organisms;
iii. to the resource quality; or
iv to property.

Protection
In relation to a water resource, means -
a) maintenance of the quality of the water resource to the extent that the water resource may be used in an ecologically sustainable way;
b) prevention of the degradation of the water resource; and

c) the rehabilitation of the water resource.

Regulated area of a watercourse
a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

Resource quality
Means the quality of all the aspects of a water resource including -
a) the quantity, pattern, timing, water level and assurance of in-stream flow;
b) the water quality, including the physical, chemical and biological characteristics of the water;
c) the character and condition of the in-stream and riparian habitat; and
d) the characteristics, condition and distribution of the aquatic biota.

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

Section 21(c) water use
One which can *impede* or *divert* the flow of water in a watercourse:

Diverting the flow - a temporary or permanent structure causing the flow of water to be rerouted in a watercourse for any purpose.

Impeding the flow - a temporary or permanent structure causing the flow of water to be rerouted in a watercourse for any purpose.

Section 21(i) water use
One which can lead to the altering of the bed, banks, course or characteristics of a watercourse.

Watercourse
a) a river or spring;
b) a natural channel in which water flows regularly or intermittently;
c) a wetland, lake or dam into which, or from which, water flows; and
d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Water resource
Includes a watercourse, surface water, estuary or aquifer.

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

1 INTRODUCTION

Enel Green Power (Pty) Ltd (**EGP**) intends to submit an application for Environmental Authorisation for development of a Battery Energy Storage System (BESS) in the proximity of the existing Pulida Solar photovoltaic facility (Re. No.: 14/12/16/3/3/2/391) located in the Letsemeng Local Municipality in the Free State province.

EGP appointed NCC Environmental Services (Pty) Ltd (**NCC**) to carry out a specialist freshwater study in terms of the overarching regulatory framework, primarily the National Environmental Management Act (Act 107 of 1998) and the National Water Act (Act 36 of 1998).

2 SITE LOCATION

The proposed BESS site is in close proximity and directly adjacent to the existing (i.e. authorised) Pulida Solar PV Facility approximately 40 kilometers to the south-east of Kimberley on the remainder of farm Klipdrift No. 20 in the Magisterial District of Jacobsdal, Letsemeng Local Municipality, Xhariep District Municipality, Free State Province (**Figure 2-1**). The site is accessible via either the N8, N12 and R705 and secondary farm gravel roads and is situated adjacent to Eskom's "Kimberley DS - Skietpan Switching Station" 132kV power line with an existing substation feeding the powerline via loop in and loop out connections.

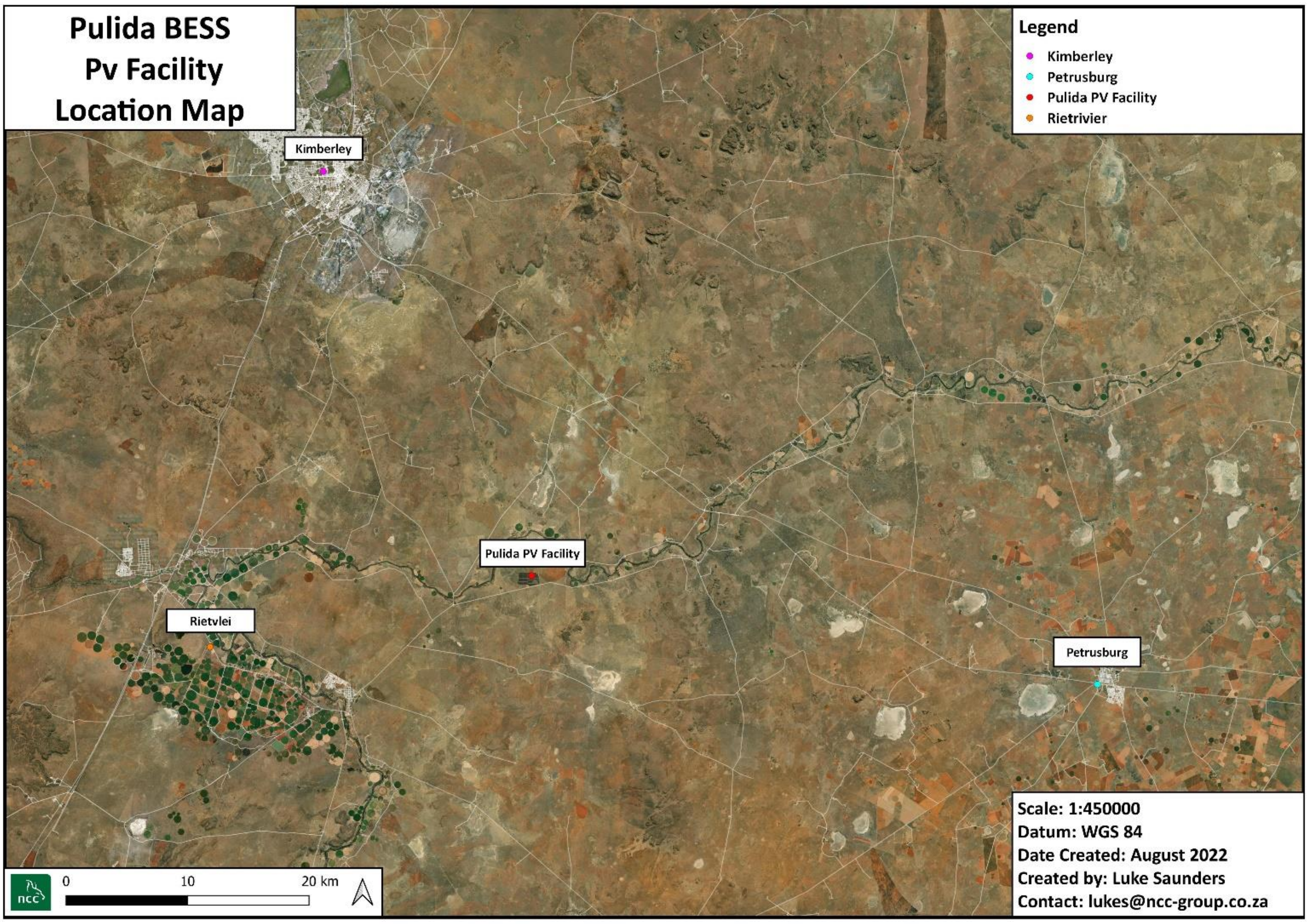


Figure 2-1: Site location.

Surface water freshwater resources and Alternative BESS sites 1 and 2 are indicated in **Figure 2-2**. Alternative 2 (preferred) is on the same property several hundred meters west of Alternative 1.

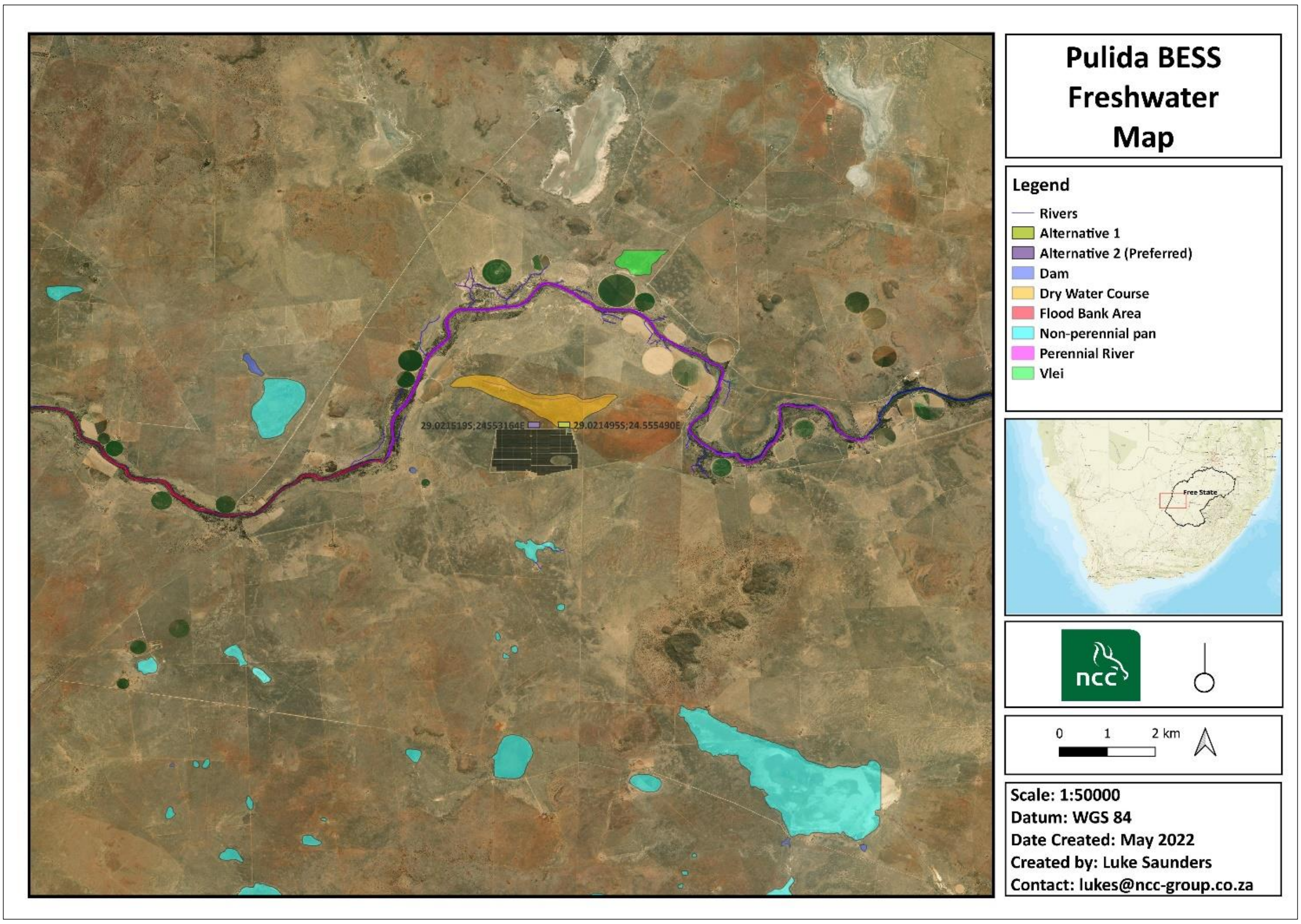


Figure 2-2: Alternative BESS sites in relation to freshwater resources and the existing Pulida Solar PV facility.

3 CLIMATE, VEGETATION AND GEOLOGY

The study area is situated within the later summer rainfall region (hydrological region 3) with the mean annual precipitation varying between 200 and 400mm peaking around the month of March. The mean maximum and minimum monthly temperatures for the area are 37.1°C and -2.3°C (Barbour et al. 1987). The proposed development area lies within the Nama Karoo biome which occurs on the central plateau and western half of South Africa, at altitudes ranging between 500 and 2000m across most of the biome, mostly flat to gently sloping with isolated hills of Upper Karoo Hardeveld in the south and Vaalbos Rocky Shrubland in the northeast and many interspersed pans (Mucina & Rutherford, 2006). The pans, represented as the Highveld Salt Pans vegetation type, are depressions containing temporary water bodies with open to sparse dwarf shrubland developed along pan edges, particularly when under heavy grazing pressure.

The study area is underlain by shales of the Volksrust Formation and to a lesser extent, the Prince Albert Formation (both of the Ecca Group) as well as Dwyka Group diamictites. Wide stretches of land are covered by superficial deposits including calcretes of the Kalahari Group. Soils are variable from shallow to deep, red yellow, apedal, freely drained soils to very shallow Glenrosa and Mispah forms. Mainly Ae, Ag and Fc land types. (Mucina & Rutherford, 2006). The Prince Albert Formation consists of mainly black mica rich shale and subordinate sandstone and mudstone. Surface calcrete occurs as discontinuous layers and concretions and is associated with mudstone, shale, tillite, dolerite and dolomite. The calcrete is generally associated with low relief and depressions in the landscape. The three types of calcrete represented in the area include hardpan calcrete, nodular calcrete and cliff calcrete.

4 PROJECT DESCRIPTION

A Battery Energy Storage System (BESS) is designed to save and store excess electrical output as it is generated. This can later be released into the grid as and when required. The Battery system is able to provide to the grid ancillary services as well. In this scenario the BESS system is housed inside containers or similar housing structures with a footprint of up to 4ha in extent. Both Lithium-ion and Redox-flow technology are being considered for the project, depending on which is most feasible at the time of implementation.

Roughly 4ha in size:

- A Substation with a maximum height of - HV busbar up to 10m max and an HV Building up to 4m maximum.
- Access road to the BESS (6m wide road surface with side ditch drainage on each side of the road) branching off the existing roads, and internal roads (up to 8m wide) within the footprint of the BESS, as needed. The length of the road will not exceed 700m.
- MV Cabling (underground or overhead) between the BESS and the HV/MV BESS substation.
- HV Cabling (underground or overhead) between the HV/MV BESS substation and the existing HV substation or for loop in and loop out to the existing HV connection line.
- Fencing around the BESS and the substation for increased security measures.
- Temporary laydown area within the 4ha footprint of the BESS.
- Possible firebreak around the BESS facility which is to be located within the 4ha BESS footprint.

5 SCOPE OF WORK

The objectives of this assessment included the following:

- To undertake a desktop analysis, site sensitivity verification and site inspection to verify the sensitivity of aquatic biodiversity on a continuum ranging from either **Very High** to **Low**;

- In the event that any watercourses and aquatic biodiversity features are confirmed to fall within the development footprint and where these watercourses will be impacted by the development, then the site sensitivity is confirmed as **Very High** and a full specialist freshwater assessment would be required;
- Identification of any freshwater resources/ecosystems (wetlands and watercourses) associated with the proposed development in relation to the NEMA and NWA regulated areas and activities;
- Delineation of any freshwater resources according to standard and widely used approaches in South Africa;
- Assess potential impacts/risks to freshwater resources/watercourses associated with the proposed development;
- Provide mitigation and management measures and monitoring recommendations for the management and mitigation of significant negative impacts that the proposed development may have on freshwater resources and/or biodiversity;
- Provide recommendations for rehabilitation measures which may be required for the long-term protection of watercourses and wetlands post-construction;
- Provide recommendations for the application for an EA and WUA from the relevant competent authorities.

6 LIMITATIONS AND ASSUMPTIONS

There are often limitations when assessing ecological systems which are complex, dynamic and often evolving on relatively short temporal scales, such as over decades in the context of the current climate change scenario and particularly with watercourse features which are often cryptic and transient in drier climatic regions such as where the development is proposed. In order to apply generalised and often rigid scientific methods or techniques to natural, dynamic environments, a number of inherent assumptions are stated below:

- The determination of the watercourse boundary and assessment thereof is confined to the study area (properties) of the identified wetland features
- The databases consulted may not at all times be recent or as fully reliable as is the nature databases;
- This study assumes the previous EIA and assessments undertaken during 2014 by the previous EAP and specialists are unbiased where appropriate assessment methods were followed;
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of this assessment;
- Since environmental impact studies of this nature deal with dynamic natural systems which evolve and change over time, obtaining higher accuracy interpretations with a greater degree of confidence

is better achieved over several years and seasons based on iterative field sampling and observations to account for fluctuations in environmental conditions;

- Any recommended watercourse buffer zones do not account for any impacts of future climate change or any future changes resulting from other activities in the immediate catchment.

7 METHODOLOGY

7.1 Desktop study

An initial site sensitivity verification exercise to determine if there are any potential inconsistencies, if applicable, between the national screening tool data and the current status quo on the site was undertaken at desktop level followed by a site visit. The purpose is to identify if any features are identifiable on the site that are not currently reflected in the screening tool data/report and whether any areas have been significantly modified since the data were updated and input into the tool.

The determination of the site sensitivity relied upon a review and interrogation of available desktop and other literature resources including:

- DFFE National Screening Tool
- DWS spatial layers
- National Freshwater Ecosystem Priority Area (NFEPA) spatial layers and reports (Driver *et al*., 2011, Nel *et al*., 2011)
- The National Wetland Map 5 (Van Deventer et al., 2018)
- Information and data on SANBI's BGIS platform
- The Freshwater Biodiversity Information System (FBIS)
- Satellite aerial imagery (Google Earth Pro)
- Topographical maps, aerial photos, contour data and drainage data (CDNGI)
- Cape Farm Mapper (https://gis.elsenburg.com/apps/cfm/)
- 2016 Northern Cape Critical Biodiversity Areas (DENC, 2016)
- Existing approvals/authorisations and previous specialist studies for the existing PV facility

7.2 Site visit

A site visit was undertaken on 14th December 2022 where a ground-truthing exercise was carried out to identify any watercourses and wetlands within the footprint of the site and 500m from the site according to methods detailed in Ollis et al. (2013) and DWAF (2005, 2008).

7.2.1 Wetlands & watercourses

Distinguishing features which formed the basis /criteria for the delineation are as follows:

- the presence, either permanently, seasonally or temporarily, of water at or near the surface – *Hydrological indicators*;
- the topographic setting and gradient of the landscape (**Figure 3**) and shape and structure of any preferential surface water flow paths - *Terrain Unit indicator;*
- A rapid survey of any wetland / riparian vegetation habitats and hydrophytic plant species adapted to or tolerant of saturated soil conditions which may indicate the presence of wetland plant species, if applicable. This included an observation of any perceived changes or transition in the vegetation's physical structure *i.e.* where a more vigorous and robust growth form may be different to that of the adjacent (terrestrial) areas - *Vegetation indicators;*
- Site photographs were taken to document the site conditions at the time of the field visit (See report section 8).

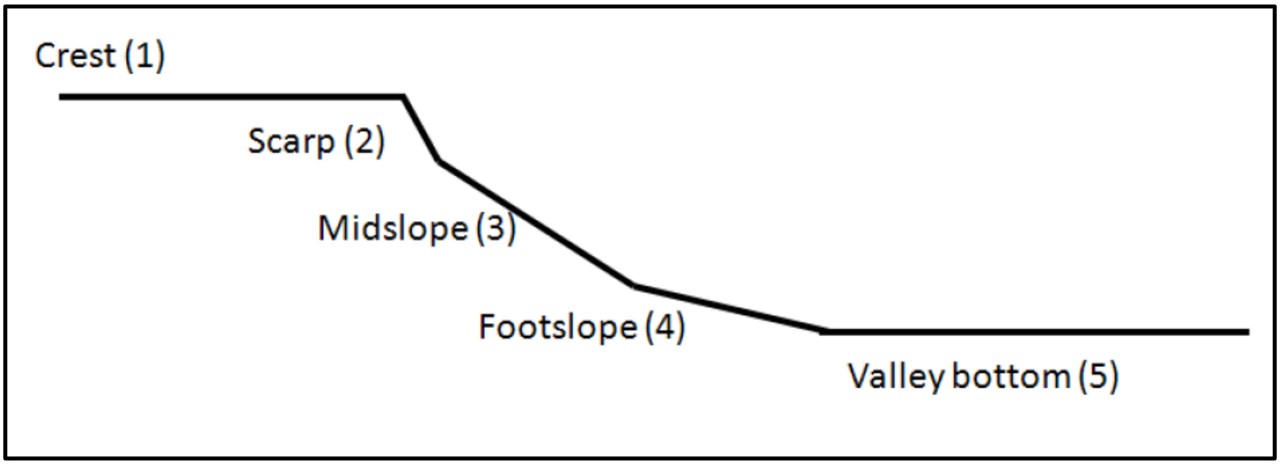


Figure 3: The five main landscape components or terrain units where wetlands may exist (*Source*: DWAF, 2008a).

7.2.2 Freshwater biodiversity

To facilitate biodiversity conservation in priority areas outside protected areas, biodiversity priorities i.e. Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) for both the terrestrial and aquatic realms are used in biodiversity planning where it is intended to be integrated into and inform land use planning, environmental assessment and decision making i.e. authorisations as well as natural resource management by a range of sectors whose policies and decisions impact on biodiversity. There are also national guidelines for biodiversity assessment which should be consulted and utilised wherever applicable to a degree of detail as deemed appropriate.

In the context of this proposed BESS development, the intention from a freshwater perspective was to determine whether there may be any threatened wetland or aquatic species (freshwater biodiversity), river/ecological corridors, fish support areas (FSAs), wetland or river freshwater ecosystem priority areas (FEPAs) or river/wetland critical biodiversity areas (CBAs) which would be negatively impacted by the development and/or whether impacts on freshwater biodiversity would be either minor/negligible or significant. The author of this report consulted the 2015 Free State Biodiversity Plan, the NFEPA databases, the Freshwater Biodiversity Information System (FBIS), the SANBI BGIS databases and the Letsemeng Local municipality and Xhariep District municipality IDPs to determine the status of aquatic biodiversity (and any aquatic conservation status, if applicable) relating to the study area where the BESS is proposed.

7.3 Freshwater resource classification

The manual for the Classification System for Wetlands and other Aquatic Ecosystems in South Africa developed for the South African National Biodiversity Institute (SANBI) was consulted for guidance. The manual comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels. The methods in the manual also include the assessment of structural features at the lower levels of classification (Ollis, *et al*. 2013).

7.4 Wetland Assessment

WET-Health Version 2 (Macfarlane *et al*. 2020) consists of a series of three tools developed to assess the Present Ecological State (PES) or "ecological health" of wetland ecosystems of different hydrogeomorphic (HGM) types at three different levels of detail/resolution. These tools build on previous assessment methods, including WET-Health Version 1 and Wetland-IHI, in response to the need that was identified to develop a refined and more robust suite of tools for the assessment of the PES of wetland ecosystems in South Africa. The tool is designed to assess the PES of a wetland by scoring the perceived deviation from a theoretical reference condition, where the reference condition is defined as the un-impacted condition in which wetland ecosystems show little or no influence of human actions. It is thus appropriate to consider 'deviation' from the natural or reference condition, with the ecological state of a wetland taken as a measure of the extent to which human impacts have caused the wetland to differ from the natural reference condition. The PES is assessed by evaluating the extent to which anthropogenic activities have altered wetland characteristics across the four inter-related components/modules of wetland health namely:

- **Hydrology**; defined in this context as the distribution and movement of water through a wetland and its sediments;
- **Geomorphology**; where changes to geomorphic processes and the geomorphic structure of the wetland are assessed;
- **Water quality**; where physico-chemical attributes of the water in a wetland are assessed based on potential diffuse runoff from land-uses within the wetland and from the areas surrounding the wetland together with point-source discharges of pollution entering directly into the wetland and/or into streams that flow into that wetland;
- **Vegetation**; where changes in vegetation composition and structure as a consequence of current and historic on-site transformation and/or disturbance are evaluated.

An aggregation of scores for the 4 components are calculated according to the following formula:

[Overall (Combined) PES Score] = ([(Hydrology score) x 3] + [(Geomorphology score) x 2] + [(Water Quality score) x 2] + [(Vegetation score) x 2)] ÷ 9)

This produces a final score ranging from **0** (pristine) to **10** (critically impacted in all respects). The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in **Table 1-1** which illustrates how the resultant impact scores fall into one of six health categories (A – F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F).

7.4.1 Present Ecological State

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area.

Table 1-1: Health categories used by WET-Health for describing the integrity/PES of wetlands (Macfarlane *et al*. 2020).

Health (PES) category	Description	Impact score range	PES Score (%)
A	Unmodified, natural.	0-0.9	90-00
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.	1-1.9	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.	2-3.9	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	40-59
E	The change in ecosystem processes and the loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	20-39
F	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	0-19

7.4.2 Ecosystem Services

WET-EcoServices includes an assessment of 16 different ecosystem services (**Table 1-2**), which were selected for their specific relevance to the South African situation. This full suite of ecosystem services is assessed for both wetlands and riparian areas, apart from streamflow regulation which is not included in the riparian assessment owing to a lack of relevant studies. The tool provides a set of indicators (e.g. slope of the wetland) rated on a five-point scale of 0 to 4 that reflect the supply/capability of a wetland for each of the 16 different ecosystem services.

A Microsoft Excel™ based spreadsheet/tool, revised in February 2020, is used to conduct the assessment where for each ecosystem service, indicator scores are combined automatically in an algorithm built into in the model/spreadsheet that has been designed to reflect the relative importance and interactions of the attributes represented by the indicators to arrive at an overall supply score. In addition, the demand for the ecosystem service is assessed based on the wetland's catchment context (e.g. toxicant sources upstream), the number of beneficiaries and their level of dependency, which are also all rated on a five-point scale. Similarly, an algorithm automatically combines the indicator scores relevant to demand to generate a demand score.

The tool is designed to assign either an estimated *percentage range* or a *qualitative description* (e.g. low or high) in conjunction with the score. This depends on the type of services which are provided by the wetland under assessment; an example extract is illustrated from the datasheet (**Table 1-3**). As per the datasheets a rating of **zero** (low importance) to **four** (very high) is allocated to each factor/service assessed.

Table 1-2: Ecosystem services supplied by wetlands and assessed by WET-EcoServices (after Kotze *et al*. 2009).

INDIRECT BENEFITS (Regulating and supporting)	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream.
	Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter.
	Streamflow regulation		Sustaining streamflow during low flow periods.
	Water quality enhancement	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters.
		Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters.
		Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters.
		Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters.
		Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
DIRECT BENEFITS	Biodiversity maintenance		Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity.
	Cultural	Cultural heritage	Places of special cultural significance in the wetland, e.g. for baptisms or gathering of culturally significant plants.
		Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife.
		Education and research	Sites of value in the wetland for education or research.
	Provisioning	Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.
		Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish etc.
		Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods.

Table 1-3: *Scoring approach for the various ecosystem services assessed by the WET-EcoServices score sheet.

SCORE	0	1	2	3	4
% RANGE (e.g. for the average slope of the wetland)	<3%	3-5%	6-8%	9-11%	>11%
RATING DESCRIPTION (e.g. extent of toxicant sources in the wetland's catchment)	Low	Moderately low	Intermediate	Moderately high	High

*Only an extract example from the datasheet.

Indicators, where the rationale and method for each are incorporated into the tool, are used to generate scores for the ecosystem services where the indicator scores are combined to generate supply and demand scores for individual ecosystem services. Individual supply and demand scores are integrated into an overall wetland importance score. The assessment examines and rates the following services according to their degree of importance and the degree to which the services are provided (**Tables' 1-4** and **1-5**). As per the rating criteria a rating of zero (low importance) to four (very high) is allocated to each factor/service assessed.

Table 1-4: Integration of scores for supply & demand to obtain an overall importance score (after Kotze *et al*. 2020).

Demand		Supply				
		Very Low	Low	Moderate	**High**	**Very High**
		0	1	2	3	4
Very Low	0	0.0	0.0	0.5	1.5	2.5
Low	1	0.0	0.0	1.0	2.0	3.0
Moderate	2	0.0	0.5	1.5	2.5	3.5
High	3	0.0	1.0	2.0	3.0	4.0
Very High	4	0.5	1.5	2.5	3.5	4.0

Table 1-5: Rating of importance categories (after 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.**

7.4.3 Ecological Importance and Sensitivity

The method used for the EIS determination was initially adapted from the method as provided by DWS (1999) for floodplains. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in **Table 1-5**. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. This is a similar approach to the WetEcoservices proposed method for integrating EI and ES to derive the EIS of the wetland(s). **Table 1-6** indicates how the EIS score is calculated by using the EI score for a wetland system with moderate sensitivity as a starting (benchmark) score and adjusting scores up or down by up to one class based on actual sensitivity. Criteria included in the EIS calculation include biodiversity support, landscape scale and wetland sensitivity.

Table 1-6: EIS categories and the interpretation of median scores for freshwater biota and habitats (adapted after DWA, 2013 and DWS, 1999).

EIS rationale/general description	Score range	EIS Categories
Wetlands/quaternary catchments that are not unique or ecologically important and sensitive at any scale. The biodiversity of these systems (in terms of biota and habitat) is ubiquitous and not sensitive to flow and habitat modifications and they play an insignificant role in moderating the quantity and quality of water of major rivers and have a substantial capacity for use.	>0 and ≤1	Low / Marginal (D)
Wetlands/quaternary catchments that are considered to be ecologically important and sensitive on a provincial or local scale due to habitat diversity, species diversity, unique species and rare/endangered species. The biodiversity of these systems (in terms of biota and habitat) is not usually sensitive to flow and habitat modifications and they play a small role in moderating the quantity and quality of water of major rivers and often have a substantial capacity for use.	>1 and ≤2	Moderate (C)
Wetlands/quaternary catchments that are considered to be unique, ecologically important and sensitive on a national scale due to habitat diversity, species diversity, unique species and rare / endangered species. The biodiversity of these systems (in terms of biota and habitat) may be sensitive to flow and habitat modifications and they play a role in moderating the quantity and quality of water of major rivers. May still have substantial capacity for use.	>2 and ≤3	High (B)
Wetlands/quaternary catchments that are considered ecologically important and sensitive on a national or even international level based on unique biodiversity due to habitat diversity, species diversity, unique species and rare/endangered species and the biodiversity of these systems (in terms of biota and habitat) are usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers with no or only a small capacity for use.	>3 and ≤ 4	Very high (A)

Table 1-7: Proposed table for integrating EI and ES into a composite EIS score (after Kotze *et al*. 2020).

		Ecological Importance (EI)				
		Very Low	Low	Moderate	High	Very High
Ecological Sensitivity (ES)		0	1	2	3	4
Very Low	0	0.00	0.00	1.00	2.00	3.00
Low	1	0.00	0.50	1.50	2.50	3.50
Moderate	2	0.00	1.00	2.00	3.00	4.00
High	3	0.50	1.50	2.50	3.50	4.00
Very High	4	1.00	2.00	3.00	4.00	4.00

7.5 NEMA Impact assessment

Given that human activities and developments have an effect on the natural environment it is important to provide information on the environmental impacts and consequences of these activities will have and to inform the decision-makers thereof. Impacts are assessed using a common method which assesses significance based on various criteria that enables comparisons to be made between risks/impacts to assist authorities, stakeholders and the developer to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing impacts is outlined in 7.5.1. below.

Potential impacts are evaluated against the results of the wetland delineation and PESEIS assessment where impacts are assessed in terms of both the construction and operational phases. The operational phase refers to the phase of the development where the infrastructure has been complete with normal school operational activities underway. Due to the nature of this development, the operational phase is considered to continue long-term and as a result, no assessment of any closure or post-closure phases applied in this assessment. Mitigation measures were applied only to impacts deemed relevant/significant based on the impact screening and analysis.

7.5.1 Assessment methodology

The Guideline Documentation on EIA Regulations (DEAT, 1998) provided guidance on the methodology/approach for impact assessment. The criteria and terminology descriptions which are considered in the impact assessment are as follows:

Nature of the Impact – This is an appraisal of the type of effect the project would have on the freshwater environment. This description includes what would be affected and how and whether the impact is expected to be positive (+ve) or negative (-ve).

Extent of the Impact – A description of whether the freshwater impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.

Duration of the Impact – This provides an indication of the lifespan of the freshwater impact (the time period over which freshwater resources are affected).

Severity (Magnitude) of the Impact – This indicates the degree to which the impact would affect freshwater resources.

Likelihood of Occurrence – This is an estimation of the likelihood of the impact on freshwater resources actually occurring.

Degree of Confidence – This describes the degree of confidence for the predicted impact on freshwater resources based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

Table 2-1 below is an illustrative overview of the impact characterisation and criteria matrix with the various impact criteria described and rated on a scale of numerical values.

Table 2-1: Characterisation and criteria matrix for assessment of impacts.

		Description	Numerical value		Description	Numerical value
Occurrence	**Duration**	Temporary – period of less than 1 year	1	**Likelihood**	Highly unlikely – will likely not occur	1
		Short term – period of less than 5 years	2		Unlikely – some possibility but low likelihood	2
		Medium term – period of less than 15 years	3		Likely – distinct possibility	3
		Long term – period of less than 20 years	4		Highly likely – most likely	4
		Permanent – a period that exceeds the life of the development	5		Definite – impact will occur regardless of any prevention measures	5
Severity	**Extent** (spatial scale)	On-site – impacts that are limited to the site/project footprint	1	**Severity**	No effect – will have no effect on the ecosystem	0
		Local – impacts that are limited to the project site and adjacent properties	2		Minor – minor and will not result in an impact on ecosystem processes	2
		Regional – impacts that are experienced at a regional scale e.g. municipal/provincial	3		Low – low and will cause a slight impact on ecosystem processes	4
		National – impacts that are experienced at a national scale	4		Moderate – moderate and will result in ecosystem processes continuing but in a modified way	6
		Trans-boundary / International – impacts that are experienced outside of South Africa	5		High – ecosystem processes are altered to the extent that they temporarily cease	8
					Very high – results in complete destruction of ecosystem patterns and permanent cessation of processes	10

The environmental significance of each potential impact is then calculated using the following formula:

***Significance Points (SP) =** (Severity + Duration + Extent) x Likelihood*

The maximum value is 100 significance points (SP) with potential impact significance ranked as *HIGH*, *MODERATE* or *LOW* based on the criteria in **Table 2-2**.

Table 2-2: Significance criteria ranking.

≤29 significance points	**LOW** significance
30 – 59 significance points	**MODERATE** significance
≥60 significance points	**HIGH** significance

7.6 Cumulative impacts

Cumulative ‘effects’ can occur when impacts take place so frequently in time or so densely in space that the effects of individual impacts cannot be assimilated or when the impacts of one activity combine with those of another in a synergistic manner. Cumulative impacts can occur over different temporal and spatial scales by interacting, combining and compounding so that the overall effect often exceeds the simple sum of previous effects. An approach to assessing cumulative impacts, including on freshwater resources/biodiversity, is to consider potential interactions with other land-uses on the basis of past, present impacts and future impacts and surrounding land uses and development pressures. GIS spatial mapping which displays and analyses digital data including historical information to create map overlays can be used to identify areas where cumulative effects are likely to occur. Historical maps, aerial imagery and spatial freshwater-related data was explored in relation to the cumulative effects of the proposed development.

7.7 NWA Risk Assessment

Risks of the development on watercourses in terms of Section 21 (c) and/or (i) of the National Water Act were assessed using the DWS-regulated risk matrix approach promulgated in terms of the Act under GN509 dated 26th August 2016. Refer to **Annexure F** for the risk assessment methodology. As indicated in DWS (2018a), borderline low/moderate risks can be manually adapted downwards up to a maximum of 25 points where additional mitigation is provided.

8 RESULTS

For ease of report reading, accessory results in the form of diagrams, photos and maps are also included at the end of this report as various **Annexures**.

8.1 DFFE Screening tool output

As per the DFFE screening tool, the proposed development site (Alternative 1) is in an area considered to have a very high sensitivity for the aquatic biodiversity theme based on presence of wetlands (**Figure 4-1**). The broader study area is not situated within any Strategic Water Source Areas (SWSAs) for surface water or groundwater.

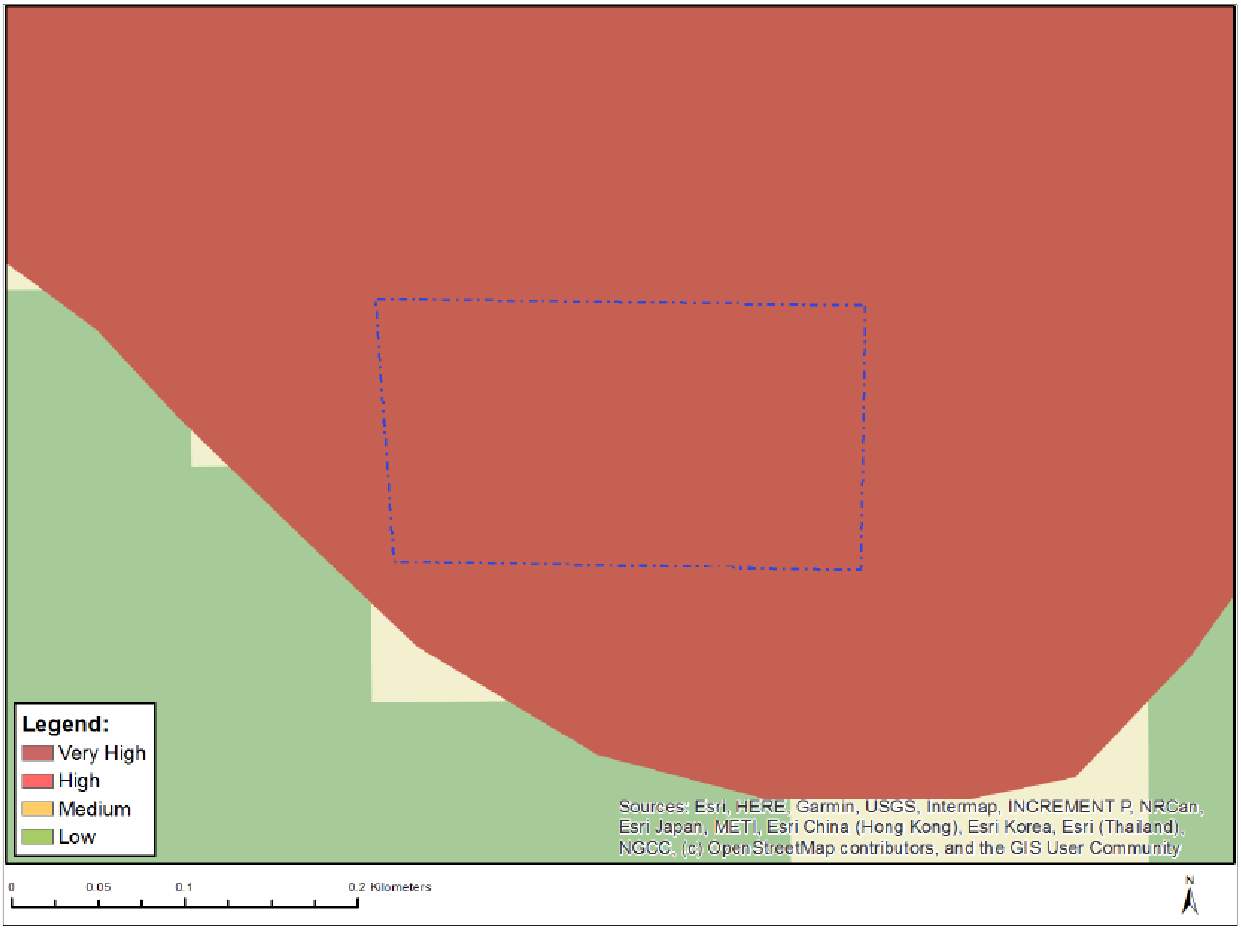


Figure 4-1: Very high relative aquatic biodiversity theme sensitivity of the area in which Alternative site 1 is situated. (Source: DFFE Screening Tool report https://screening.environment.gov.za)

8.2 Desktop

Desktop screened information is presented in tabular form in **Annexure A**.

On a regional scale, the study area is located within the Upper Orange Water Management Area (WMA) in quaternary catchment C52L (**Figure 4-2**).

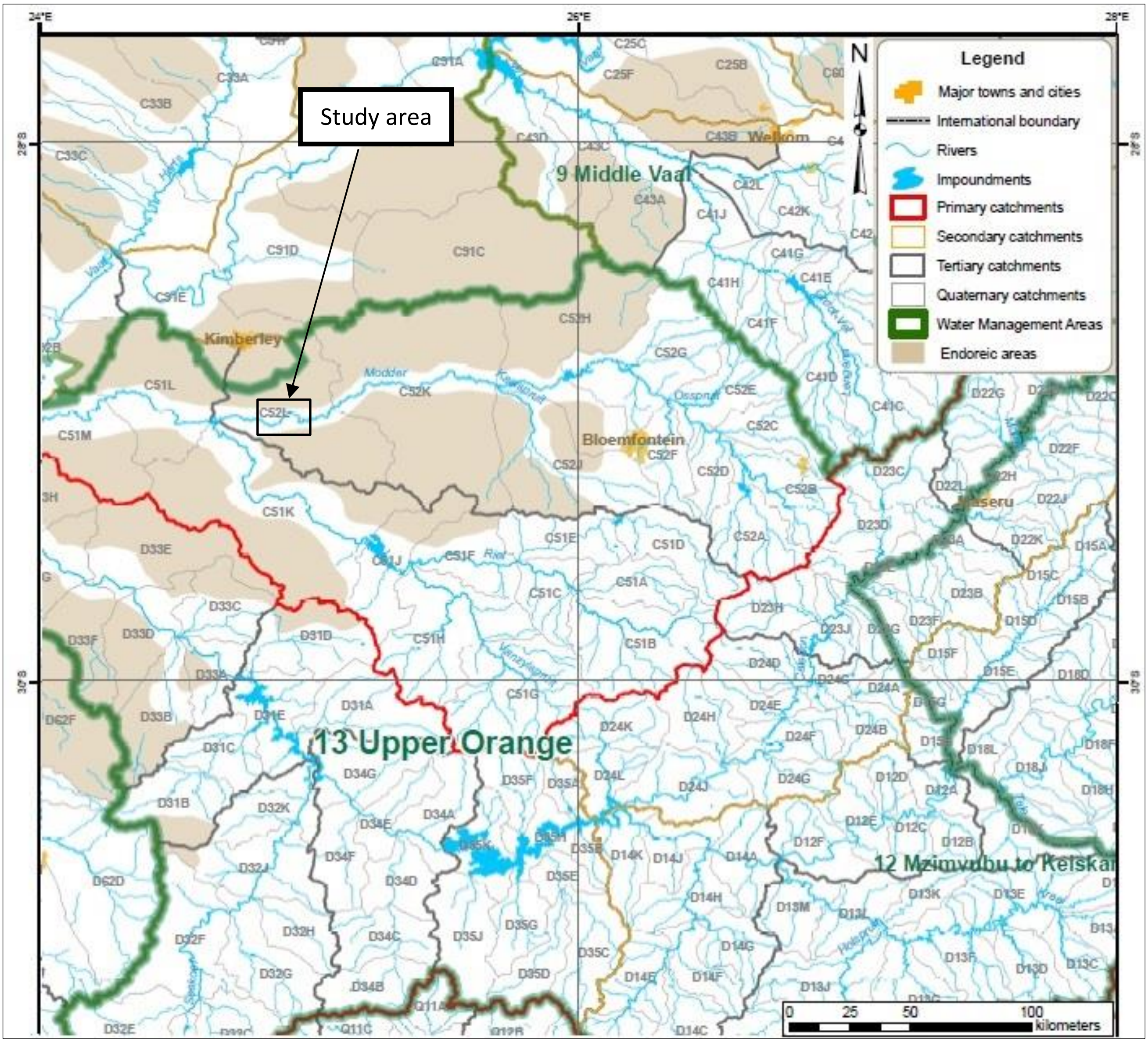


Figure 4-2: Study area site location in the Upper Orange WMA in quaternary catchment C52L (Source: Bailey and Pitman, 2016).

According to geospatial data sources, a dry watercourse/NWM5 depression wetland is situated to the north of the existing solar plant with the footprint of the BESS Alterative 1 site directly within this feature (**Figure 4-3**). BESS Alternative site 2 is considered as a possible option (See **Figures' 4-4a 4.4b** and **4.4c**) and is the preferred alternative from a freshwater perspective.

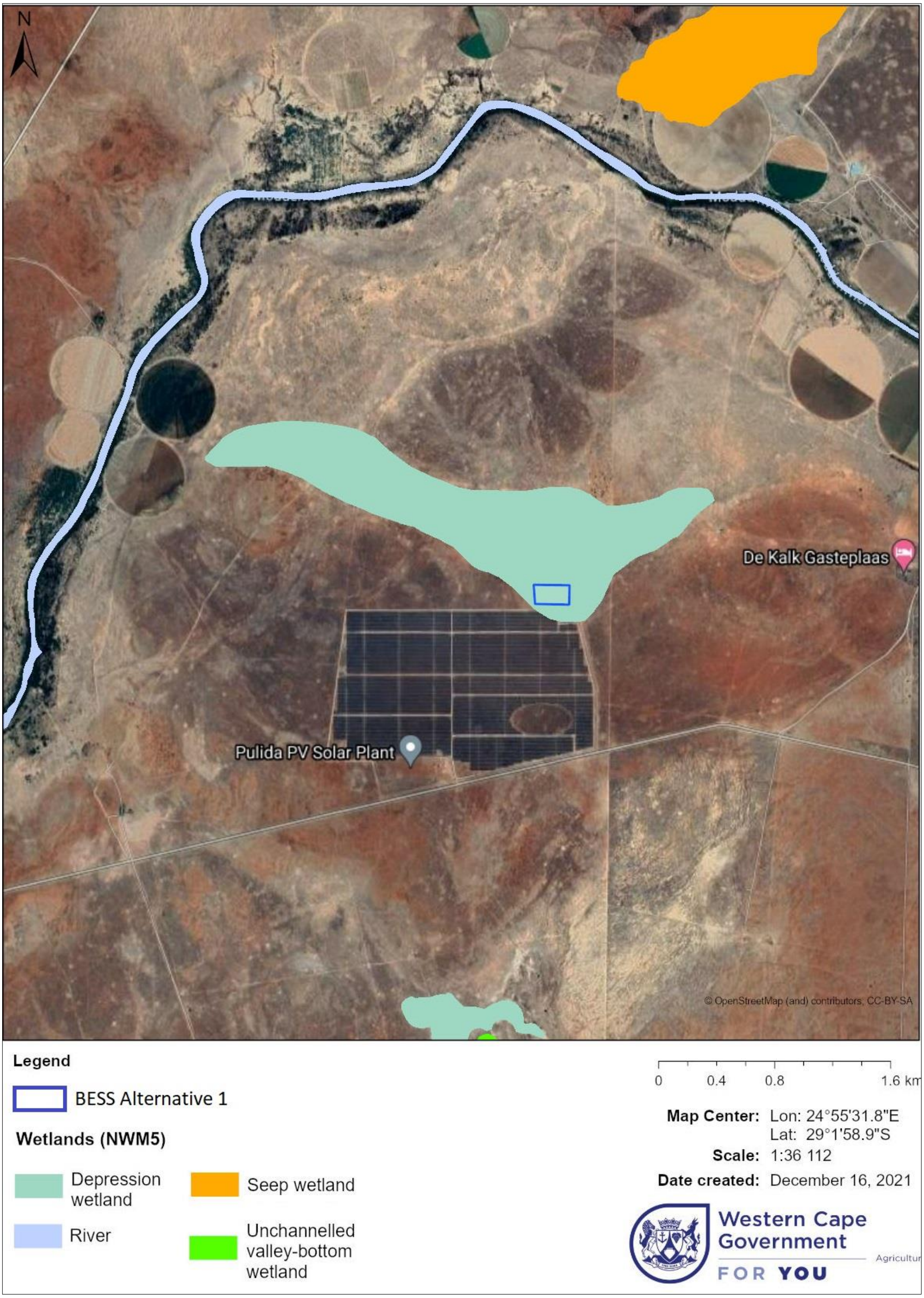


Figure 4-3: Map indicating freshwater resources within the study area. The perennial Modderrivier is located several kilometres away meandering around the entire site. Proposed alternative site 1 is situated within a dry watercourse mapped as a NWM5 wetland depression i.e. a pan.

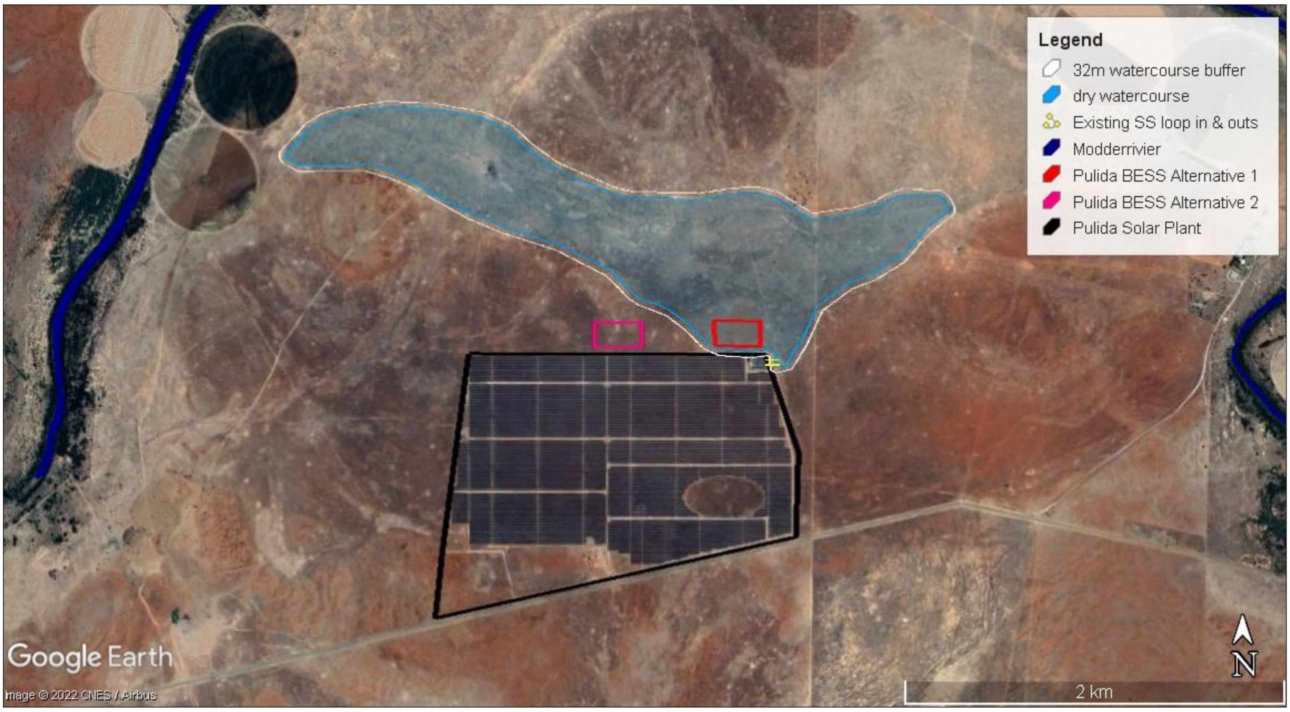


Figure 4-4a: Site map of the watercourse and 32m buffer in relation to the BESS sites (Alternative 1 and 2) and the existing Pulida Solar Plant (Source: Google Earth).

Figure 4-4b: Site map of the watercourse and 32m buffer in relation to the alternative BESS sites and the existing Pulida Solar Plant (Source: Google Earth).

8.3 Site visit

The site sensitivity verification field visit and ground-truthing exercise was conducted in the summer season by the freshwater specialist on 14th December 2021. The depression dry watercourse feature identified during the desktop study in which Alternative site 1 is proposed was ground-truthed where signs of inundation and more rigorous plant growth was observed moving northwards towards the preferential flow path at the centre of the feature (**Photo 1**). Sedges (*Cyperus* spp) were observed (**Photo 2**) as well as cracks in the ground surface (**Photo 3**) from intermittent/periodic inundation and drier climatic hydroperiods which are characteristic of the drier parts of the country where endorheic seasonal pans and depression wetlands are commonly found. An invasive facultative grass species, Genus *Polypogon*, was present across parts of the site (**Photo 4**), a ruderal grass often found in brackish (salty) soils, alluvial floodplains, seepage areas and moist soil in disturbed areas, often where grazing pressure is high.

Photo 1: View north across HGM 1 (dry watercourse/depression) towards a central preferential flow path in the background along the treeline.

Photo 2: *Cyperus* (sedge) species observed in HGM 1.

Photo 3: Cracking of ground surface indicating periods of intermittent inundation alternating with a drier hydroperiod.

Photo 4: *Polypogon* spp in HGM 1, an invasive facultative grass species observed in wetlands or saturated areas ~50% of the time.

8.4 Watercourse delineation

For the purposes of this assessment, the terms 'watercourse', 'depression', 'pan' and 'wetland' are used interchangeably to mean the same feature which meets the legal definition of a watercourse in terms of the National Water Act. Although not classified as an NFEPA wetland, the dry watercourse feature (seasonal depression) has been recently classified (during the 2018 NBA) as a NWM5 depression wetland (**Figure 4-3**). Several NFEPA wetland clusters occur to the north of the Modderrivier however none are within 500m from any of the BESS alternatives (See **Figure 6-1** in section 8.7).

The location of the alternative BESS sites in relation to the dry watercourse is shown in **Figures 4-4a** and **4-4b**. The Modderrivier, a perennial fourth order river and tributary of the Orange River, is located +/-2.5km from either of the alternative sites to the east, north and west respectively (**Figures' 4-3** and **4-4c**). **Figure 4-4c** below illustrates the dry watercourse in relation to proposed BESS Alternative 2 and the associated infrastructure (powerline and access road).

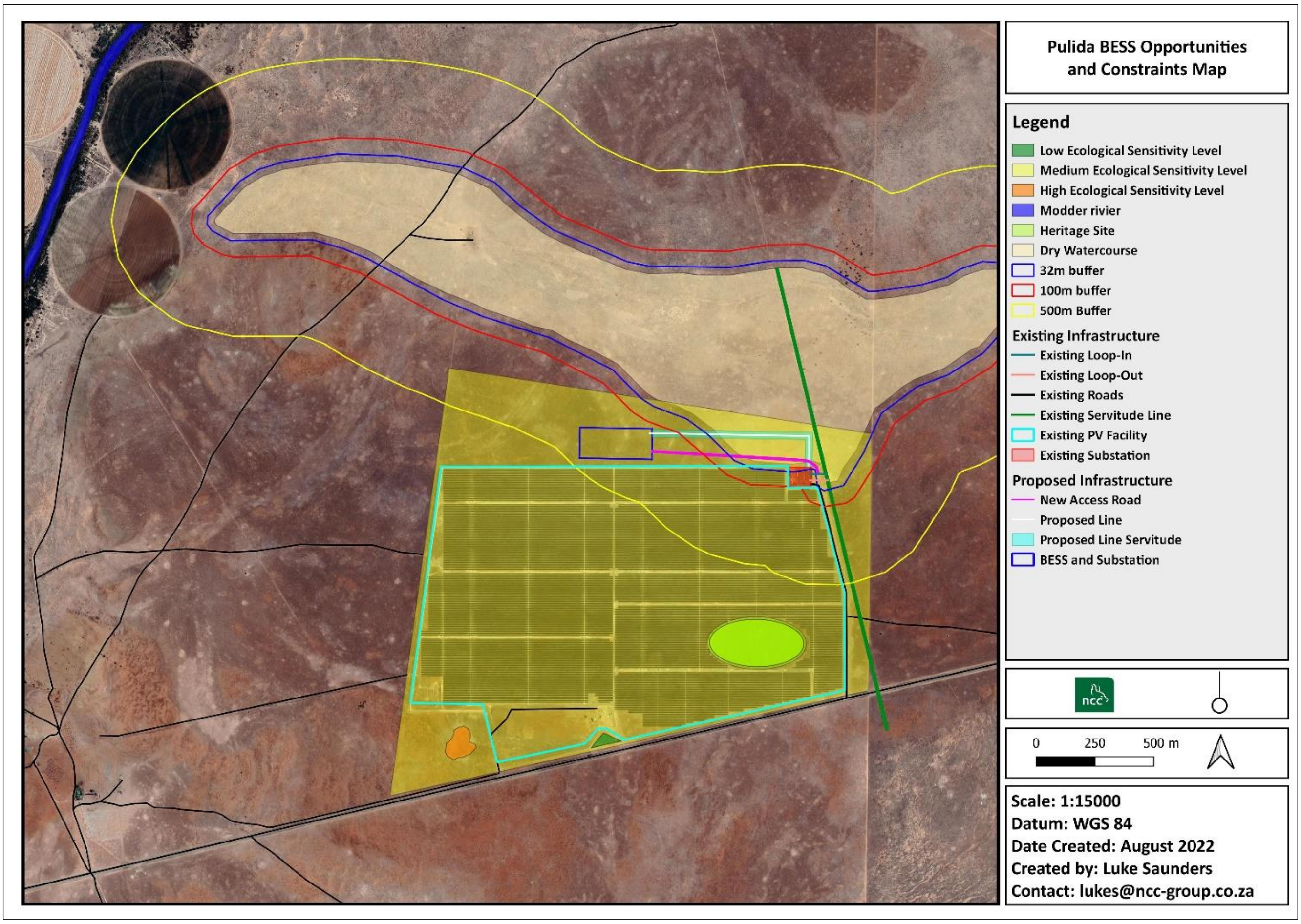


Figure 4-4c: Opportunities and Constraints map showing the dry watercourse in relation to BESS Alternative 2 and associated infrastructure.

8.5 Freshwater resource classification

The classification system for inland wetland systems (Ollis *et al*. 2013) and the formal geomorphological zonation classification for streams followed as described in Rowntree and Wadeson (1999) provided the overarching guideline approach for classification of freshwater resources in the area regulated by the National Water Act, as summarised in **Table 3-1**. For ease of reference the wetland has been named HGM 1.

Table 3-1: Classification of HGM 1 situated within 500m (NWA regulated area) of the proposed BESS sites.

Freshwater resource	Level 1	Level 2		Level 3	Level 4: HGM unit			Level 5	Level 6
	System	DWS Ecoregion	NFEPA WetVeg Group/s	Landscape Unit	4A	4B	4C	Hydrological regime	Descriptor
HGM1	Inland	Southern Kalahari (29)	Upper Nama Karoo	Plain	Depression	Exorheic	without channelled outflow	Intermittently / rarely inundated	Natural and vegetated (grasses and sedges)

8.6 Wetland PESEIS Assessment

8.6.1 Present Ecological State

The results of the Wet-Health PES assessment are summarised below in **Table 3-2**.

8.6.2 Ecosystem Services

The results of the Wet-Ecoservices assessment are summarised below in **Table 3-3** including the integrated wetland importance score with **Figure 5** displaying the supply and demand scores in the form of a radar diagram.

8.6.3 Ecological Importance and Sensitivity

The EIS assessment was applied to the delineated HGM unit to estimate the levels of sensitivity and ecological importance of HGM 1. The criteria utilised for the EIS assessment is shown in **Table 1-6**. EIS scores (**Tables 3-4** and **3-5**) reflect the observations during the field visit coupled with the desktop literature review and assessment of historical maps and imagery. Based on the assessment criteria in **Table 1-6** and the site observations, HGM1 was assessed to have a moderate (C) EIS.

Table 3-2: PES and associated scores for HGM 1 assessed using Wet-Health.

HGM wetland type	Study unit size (ha)	Individual scores & PES category				Assessment date: Jan 2022	
		Hydr	Geo	WQ	Veg	Overall PES	Combined Score
Depression	160	2.4	1.2	2.5	2.1	C	2.1
		C	B	B	B		

Comments

Historical aerial imagery/maps dating back to 1944 shows the depression (HGM1) as lighter shading in the image. A 2015 image shows the same feature with few noticeable changes over the 70-year period apart from the construction of the Pulida Solar Plant to the south of the feature from ~2015. Topographical maps dated 1967, 1990, 2005 and 2015 were examined which showed that no active crop cultivation (an agricultural activity) has taken place in the immediate study area including in HGM1. Only a few pivot lands closer to the banks of the Modderrivier are evident where water is obtained from the river for irrigation purposes. Animal husbandry such as livestock grazing is the likely agricultural activity that may have impacted on HGM1.

Any modifications to the original vegetation (Sub-Escarpment Grassland) to some extent may be attributable to impacts caused by livestock grazing as well as climate change. Where some transformation of the original vegetation species is likely to have taken place, alien invasive vegetation (and more specifically category 1 species) was not observed to be a major impact on the wetland with no such species being encountered during the field visit.

Apart from the existing solar plant constructed from between 7-8 years ago, there has not been any significant increase in human settlement and hardening of the upstream catchment.

Relatively minor modifications/alterations of the surface-soil hydrology and surface run-off dynamics into and through HGM 1 may have resulted due to stormwater run-off from the existing district road and the solar plant surface area, however these would be relatively short-lived only during heavy rainfall events which occur relatively infrequently. A 132kV powerline servitude also traverses in a general north-south direction the eastern section of the wetland.

Erosion and sedimentation within the wetland does not appear to be a major impact as observed during the site visit. The wetland still has the functional ability to filter and purify water and trap sediments as well as provide an important habitat for wetland dependant flora and fauna such as birds and frogs.

Table 3-3: Present and future state wetland ecosystem services and integrated 'Importance' scores calculated using Wet-EcoServices.

ECOSYSTEM SERVICE		HGM1	
		Supply	Demand
REGULATING AND SUPPORTING SERVICES	Flood attenuation	2.0	2.1
	Stream flow regulation	1.0	1.0
	Sediment trapping	1.0	1.2
	Erosion control	1.0	1.2
	Phosphate assimilation	1.0	1.0
	Nitrate assimilation	1,5	1,5
	Toxicant assimilation	1,5	1,5
	Carbon storage	1.5	1.5
	Biodiversity maintenance	1.0	1.0
PROVISIONING SERVICES	Water for human use	1.0	1.0
	Harvestable resources	1.0	1.0
	Food for livestock	2.0	2.0
	Cultivated foods	1.0	1.5
CULTURAL SERVICES	Tourism and Recreation	0.5	0.0
	Education and Research	0.5	0.5
	Cultural and Spiritual	0.0	0.0
OVERALL IMPORTANCE		1.16	

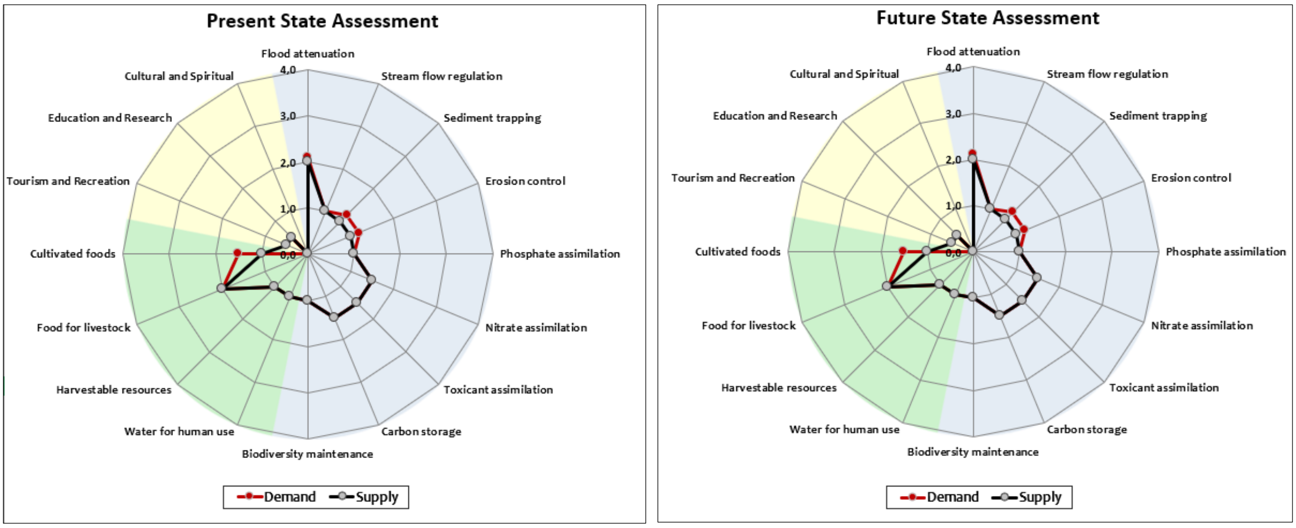


Figure 5: Radar diagrams displaying the Present and Future State supply and demand scores.

Table 3-4: Summary EIS.

Wetland unit	EIS Score (combined)	EIS Category	Biodiversity support / maintenance	Landscape scale	Wetland sensitivity
HGM1	0.78	**Low / D**	0.33	1	1

Table 3-5: EIS rationale / motivational explanations.

ECOLOGICAL IMPORTANCE & SENSITIVITY (EIS)	Score (0-4)	Confidence (1-5)	Rationale/explanation
Biodiversity Support	**0.33**	**3**	
Presence of red data species	0	3	No *EN* or *CR* red data species observed during field visit or found to occur in the wetlands based on existing literature. Although adult frogs are classified as terrestrial, they do in reality rely on water (semi-aquatic) with eggs and tadpoles fully aquatic. No fish species of conservation concern (in terms of the IUCN red list) in the Modderrivier were identified on the FBIS website. No wetland birds such as waders were observed and none of conservation concern occur in the quarter degree grid square pentad, apart from the white backed vulture which has occurrence in this area (not a wetland dependant bird).
Populations of unique species	0	3	No endemic or unique aquatic/wetland biota observed in the field or from existing literature sources such as FBIS, https://amphibiaweb.org, SANBI, SAIAB, and EWT databases.
Migration/ breeding / feeding sites	1	3	The wetland does not occur within or intersect with any nature reserves or IBAs. It is situated within an ESA meaning it still has importance to biodiversity in terms of providing breeding, foraging and nesting sites (habitats) for various birds as well as amphibians such as frogs and other terrestrial species which nonetheless are likely present within and rely on the mosaic of habitats in the wetland and the adjacent Modderrivier.
Landscape scale	**1**	3.4	
Protection status of the wetland	1	4	All wetlands are provided with legal protection in terms of the NWA. HGM 1 is not classified as a Ramsar site in terms of the Ramsar Convention and does not have any official protection status provincially or nationally. It was delineated as part of the 2018 NBA as a depression wetland and added to the NWM5 database.

Protection status of the vegetation type	1	4	HGM 1 is situated within the Northern Upper Karroo which has a conservation status of least threatened. The NFEPA WetVeg Group is Sub-Escarpment Grassland Group 5 which is not protected. No species of conservation concern (SCC) in this grassland type were identified on the BESS Alternative sites, one which is situated within the wetland and the other outside the wetland boundary.
Regional context of the ecological integrity (EI)	1	3	A **D** median wetland PES category and a *High* EI and ES in catchment C52K in SQ reach C52K-03183 was assigned by experts during a desktop reserve study which included reaches of the Modderrivier (DWS, 2017). Some transformations have taken place in the surrounding catchment but not extensively within the wetland. The EI and ES for HGM 1 can be considered *moderate* based on the site visit and local impacts / level of human disturbances observed.
Size and rarity of the wetland type/s present	1	3	HGM 1 is depression wetland type which is not a typically rare wetland type however wetlands in drylands such as in the geographical area are less abundant and common compared to other wetland types found in more tropical and sub-tropical climates. Human activity in the surrounding catchment area has not largely modified the catchment and has not yet reduced the original wetland extent over the last ~70-80 years.
Diversity of habitat types	1	3	A predominantly grassland-type habitat exists in the wetland feature with some sedge species observed to a lesser density and abundance. Any seasonal surface inundation provides temporary aquatic habitats for aquatic invertebrates (e.g. Odonates) as well as semi-aquatic vertebrates (e.g. frogs) & habitats for both birds with a preference for wetland habitat or migratory birds, both which are able to nest and feed within this ecosystem.
Wetland sensitivity	**1**	3	
Sensitivity to changes in floods	1	3	The wetland is well vegetated with primarily indigenous grassland vegetation. The majority of the sub-catchment is not urbanised with vast open spaces where commercial agriculture (mainly grazing pastures for livestock) and some crop irrigation still occurs. It is anticipated that the BESS Alternative 2 poses the lowest risk to the wetland and would not significantly increase volumes of stormwater runoff causing erosion or sedimentation of the wetland. The wetland has an inherent, natural capacity to buffer and retain stormwater and this function should be maintained by the implementation of suitable mitigation measures (sediment and erosion control around the BESS infrastructure) and adequate stormwater drainage. The inherent capacity of HGM1 to attenuate floods in all seasons is not likely to be significantly altered for BESS Alternative 2.
Sensitivity to changes in low flows/dry season	1	3	Depression wetlands such as HGM1 have very limited functionality/capacity to attenuate floods in both the dry and wet seasons and are unlikely to significantly augment higher stream flows in the early and late wet season.
Sensitivity to changes in water quality	1	3	Depression wetlands have an inherent functional ability to enhance / improve/ maintain water quality by removing toxicants and nitrates to a similar degree to other HGM types such as floodplains and valley bottoms. Sensitivity to WQ changes are considered moderately high based on the nature of the BESS development where any leaks of electrolyte from the battery could affect groundwater and sub-surface water. Any decline in water quality (nutrients, turbidity, sediments, toxicants, pathogens) is considered a low risk if effective mitigation measures are implemented.

* Various literature sources were utilised to inform the assessment and scoring however extensive species-specific data was not gathered during the study in terms of populations of unique or potentially obligate animal species (such as invertebrates, amphibians, birds or mammals) which may rely on wetlands for habitats, migration, breeding, or feeding sites within wetlands. No nocturnal surveys were conducted.

8.6.4 Wetland REC

At a desktop level, SQ reach C52K-03183 which is a reach of the Modderrivier in adjacent catchment C52K, has been assessed to have a **High** mean Ecological Importance (EI), a **High** mean Ecological Sensitivity (ES) and a **B** default EC (DWS, 2012). A **D** PES category has been assigned based on metrics assessed by experts. However no information was found on recommended ecological categories for wetlands in the same quaternary catchment (C52L). Although desktop DWS PESEIS assessments of rivers are available for catchment C52L, they were not used proxies to compare with HGM 1 as the methods for assessing PES and EIS of wetlands and rivers have different approaches. Therefore no other wetlands in the same catchment (C52L) were assessed in this study as a proxy to HGM 1 as reserve determination studies for the Upper Orange are not available on the DWS RDM website.

Based on the existing land-use impacts in the immediate study area (historical and existing), the REC for HGM 1 is a C with no further decline in the January 2022 PES and EIS scores. Meeting and attaining this REC will be contingent on rehabilitation being carried out effectively after construction to protect wetland functioning and integrity during the future operational lifespan of the BESS infrastructure.

8.7 Freshwater biodiversity

Figure 6-1 represents an overview of aquatic biodiversity of the sub-quaternary catchment in Upper Orange WMA in the context of the NFEPA Map (CSIR, 2011). No notable biodiversity features occur in the study area and the wetland clusters (WetCluster FEPAs) which do occur are several kilometres from the site to the north of the Modderrivier where the proposed development will not have any significant impact on them. Furthermore, there are no fish support areas, fish sanctuaries (for critically endangered or threatened fish species), fish translocation areas, fish migration corridors, fish rehabilitation areas or NFEPA wetlands (**Figure 6-1**).

Examination of the Freshwater Biodiversity Information System (FBIS) revealed records for fish and invertebrates existed at the two closest sites, C5MODD-PERD2 (upstream) and C5MODD-00016 (downstream) on the Modderrivier (**Figure 6-2** and **6-3**) with the taxon/species lists included in tables beneath the figures. The conservation status of both fish species is 'Least Concern' and is 'Not Evaluated' for the invertebrate taxa.

In terms of wetland species on the site, the NFEPA Wet-Veg type is the Upper Nama Karoo. *Cyperus* (sedge) *and Polypogon* (grass) species were observed at the time of the field visit as well as *Panicum* spp. No red-list plant species were identified on the BESS alternative 1 (the footprint within the extent of the watercourse feature). In term of BESS alternative 2, this footprint falls outside the edge of the wetland boundary which is less sensitive (low sensitivity) from a freshwater perspective.

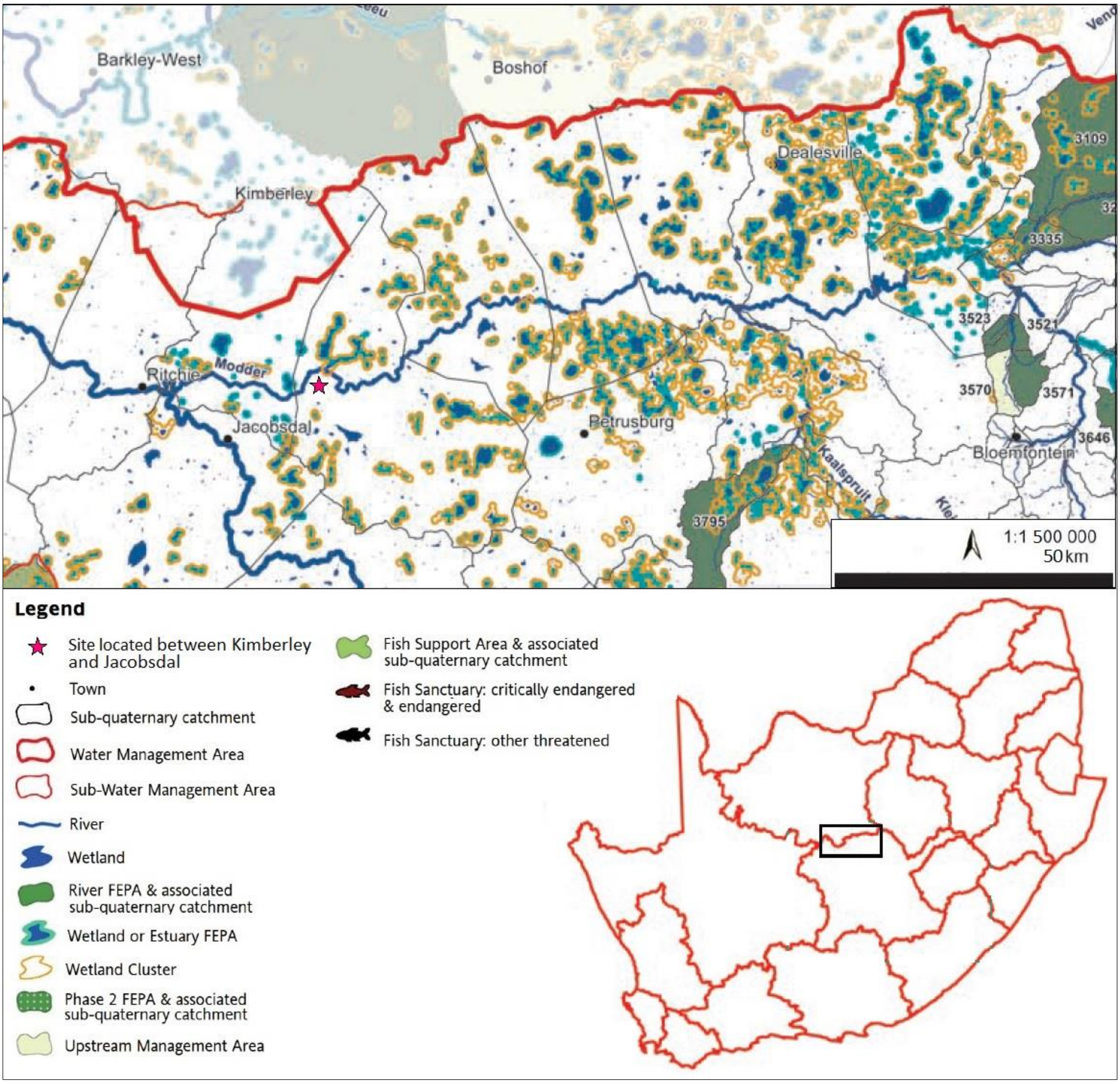


Figure 6-1: Overview of aquatic biodiversity in the study area within the Upper Orange WMA (13) in the context of the NFEPA Map (Source: CSIR, 2011). The site (denoted by the pink star) is situated +/-2.5km from the Modderrivier between Jacobsdal and Kimberley.

Taxon	Occurrence	Origin	Conservation status
Atyidae	3	Unknown	Not evaluated
Baetidae	2	Native	Not evaluated
Ceratopogonidae	1	Unknown	Not evaluated
Chironomidae	2	Unknown	Not evaluated
Clitellata	3	Unknown	Not evaluated
Corixidae	4	Native	Not evaluated
Culicidae	1	Unknown	Not evaluated
Dytiscidae	1	Native	Not evaluated
Gomphidae	2	Native	Not evaluated
Hydrophilidae	1	Native	Not evaluated
Lymnaeidae	2	Native	Not evaluated
Naucoridae	2	Native	Not evaluated
Nepidae	1	Unknown	Not evaluated
Notonectidae	4	Unknown	Not evaluated
Pleidae	2	Native	Not evaluated
Simuliidae	1	Unknown	Not evaluated

Figure 6-2: FBIS site C5MODD-PERD2 situated under the N8 between Kimberley and Petrusburg at in the Nama Karoo ecoregion on Modderrivier (coordinates -25.081, -28.993). Only invertebrate records for this site exist on the database. No algae (aquatic vegetation), fish or dragonfly data are available.

Scientific name	Common name	Origin	Conservation status
Pseudocrenilabrus philander	Southern mouthbrooder	Native	Least concern
Tilapia sparrmanii	Banded tilapia	Native	Least concern

Figure 6-3: FBIS site C5MODD-00016 situated at coordinates 24.862, -29.057 in the Southern Kalahari ecoregion on the Modderrivier. Only two fish records for this site exist on the database. No algae (aquatic vegetation), invertebrate or adult dragonfly data are available on the database.

9 FRESHWATER BIODIVERSITY COMPLIANCE STATEMENT

Based on the results of the combined desktop review and site sensitivity verification in the field, it is concluded with a relatively high degree of confidence that the sensitivity of aquatic and wetland biodiversity at the proposed Pulida BESS sites is regarded to be **Low** at both sites. The development will not significantly impact on any freshwater biodiversity features and no specific impact management interventions or monitoring requirements for freshwater biodiversity is considered necessary or provided in this respect.

However there are higher impacts (risks) to the depression wetland which will result in the event that BESS Alternative 1 is constructed directly within the depression i.e. watercourse. Wetlands are still ecologically sensitive ecosystems which provide important ecosystem services. The assessment and mitigation of impacts and risks to the wetland based on the two alternatives are covered under the next section of this report.

10 IMPACT AND RISK ASSESSMENT

10.1 NEMA Impact Assessment

10.1.1 Existing impacts

Agricultural activity (livestock grazing) in and around the study area has not likely had a major impact on the wetland feature (historically or currently). The following existing (historical) impacts, observed in or directly adjacent to the wetland, extend into the broader study area:

- Anthropogenic impacts and accessory human infrastructure *i.e.* a large solar plant, roads, a powerline servitude and pivot agricultural fields exist in the broader study area;
- Impacts as a result of vegetation modifications leading to alteration of the original ecosystem extent.

10.1.2 Additional impacts based on the proposed development activities

Table 4 provides a list of the anticipated (potential) freshwater impacts associated with the proposed BESS development based on the aspect and activities.

Table 4: Potential aquatic impacts which may occur as result of the proposed development.

Impact	Aspects and activities	
1. Loss of wetland area	a. Aspects that can cause loss of wetland areas	i. Soil/trench/foundation excavations and stockpiles ii. Creation of additional access routes to site areas iii. Temporary construction camps & laydown areas iv. Vegetation clearance
	b. Secondary impacts associated with direct loss of wetlands	i. Loss of ecosystem services
2. Altered hydrological regime	a. Aspects that can causes changes to surface hydrology	i. Vegetation removal ii. Soil excavations iii. An increase in extent of hardened, impermeable surfaces iv. Infrastructure (buildings, roads, trenches, etc) v. On-site stormwater management
	b. Secondary impacts associated with an altered regime	i. Loss of ecosystem services ii. Deterioration in the ecological status of the wetland ecosystem iii. Increased or reduced runoff dependent on system manipulation iv. Loss of wetland ecosystem services through interruption of seasonal recharge and natural flow v. Loss of soil fertility and topsoil recharge through interruption of seasonal recharge and natural flow, including natural sedimentation vi. Scouring and erosion of wetland
3. Impaired water quality	Aspects/activities that can impact on local water quality	i. Clearing of vegetation ii. Earth moving (removal and/or stockpiling of soil) iii. Pollution of water courses due to dust fallout, chemical (organic / inorganic / hydrocarbon) spills and contaminated stormwater and/or construction material runoff iv. Erosion/sedimentation
4. Erosion and sedimentation of wetland	a. Aspects that can cause increased erosion and sedimentation	i. Vegetation removal ii. Soil excavations and stockpiles iii. An increase in extent of hardened, impermeable surfaces iv. Erosion v. On-site stormwater management
	b. Secondary impacts associated with sedimentation	i. Loss of ecosystem services
5. Spread and/or	a. Primary aspects that can cause	i. Vegetation removal

establishment of alien and/or invasive species	the spread and/or establishment of alien and/or invasive species	ii. Soil excavations, transportation and stockpiling of building materials iii. Transportation vehicles spreading exotic seed while moving on, to and from working areas iv. Disturbed conditions surrounding infrastructure promoting the establishment of alien and/or invasive flora and fauna species *incl.* pests
	b. Secondary impacts	i. Deterioration in the ecological status of wetland

10.1.3 Cumulative impacts

Addressing cumulative impacts on freshwater ecosystem functioning is a challenging and often subjective process notwithstanding the guidelines and terms of reference published both nationally and within the province. An argument can be presented that the long terms cumulative impact of any human development which leads to the permanent loss of natural infrastructure/capital can be considered cumulatively destructive to natural habitats i.e. 'nibbling loss' concept (See Hegmann et al, 1999); more so on terrestrial biodiversity but likewise on aquatic biodiversity. Residual flora and fauna i.e. biodiversity that does persist is often artificially maintained and may generally be modified into assemblages of more resilient (hardy) plant and animal species with evolved biological traits/mechanisms and inherent and/or learnt strategies to tolerating cumulative anthropogenic disturbances and loss of natural habitat.

Some of the fundamental ecosystem processes that can potentially be altered through changes in biodiversity include community respiration, decomposition, nutrient retention, plant productivity and water retention (Diaz and Tilman, 2004). The site's freshwater resource i.e. the wetland performs intrinsic (underlying) ecological processes and hydrological functions, provides ecosystem goods and services and needs to be maintained in a state of good ecological health owing to its connectivity to downstream habitats and biodiversity.

Considering the state of the landscape, the sensitivity of the area, the nature and extent of the proposed development, the potential for cumulative impacts are expected to be low to moderate. Freshwater resources within the general study area catchment (C52K) have historically been modified as a result of surrounding agricultural land use activities. It can be argued that given the current existence of a 209ha solar plant, any potential cumulative effects of a 4ha BESS will be of relatively low significance (if BESS Alternative 2 is authorised) on the adjacent freshwater ecosystem including the downstream ecological reserve. The cumulative impact of BESS Alternative 2 would be greater and can be quantified as 4ha of the original depression wetland (160ha) being modified and lost. It is possible to minimise cumulative impacts to a level of ecosystem disturbance that currently exists if BESS Alternative 2 is authorised.

10.1.4 BESS Alternative 1

The various impacts if the BESS is constructed directly within the watercourse or within 32m from the edge of the watercourse boundary, i.e. within the NEMA "regulated area", are summarised in **Tables 5-1** and **5-2**.

10.1.5 BESS Alternative 2

The various impacts if the BESS is constructed outside the watercourse where only an access road and cable trenches are constructed within the watercourse are summarised in **Tables 6-1** and **6-2**.

10.2 NWA Risk Assessment

A summary of aquatic impacts on freshwater resources within the NWA "regulated area" *i.e.* wetlands within 500m from a water use activity in terms of section 21 (c) and (i) of the Act, is included in the risk assessment matrix (**Annexure B**).

Table 5-1: Assessment of significant potential impacts associated with BESS Alternative 1 - Construction Phase.

Phase	Impact	Pre-mitigation					Post-mitigation				
		Duration	Spatial Scale / Extent	Severity	Likelihood	Significance	Duration	Spatial Scale / Extent	Severity	Likelihood	Significance
CONSTRUCTION	Loss of wetland	4	2	8	5	**70**	4	1	8	5	**65**
		long term	local	high	definite	high	long term	on-site	high	definite	high
	Impaired water quality	2	2	6	4	**40**	2	2	6	3	**30**
		short-term	local	moderate	highly likely	moderate	short-term	local	moderate	likely	moderate
	Altered hydrological regime	2	2	6	4	**40**	2	1	6	4	**36**
		short-term	local	moderate	highly likely	moderate	short-term	on-site	moderate	highly likely	moderate
	Erosion and sedimentation of wetland	2	2	6	4	**40**	2	1	6	3	**27**
		short-term	local	moderate	highly likely	moderate	short-term	on-site	moderate	likely	low
	Spread and/or establishment of alien and/or invasive species	2	2	6	3	**30**	2	2	6	2	**20**
		short-term	local	moderate	likely	moderate	short-term	local	moderate	unlikely	low
	Loss of freshwater biodiversity	2	2	4	2	**16**	2	1	4	1	**7**
		short-term	local	low	unlikely	low	short-term	on-site	low	highly unlikely	low

Table 5-2: Assessment of significant potential impacts associated with BESS Alternative 1 - Operational Phase.

Phase	Impact	Pre-mitigation					Post-mitigation				
		Duration	Spatial Scale / Extent	Severity	Likelihood	Significance	Duration	Spatial Scale / Extent	Severity	Likelihood	Significance
OPERATIONS	(Further) loss of wetland	4	2	6	3	**36**	4	2	4	2	**20**
		long term	local	moderate	likely	moderate	long term	local	low	unlikely	low
	Impaired water quality	5	2	8	4	**60**	4	2	8	2	**28**
		permanent	local	high	highly likely	high	long-term	local	high	unlikely	low
	Altered hydrological regime	4	2	6	3	**36**	4	2	6	2	**24**
		long-term	local	moderate	likely	moderate	long-term	local	moderate	unlikely	low
	Erosion and sedimentation of wetland	4	2	6	4	**40**	2	1	6	3	**27**
		long-term	local	moderate	highly likely	moderate	short-term	on-site	moderate	likely	low
	Spread and/or establishment of alien and/or invasive species	4	2	6	3	**36**	3	2	4	2	**18**
		long-term	local	moderate	likely	moderate	medium-term	local	moderate	unlikely	low
	Loss of freshwater biodiversity	4	1	4	2	**18**	2	1	4	1	**7**
		long-term	on-site	low	unlikely	low	short-term	on-site	low	highly unlikely	low

Table 6-1: Assessment of significant potential impacts associated with BESS Alternative 2- Construction Phase.

Phase	Impact	Pre-mitigation					Post-mitigation				
		Duration	Spatial Scale / Extent	Severity	Likelihood	Significance	Duration	Spatial Scale / Extent	Severity	Likelihood	Significance
CONSTRUCTION	Loss of wetland	4	2	6	3	**36**	4	1	6	2	**22**
		long term	local	moderate	likely	moderate	long term	on-site	moderate	unlikely	low
	Impaired water quality	2	2	6	3	**30**	2	2	6	2	**20**
		short-term	local	moderate	likely	moderate	short-term	local	moderate	unlikely	low
	Altered hydrological regime	2	2	6	3	**30**	2	2	4	3	**24**
		short-term	local	moderate	likely	moderate	short-term	local	low	likely	low
	Erosion and sedimentation of wetlands	2	2	6	3	**30**	2	1	4	2	**14**
		short-term	local	moderate	likely	moderate	short-term	on-site	low	unlikely	low
	Spread and/or establishment of alien and/or invasive species	2	2	6	3	**30**	2	2	4	2	**16**
		short-term	local	moderate	likely	moderate	short-term	local	low	unlikely	low
	Loss of freshwater biodiversity	2	2	4	2	**16**	2	2	4	1	**8**
		short-term	local	low	unlikely	low	short-term	local	low	highly unlikely	low

Table 6-2: Assessment of significant potential impacts associated with BESS Alternative 2- Operational Phase.

Phase	Impact	Pre-mitigation					Post-mitigation				
		Duration	Spatial Scale / Extent	Severity	Likelihood	Significance	Duration	Spatial Scale / Extent	Severity	Likelihood	Significance
OPERATIONS	(Further) loss of wetland	4	2	4	2	**20**	4	1	4	2	**18**
		long term	local	low	unlikely	low	long term	on-site	low	unlikely	low
	Impaired water quality	2	3	6	3	**33**	2	3	4	2	**18**
		short-term	regional	moderate	likely	moderate	short-term	regional	low	unlikely	low
	Altered hydrological regime	2	2	6	2	**20**	2	2	4	2	**16**
		short-term	local	moderate	unlikely	low	short-term	local	low	unlikely	low
	Erosion and sedimentation of wetlands	4	2	4	2	**20**	2	2	4	2	**16**
		long term	local	low	unlikely	low	short-term	on-site	low	unlikely	low
	Spread and/or establishment of alien and/or invasive species	2	2	6	3	**30**	2	2	4	2	**16**
		short-term	local	moderate	likely	moderate	short-term	on-site	low	unlikely	low
	Loss of freshwater biodiversity	2	2	6	2	**20**	2	2	4	2	**16**
		short-term	local	moderate	unlikely	low	short-term	on-site	low	unlikely	low

11 IMPACT MITIGATION MEASURES

Recommended mitigation measures to reduce impacts/risks to the wetland during the construction and operational phases of the BESS (Alternative 1 or 2) are provided in the watercourse risk assessment matrix (**Annexure B**). The mitigation measures described in the RAM are recommended as standard best practice measures applicable to a development of this nature and should be implemented during both construction and where applicable, the operational phase. These are made in support of ensuring the protection of the wetland in the receiving environment i.e. adjacent to the proposed development.

11.1 Generic mitigation measures

A list of generic impact management outcomes and monitoring requirements for inclusion in the EMPr are provided (**Annexure D**) to manage alien invasive plants, stormwater around the BESS and to manage spills during construction and operations in order to reduce the risk of potential groundwater pollution.

11.2 Battery storage

It is understood that both Lithium-ion (Li-ion) and Vanadium Redox flow batteries are being considered as options however owing to the tender and procurement processes associated with the proposed BESS, final selection of the battery technology has not yet been confirmed at the time this report was compiled. For Li-ion batteries, prevailing site temperature instability can have an impact on these battery types which can include fire, or permanent structural damage to the batteries. The volatility of the battery system, prior to any mitigation, could result in significant fire risk. In addition to this there is a risk associated with the chemicals contained within the actual battery storage system itself leaking into the ground.

Vanadium Redox Flow batteries have a corrosive character as the electrolyte solution contains highly acidic (or alkaline) ion exchange materials which are classified as toxic and hazardous to groundwater and the relatively high toxicity of oxides of vanadium (USEPA, 2011). If selected, the electrolyte tanks and associated pipes, valves, etc need to be designed from materials that are resistant to corrosion in a very low pH environment and batteries stored in tanks within containers mounted onto plinths and secured within a secondary or tertiary bunded platform, **Annexure E** provides the risks and mitigation battery technology options being considered. It is recommended that the environmental impact assessment process includes a comparative assessment of the preferred battery technologies being considered for the proposed Pulida BESS.

12 DISCUSSION

The findings of the study are a reflection of the results available at the time of field visit (mid-December 2021) and subsequent assessment prior to final report synthesis. In the South African context, specialist studies including those focussing on freshwater ecosystems (wetlands, rivers and riparian zones) should ideally be carried out in the rainfall season for a higher confidence and more accurate synopsis of both biotic and abiotic factors within both terrestrial and aquatic ecosystems. The field visit was carried out during the summer rainfall season in the Southern Temperate Highveld freshwater ecoregion of the Free State where diagnostic signs of surface inundation and vegetation observed in HGM 1 confirmed the presence of wetland features. Any results from a winter (dry season) assessment do not form part of the results for this study.

The study aimed to determine the proximity and current state of freshwater ecosystems and aquatic biodiversity within the study area and assess the risks and impacts of the proposed development on freshwater ecosystems/watercourses. The assessments carried out were done in accordance with the relevant legislation and standard practise guidelines with regards to managing the environment. A combined qualitative and quantitative assessment of potential and observed impacts resulting from the proposed development was undertaken and recommendations for mitigation measures and minimising negative impacts have been provided.

13 CONCLUDING COMMENTS

Based on the findings of the desktop literature and historical imagery survey and the in-field observations and results, the depression wetland was found to be in a moderately modified ecological condition. The specialist opinion in terms of this study is that BESS Alternative 2 is the preferred alternative from a freshwater perspective. BESS Alternative 1 will result in the loss of ~4ha of wetland (2.5% of total wetland area) with a higher risk to soil and water resources to the remaining ~156ha wetland area posed by any leaks or major incidents which may result in releases of electrolyte from the stored batteries into the environment. The need to explore and consider wetland offsets may be necessary if BESS Alternative 1 is authorised.

If all mitigation measures provided in this report are rigorously implemented as well as good environmental practice followed, the residual risks of the proposed development will pose low risks to freshwater biodiversity and water resource quality and will not compromise the requirements of the ecological reserve and other downstream water users. It is the opinion of the author that if BESS Alternative 2 is authorised, a water use authorisation (WUA) in terms of section 21 (c) and (i) of the National Water Act (Act 36 of 1998) will not be required based on the low residual risks after mitigation measures are implemented. There is no reason or fatal flaw from a freshwater biodiversity perspective that an environmental authorisation (EA) applied for under the framework of the National Environmental Management Act (Act 107 of 1998) and in terms of the 2014 EIA Regulations (as amended) should not be considered favourably by the competent authority. An EA being issued to the applicant is however contingent on the outcomes of the other specialist studies including input from other authorities, stakeholders and interested and affected parties.

14 REFERENCES

Bailey, A.K. and Pitman, W.V 2016. Water Resources of South Africa 2012 (WR2012). Book of Maps. WRC Report Number TT 382/08. Pretoria.

Chief Directorate National Geospatial Information (CDNGI). 2021. Department of Rural Development and Land Reform. Available online http://www.ngi.gov.za/index.php/resources.

Council for Geoscience. 2003. *Simplified Geology of South Africa, Lesotho and Swaziland*. Map compiled by CJ Vorster.

Council for Scientific and Industrial Research (CSIR). 2011. *National Freshwater Ecosystem Priority Areas (NFEPA).* Council for Scientific and Industrial Research, Pretoria, South Africa.

Diaz, S. and Tilman, D. 2004. Millennium Ecosystem Assessment Condition and Trends Assessment. Chapter 12: Biodiversity regulation of ecosystem services.

Driver, A., Nel, J.L., Snaddon, K., Murruy, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report No. 1801/1/11. Available online: http://bgis.sanbi.org/nfepa/project.asp.

DWAF (Department of Water Affairs and Forestry). 2005. *A practical field procedure for identification and delineation of wetlands and riparian areas*. Department of Water Affairs and Forestry, Pretoria, South Africa.

DWAF. 2008. *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. X. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

DWS (Department of Water and Sanitation). 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: C5. Compiled by RQIS-RDM: http://www.dwaf.gov.za/iwqs/rhp/eco/peseismodel.aspx accessed on 11 February 2022.

Hegmann, G, C Cocklin, R Creasey, S Dupuis, A Kennedy, L Kingsley, W Ross, H Spaling and D Stalker. 1999. Cumulative Effects Assessment Practitioner's Guide. Hull, Quebec: Canadian Environmental Assessment Agency.

Kleynhans, C.J., Thirion C. and Moolman J. 2005. A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/csir00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.

Nel, J.L., Driver, A., Strydom, W., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., Van Deventer, H., Swartz, E. and Smith-Adao, L.B. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources*. Water Research Commission (WRC) Report No TT 500/11. WRC, Pretoria, South Africa.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. 2013. *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems*. SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria.

USEPA (United States Environmental Protection Agency). 2011. Reportable quantities of hazardous substances designated pursuant to Section 311 of the Clean Water Act.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

ANNEXURE A: BASELINE PROFILE DESCRIPTION OF BIODIVERSITY AND ECOSYSTEMS

Province	Free State
District	Xhariep
Local municipality	Letsemeng
Ward	7
1: 50 000 grid reference	2924BB
1: 10 000 grid reference	2924BB _4
Area of proposed BESS site(s)	~ 4ha
WGS84 datum co-ordinates of BESS Alterative sites 1 & 2 – (corners)	Alternative 1: Top left: 29° 2'12.75"S 24°55'50.23"E Bottom left: 29° 2'17.01"S 24°55'50.71"E Top right: 29° 2'17.18"S 24°55'59.41"E Bottom right: 29° 2'12.86"S 24°55'59.52"E Alternative 2: Top left: 29° 2'13.16"S 24°55'27.08"E Bottom left: 29° 2'17.29"S 24°55'27.07"E Top right: 29° 2'13.11"S 24°55'36.20"E Bottom right: 29° 2'17.28"S 24°55'36.20"E
Water Management Area (WMA)	Upper Orange
Catchment Management Area (CMA)	Vaal River CMA
Quaternary catchment	C52L
Quinary catchment	C52L3
Main rivers / drainage (perennial)	Modderrivier (north) tributary of the Orange
Freshwater Ecoregion of the World (FEOW)	Southern Temperate Highveld
Ecoregion Level I - Kleynhans *et al*. (2005)	29 Southern Kalahari and 26 Nama Karoo
Ecoregion Level 2 - Kleynhans *et al*. (2005)	29.02 and 26.02
Biome	Savanna
Aquatic CBAs and/or ESAs	None on the alternative sites
Depth to groundwater	15.5 mbgl
SWSA surface water	No
SWSA groundwater	No
Aquifer Type and Yield Classification	Fractured 0.5 - 2.0 l/s
Aquifer Classification	Major
Aquifer Susceptibility	Medium
Aquifer Vulnerability	Moderate
Fish sanctuary	No
NFEPA River FEPA 2011	No
NFEPA Fish Support Area (FSA)	No
Freshwater conservation status	None
Desktop PESEIS (DWS, 2014)	SQ reach C52K-03183 = **High** Mean EI, **B** EC, **D** PES
Geology (Council for Geoscience, 2003)	Kalahari Group - Quaternary calcrete overlying Karoo shale of the Prins Albert Formation
Lithology	Calcrete, Surface Limestone, Hardpan

ANNEXURE B: RISK MATRIX

No	Phase	Activity	Aspect(s)	Impact(s)	Significance	Risk Rating (L=Low,M=Moderate,H=High)	Confidence Level (Low, Med or High)	Control / mitigation measures	Borderline LOW / MODERATE Rating Classes (Residual Risk Rating if controls & mitigation measures are followed)		PES of Watercourses	EIS of Watercourses
1	CONSTRUCTION	Site camp establishment (temporarily for construction phase)	Operation of vehicles, plant, equipment and machinery; Site clearing (vegetation stripping, soil excavation and stockpiling) Material delivery, laydown storage, installations.	Potential surface water pollution and associated biotic impacts from spills/leaks of hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds (VOCs).	60	**M**	Med	Adhere to conditions of EA, EMPr and WUA. An independent ECO appointed to conduct monthly site inspections and audits to monitor the implementation of the EMPr and the EA. Compile a site access and layout plan method statement for the site camp. Construction camp, stockpiles, and temporary storage areas must remain within the footprint. No vegetation in surrounding areas must be cleared. Fence of the site footprint before construction to prevent site creep into the wetland. All construction activities must remain within the construction footprint. Access site and deliver material using existing routes and farms tracks/roads. Temporary access roads, site camp laydown areas and storage areas for plant and vehicles should not encroach into the wetland with the only exception of the footprint for the access road and cable trench. Wherever possible, traffic should be directed over areas that must be disturbed for other construction activities (i.e. footprint). This practice reduces the net total area that is cleared and susceptible to erosion. It also may help to decrease the area of compacted soils. Stockpile and conserve topsoil and re-use where necessary. Small stockpiles can be covered with a tarpaulin to prevent erosion.	35	**L**	C	Low/D
				Disturbance of wetland vegetation and soils.	60	**M**	Med		35	**L**		
				Stripping of vegetation, alteration of soil profiles and exposure of bare soils to wind and rain effects will increase/accelerate the rate and risk of erosion.	60	**M**	Med		35	**L**		
				Increased turbidity, suspended solids and sedimentation of nearby and downstream water	60	**M**	Med		35	**L**		

				resources due to increased volume of surface water (stormwater) run-off of hardened surfaces.				Large stockpiles can be stabilised by anti-erosion measures such as stakes in the ground with hessian blankets, seeding, and/or mulching. Every effort should be made to avoid potential impacts from the outset of the project e.g. through careful spatial or temporal placement of infrastructure to prevent or limit impacts to the wetland. No clearing of any vegetation within the wetland with the exception of the footprint for the access road and cable trench. Drip trays and spill clean-up kits should be made available and used for stationary plant / machinery, re-fuelling bowsers and any emergency maintenance / repair works on site.				
				Potential risk of alien plant invasion into watercourses due to ground surface disturbance.	60	**M**	Med		35	**L**		
2		Construction of permanent internal access road and cable trench within/across wetland	Vegetation clearing and temporarily impede / divert the natural flow of sub-surface and surface water	Potential alteration of natural flow patterns (preferential flow paths) and soil saturation rates, scouring and erosion due to redirection of flows.	63	**M**	Med	• Clearly demarcate the construction footprint and restrict all activities to within this corridor. • Demarcate the road and trench construction corridor with high visibility (colour coded) durable barricading materials e.g. steel crowd barriers/fencing, barrier safety netting or roadside plastic barriers. • Minimise the disturbance footprint and the unnecessary clearing of vegetation outside of this area. • Only primary activities such as trench excavations, cable installations and road construction should be allowed within this corridor. All secondary activities and storages areas should be restricted to outside of the wetland boundary. • Appropriately contain any generators, fuel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) or construction materials on site (e.g. cement) in such a way as to prevent them leaking and entering the wetland. • Mixing of cement to produce concrete must under no circumstances take place within the wetland. Areas where storage and mixing of sand and cement does take place should be scraped and clean once finished. • Every attempt should be made to construct the road and cable trench during no or low rainfall periods /	38	**L**	C	Low/D
				Disturbance of wetland habitat and soils.	63	**M**	Med		38	**L**		
				Modification of ecological / habitat integrity.	60	**M**	Med		35	**L**		
				Increased risk of erosion.	63	**M**	Med		38	**L**		
				Increased turbidity, suspended solids, sedimentation and potential pollution (via hydrocarbon spills) of soil and groundwater.	63	**M**	Med		38	**L**		
				Potential risk of alien plant invasion into wetland due to ground	60	**M**	Med		35	**L**		

				surface disturbance.				seasons i.e. winter. • Where necessary, install sandbags around soil stockpiles and silt curtains along the corridor to prevent soil being washed away (erosion) causing sedimentation of the wetland. • Appropriate stormwater measures such as culverts with stone-pitched surfaces should be placed at regular intervals along the road to prevent wetland scouring. A combination of 'hard' and 'soft' methods can be utilised e.g. bioswales, hay or hessian geotextile fabrics such as geo-jutte, culverts with stone pitching or vegetation at outlets into wetland and re-vegetation. • Ensure that soil is backfilled and compacted to appropriate geotechnical specifications. Document the soil profile on removal and ensure the soil is backfilled into the trench in the same horizon order in which it was removed. Topsoil should be separated from sub-soil, stored separately and backfilled last into the trench.				
3	CONSTRUCTION	Construction of BESS Alternative 2 (outside wetland extent)	Operation of vehicles, plant, equipment and machinery; Vegetation clearing and impeding / diverting the natural flow of sub-surface and surface water; Excavations / removal of	Impaired water quality (potential soil and sub-surface water pollution/contamination from spills or leaks of battery electrolyte and other hazardous substances such as oils, grease and hydrocarbons).	70	**M**	Med	Apply for an Environmental Authorisation (EA). Develop a routine monitoring programme in terms of an EMPr for monitoring construction activities in or within close proximity to the wetland. Adhere to conditions of EA and EMPr. Consider wetland offsets if Alternative 1 is authorised. Compile a stormwater management plan/ method statement. Compilation of and implementation of an alien vegetation management method statement / plan. Develop and implement an method statement for integrated management of waste. An independent ECO appointed to conduct monthly site inspections and audits to monitor the implementation of the EMPr and the EA. Design of infrastructure by a competent engineer. If applicable, compile a method statement for any	45	**L**	C	Low/D
				Altered hydrological regime.	70	**M**	Med		45	**L**		
				Increased risk of erosion from cleared / exposed (un-vegetated) areas.	55	**M**	Med		30	**L**		

			topsoil; material laydown, storage, stormwater management	Greater risk of increased turbidity, suspended solids and sedimentation of wetland.	55	M	Med	construction activities in or within 32m from the wetland. Fence of the site before construction to prevent site creep into the wetland. All construction activities must remain within the construction footprint. Suitable signage must be established at the site before commencement of any land clearing or construction activities, to highlight the need to protect sensitive biophysical features on the site and prevent site creep. All workers to attend an environmental induction prior to the commencement of construction activities. Cease construction activity during rainfall and wet/ waterlogged soil conditions. Monitor the establishment of alien invasive vegetation and take corrective action where invasive species are observed to establish. Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction earthworks in that area and returning it where possible afterwards. Develop a method statement for the handling and transportation of the battery components and electrolytes. All cargo must be checked and transported to the site (by an authorised, licensed, transportation company). If flow batteries are used for the BESS, a primary and secondary containment system should be placed around the BESS. This should include a bunded platform which can contain up to 110% of the liquid contents. Training and suitably equipping of staff to deal with emergencies (fires, floods, explosions, etc) Stockpile and conserve topsoil and re-use where necessary. Small stockpiles can be covered with a tarpaulin to prevent erosion. Larger stockpiles can be stabilised by anti-erosion blankets and or silt curtains to reduce losses through erosion. Excavations must be limited to the construction footprint only. Clearing and grading should occur only	30	L		
				Potential risk of alien plant invasion into wetland due to ground surface disturbance.	50	L	Med		25	L		

								where absolutely necessary to build and provide access to structures and infrastructure. Clearing should be done immediately before construction, rather than leaving soils exposed for months or years. Design of an adequate stormwater drainage system and energy dissipation structures (e.g. stone-pitching, grassed earth berms) to re-direct and allow natural rainfall to percolate into surrounding vegetated surfaces and enter the sub-surface soil layer. Runoff from disturbed/exposed areas must be directed to silt traps (e.g. silt fences, sandbags) to remove sediment and reduce the sedimentation of the wetland.				
4		Solid (general) waste management	Incorrect and/or poor waste management practises and littering	Littering and solid waste accumulation in wetland.	55	**M**	Med	**Compile an integrated waste management plan/method statement.** All general waste bins should be covered with lids, secured and located as far as practicably possible from watercourses and should be serviced on a regular basis to prevent overflow / littering.	30	**L**	C	Low/D
5		Wastewater management	Insufficient planning and design of a wastewater management system	Potential sewerage pollution (spills and leaks) and contamination of surface water and groundwater resources.	55	**M**	Med	Provide adequate ablution facilities at the site secured to the ground to prevent units from toppling, spilling and causing soil and water pollution. All temporary (portable) ablutions / chemical toilets should be located as far as practicably possible from watercourses (>100m). All portable chemical ablutions should be emptied on a regular basis to prevent overflow spillages.	30	**L**		
6		Management of hazardous substances/ chemicals	Management (re-fuelling, storage and use) of hazardous substances (fuels, oils, grease, pesticides, fertilisers, paints, volatile	Potential soil and surface water contamination / pollution and associated negative biotic impacts.	59	**M**	Med	**Compile a method statement for hazardous substances.** A dedicated, centralised storage area for all hazardous substances (whether short or long-term) should be located ideally >100m from the edge of the watercourse. Storage areas or receptacles for hazardous substances should be bunded on an impermeable surface to ensure that spills or leaks cause contamination of soil, groundwater or surface water resources. Spill kits should be available at the storage and re-fuelling areas in the event of any accidental spillages or	34	**L**	C	Low/D

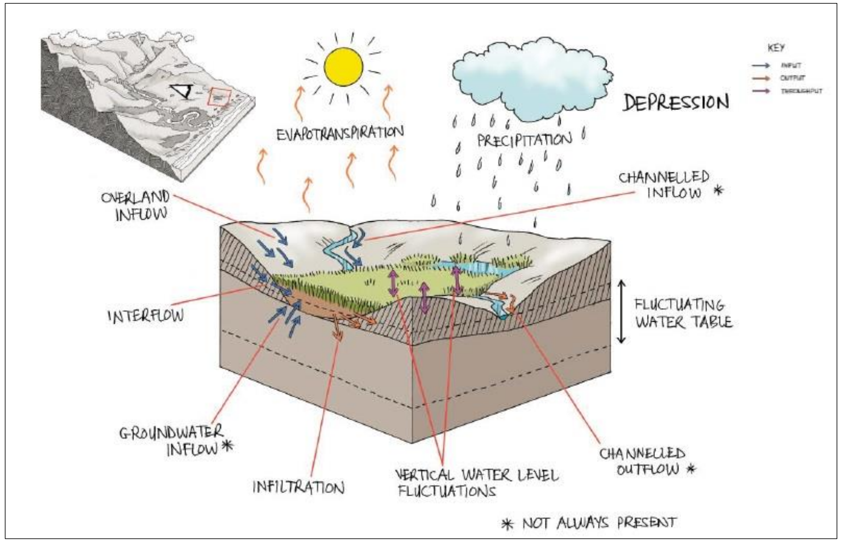
			organic compounds, etc).					leaks. All spills and contaminated soil/materials should be cleared up immediately and disposed of appropriately (i.e. as hazardous waste). Any servicing, repairs or re-fuelling of plant, vehicles and machinery should not take place within 32m from the watercourse. A dedicated re-fuelling area and workshop (if applicable) should be located > 100m from the watercourse.				
7		Hazardous waste management	Management (storage and disposal) of hazardous wastes.	Potential soil and surface water contamination / pollution and associated negative biotic impacts.	59	**M**	Med	All hazardous waste bins should be located as far as practicably possible (>100m) from watercourses and should be serviced on a regular basis to prevent overflow and spillages. Receptacles for hazardous waste should be clearly, labelled, impermeable, sealed and situated on bunded platforms with adequate cover from rainwater ingress.	34	**L**	C	Low/D
8		Rehabilitation	Lack of, poor or no rehabilitation carried out	Deterioration in wetland health (indicators being erosion, sedimentation / siltation, impaired water quality, alien vegetation proliferation)	72	**M**	Med	Rehabilitate or re-vegetate disturbed areas in accordance with the EMPr. Based on routine monitoring outcomes and if necessary, develop a Watercourse/Wetland Rehabilitation Plan or Maintenance Management Plan for the wetland. Rehabilitation should be implemented after construction phase, but as part of the construction phase. Soil roughening using construction equipment to track the surface reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares disturbed / compacted soil surfaces for seeding and planting by giving seed an opportunity to take hold and grow. Ruts and skid trails should be rehabilitated which can be done using vegetation slash and excess excavated soil to stabilise the soil and promote vegetation re-growth. If necessary, compile a Rehabilitation Plan (including for any damages / disturbances to the watercourse	47	**L**	C	Low/D

9	OPERATION & MAINTENANCE (O&M)	O&M of batteries	Battery overcharging or overheating, potential explosions or fire outbreaks resulting in electrolyte entering into wetland causing soil and water pollution; Incorrect handling and disposal of all waste types; Incorrect replacement, recycling or disposal of battery components and electrolyte; Negative environmental and health effects.	77	**M**	Med	Electrolyte and active materials are encapsulated by protective covering and on an sealed, impermeable platform, Battery Management Systems installed to ensure proper charging and effective cooling of batteries; Cell level temperature monitoring; Cell level protective devices which disconnect faulty cells / modules; Fire detection and suppression systems installed and maintained; Adhere to technical specifications and international best practices where test certificates/reports should be presented to show compliance; Training and suitably equipping of staff to deal with emergencies (fires, floods, explosions, etc); Where applicable, routinely test groundwater from boreholes around the facility to check resource quality over time; Proper recovery/recycling of batteries and components e.g. zinc when the units are decommissioned; Regular inspections should be undertaken by an experienced professional to determine the state of the battery and whether emergency replacement or maintenance is required.	52	**L**	C	Low/D
		O&M of underground cables and access road and the associated stormwater management system	Increased storm water run-off volumes and velocities on artificial, hardened surfaces during floods/high rainfall resulting in erosion and potential sedimentation of wetland.	72	**M**	Med	Develop and implement an OEMPr for monitoring the operation and maintenance of all new installed infrastructure which includes stormwater management. A maintenance schedule and checklists should be developed and implemented prior to operation. The access road should be maintained by removing any debris, unblocking drains and ensuring that stormwater releases into the wetland are controlled and dissipative so as to not result in scouring and erosion. Any cracks and / or damage should be repaired as regularly as required. Where identified and if applicable, wetland scouring can be prevented using a combination of 'hard' and 'soft' methods e.g. bioswales, hay or hessian geotextile fabrics such as geo-jutte, culverts with stone pitching or vegetation at outlets into wetland and re-vegetation.	47	**L**		
			Contaminated run-off containing pollutants entering wetland e.g. heavy metals, hydrocarbons and electrolyte (from BESS, internal access road and all hardened surfaces).	77	**M**	Med		52	**L**		

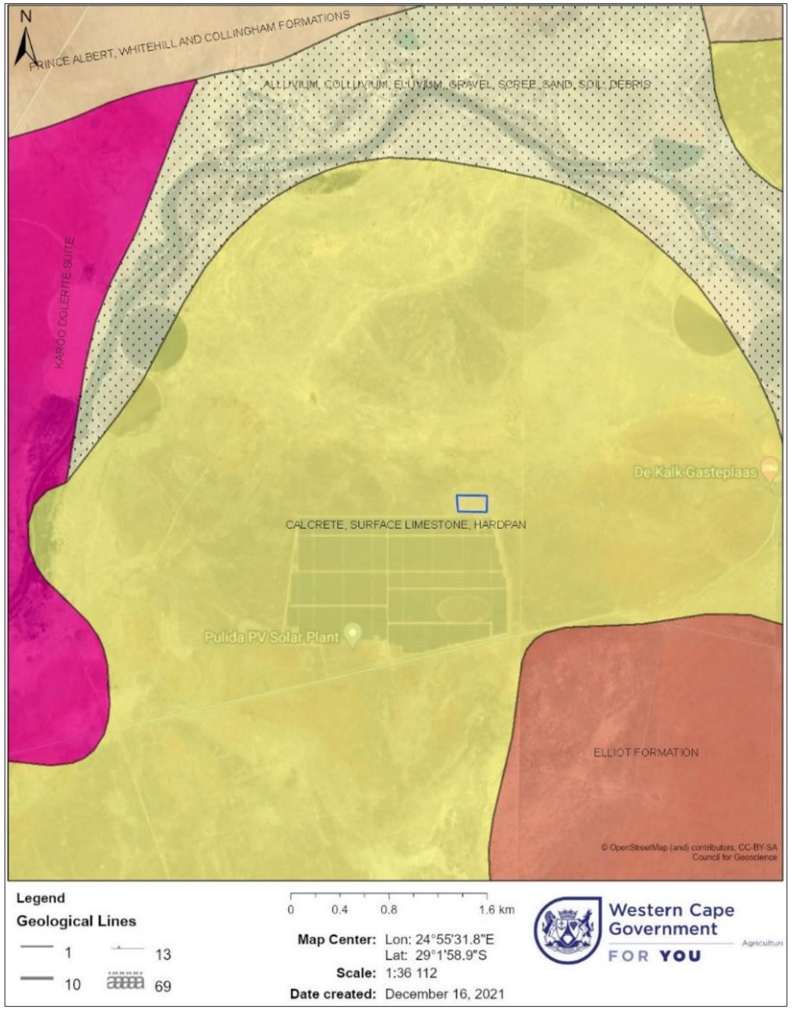
		Transport/Deliveries and Access (i.e. for routine maintenance works by contractors)	Potential surface water pollution (impaired water quality) and associated biotic impacts from spills/leaks of hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds (VOCs).	54	**L**	Med	Ensure transport companies/contractors are accredited to transport dangerous goods on public roads; Properly secure all cargo; Route planning and necessary approvals and permits; All vehicles (operational/delivery) restricted only to designated roads at the facility; Storage of materials according to OEM instructions and an EMPr; basic induction / awareness training provided to new personnel entering the site; Drip trays and spill clean-up kits to be made available and used for plant, machinery and vehicles visiting or permanently based at the facility.	29	**L**	C	Low/D
			Further disturbance of wetland vegetation and soils (increased turbidity, suspended solids and sedimentation)	54	**L**	Med		29	**L**		
		General environmental management aspects (i.e. waste, alien vegetation, weeds, erosion).	Potential for alien vegetation invasion, erosion and sedimentation, waste, decline in water quality and soil pollution collectively and negatively impacting on future wetland health.	52	**L**	Med	Implement a general **routine maintenance / environmental monitoring plan** which includes aspects of erosion control, weed control, general rehabilitation as and when required, repair/correction of structures if siltation becomes excessive, etc. The wetland should remain as a 'No-go' area during operations and routinely inspected (manually on foot) for any scour/erosion, litter, alien vegetation, siltation, etc. With proper construction methods followed, limited erosion should occur. Erosion should be monitored and corrective measures taken if observed. Any areas where active erosion is observed should be rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible. Further cutting/ clearing of vegetation or soil from within the wetland should be prohibited so as to retain soil stability provided by the grass-root structure.	27	**L**	C	Low/D

ANNEXURE C: ACCESSORY INFORMATION

C1: Google map showing depression wetland and the regulated area (32m, 100m and 500m buffer) in relation to BESS Alternatives 1 and 2.



C2: Schematic of a typical depression wetland.



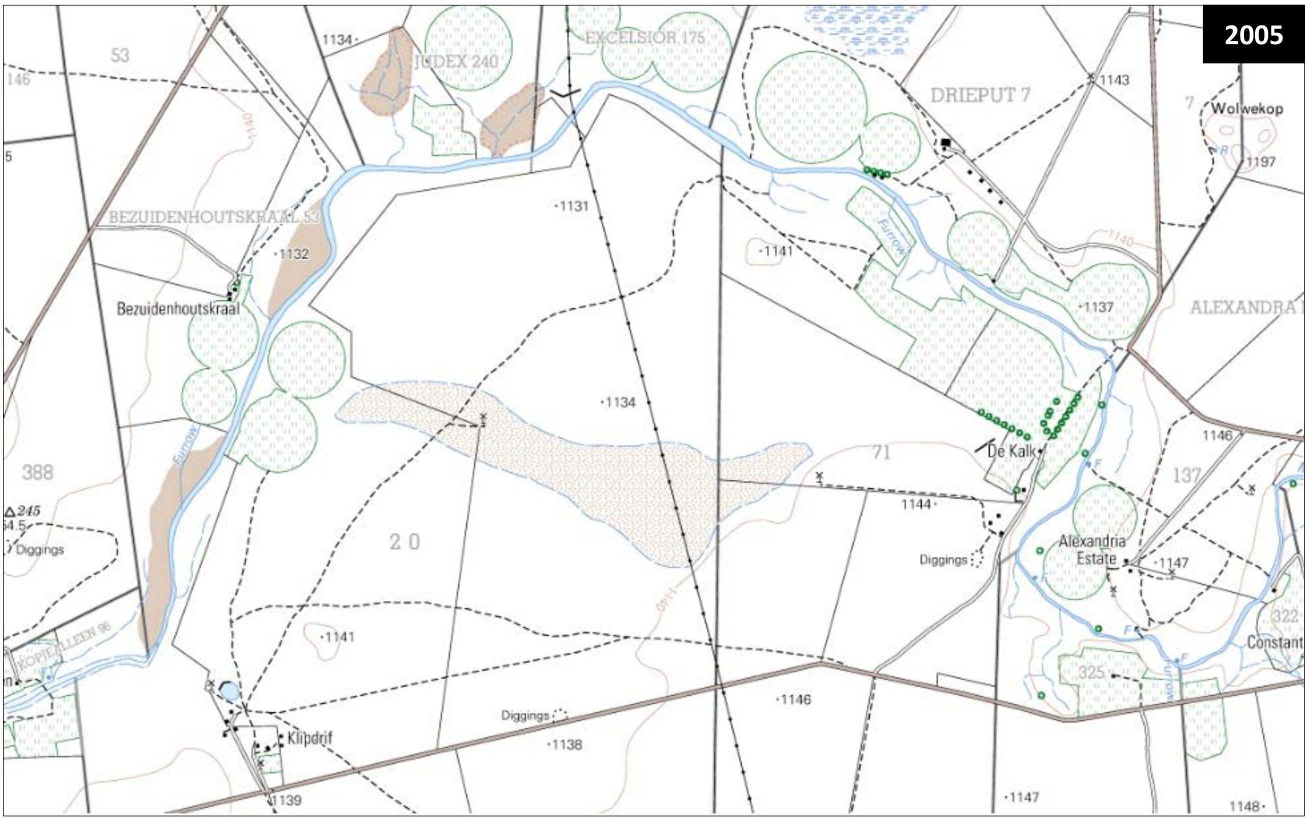
C3: Geological map of the study area showing BESS Alternative 1 as a blue polygon.

C4: 1944 aerial image of the study area where the extent of the depression (HGM 1) is represented as
The large lighter shaded area (Scale not indicated).

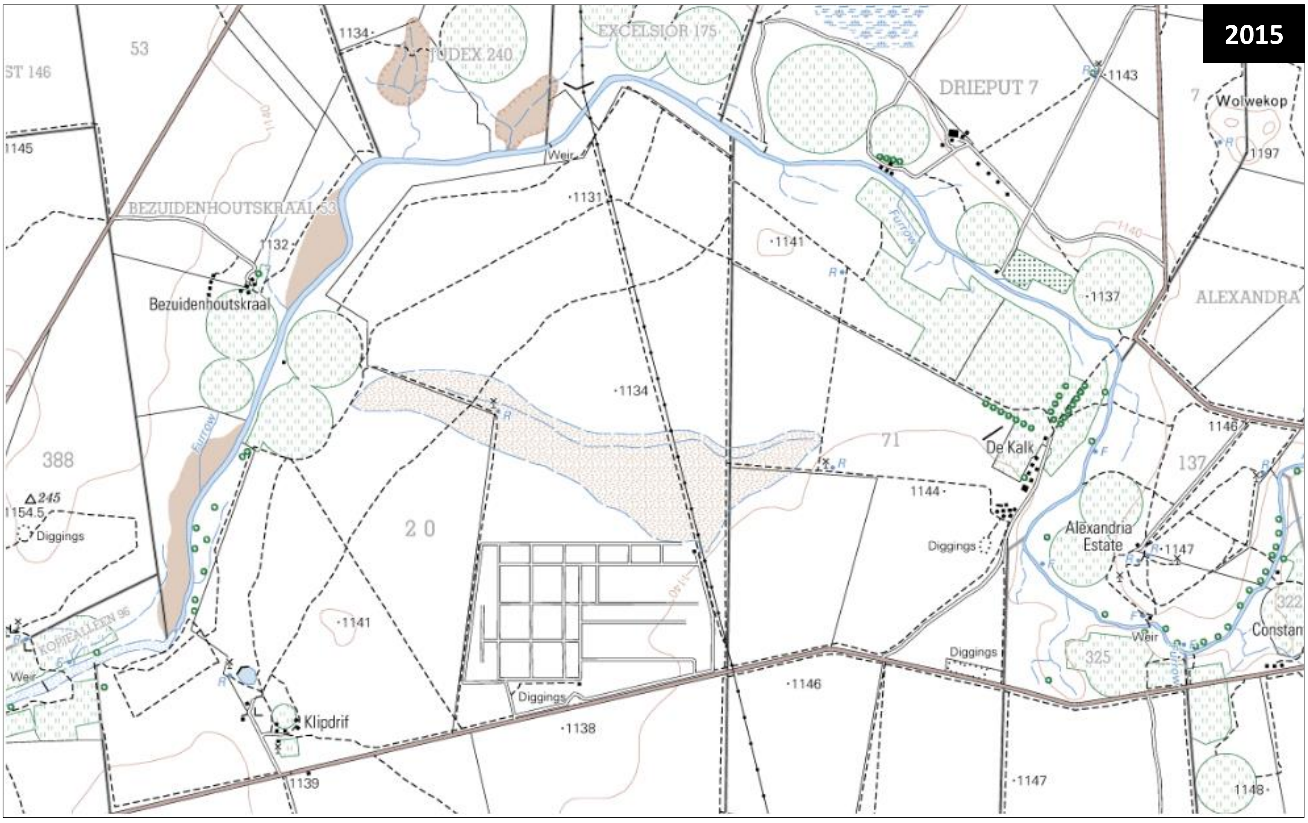
C5: 2015 aerial image of the study area where the extent of HGM 1 is represented as the lighter shading. Construction of the solar plant is visible at that time (Scale not indicated).

C6: Bing satellite image showing proposed BESS Alternative 1 footprint (blue polygon) within wetland depression.

C7: Bing satellite image of proposed BESS Alternative 1 (blue polygon) within southern extremity of the wetland depression.



C8: 2005 topographical map extract (2924BB Jacobsdal) showing the wetland depression denoted in the map legend as 'a dry watercourse' (Scale not indicated).



C9: 2015 topographical map extract (2924BB Jacobsdal) showing the wetland depression denoted in the map legend as a 'dry watercourse'. Construction of Pulida Solar Plant had recently commenced at that time as show in the map (Scale not indicated).

ANNEXURE D: IMPACT MANAGEMENT OBJECTIVES & MONITORING REQUIREMENTS

Objective	Action	Frequency
Manage alien invasive plants	i. Manage the invasive alien plants at any disturbed or spoil areas.	With immediate effect
	ii. Manage the invasive alien plants around the BESS during operation.	With immediate effect
Manage stormwater run-off from the BESS	iii. Ensure appropriate storm water infrastructure is installed to dissipate flow and direct away from concentrated paths.	During rainfall season
	iv. Ensure drip trays are used under vehicles/machinery and that impervious floor surfaces are constructed to ensure chemicals and waste do not enter the sub-surface.	With immediate effect throughout construction
	v. Where practical, plant appropriate grass species or install energy dissipation structures in stormwater drains around the BESS.	With immediate effect
Manage spills during construction	vi. Ensure drip trays are used under vehicles/machinery and erosion control measures are implemented. vii. Ensure a spill contingency plan is put into place.	With immediate effect ECO to check every 2 months
Manage spills during operation	viii. Record and report any fuel, oil, hydraulic fluid or electrolyte spills to the Site Manager/Engineer so that appropriate clean-up measures can be implemented. ix. Spills must be completely removed from the site. x. Appropriate fire extinguisher equipment installed within the BESS. xi. Temperature of battery systems monitored continually. xii. Ensure air circulation to prevent the buildup of chemicals. xiii. Implement the storm-water management plan and ensure appropriate water diversion systems are put in place. xiv. Compile (and adhere to) a procedure for the safe handling of battery cells. xv. Compile an emergency response plan and implement should an emergency occur. xvi. Ensure that spill kits (if appropriate) are available on site for clean-up of spills and leaks. xvii. Drip-trays or containment measures must be placed under equipment that poses a risk when not in use. xviii. Immediately clean up spills and dispose of contaminated soil at a licensed waste disposal facility. xix. Dispose of waste appropriately to prevent pollution of soil and groundwater. xx. Completely lined infrastructure (concrete bunded area), with the capacity to contain 120% of the total amount of chemicals stored within the BESS. xxi. Install monitoring systems to detect leaks or emissions.	With immediate effect/Ongoing

ANNEXURE E: BATTERY TECHNOLOGY RISKS AND MITIGATION

<table>
<tr><th colspan="2">Option 1: Vanadium redox flow battery (VFRB) technology</th></tr>
<tr><th>Risk</th><th>Mitigation</th></tr>
<tr><td><u>Dangerous chemicals and gases</u>
The fire risk of VRFB systems is markedly lower compared with other battery technologies due to the use of aqueous electrolytes. Overcharging the battery does not lead to fire but to a reduction in battery performance and aging of the stacks. Thermal runaway as with lithium-ion batteries is excluded.
In addition to its corrosive character, the vanadium electrolyte solution is toxic and hazardous to groundwater where although the electrolyte is used in a closed system, vanadium can escape solely through electrolyte leaks.
A small amount of hydrogen is always produced during charging at high states of charge which is a safety risk due to the possible explosive reaction with atmospheric oxygen. Although the amount is extremely small reducing this risk must be taken into account when installing the battery.</td><td>The design of the VRFBs should include:
• Battery condition monitoring;
• Fire detection and suppressant systems;
• Leak detection and monitoring system;
• A secondary containment to prevent the escape of vanadium solution into the environment during operation (storage and refilling when required). The VRFBs will be placed within a 2.5 m high berm wall.
• Hydrogen gas is discharged from the negative tank into the environment through a simple pipe and the battery room or container is well ventilated and flushed with fresh air to prevent any build-up of hydrogen gas.
• Should VRFBs be selected a Major Hazards Risk Assessment should be considered to be undertaken prior to construction and the recommendations of the assessment implemented.</td></tr>
<tr><th colspan="2">Option 2: Li-ion battery technology</th></tr>
<tr><th>Risk</th><th>Mitigation</th></tr>
<tr><td><u>Fire and dangerous/toxic chemicals</u>
The volatility of the battery system prior to any mitigation, could result in significant fire danger. Additionally there is a risk associated with the chemicals contained within the actual battery storage unit itself.</td><td>The design of the Li-ion system should include:
• Fire detection and suppressant systems;
• Gas level monitoring for several different gases (related to degradation of the batteries that increases risk of fire);
• Dousing mechanism for emergency cooling and fire suppression;
• Heat sensors;
• Battery condition monitoring;
• Density limits in the containers;
• Spacing limits between the containers.</td></tr>
<tr><td><u>Temperature fluctuations</u>
As temperature fluctuations in the Kimberley area and the Free State in general are wide ranging with the minimum temps falling below 0°C and maximum temps exceeding 25°C, Li-ion batteries may be at risk of being damaged due this temperature instability/fluctuation. Resultant impacts could include fire, or permanent structural damage to the batteries.</td><td>The design of the Li-ion system should include:
• Insulated containers;
• High powered HVAC (Heating, Ventilation and Air-Conditioning) System, monitored centrally;
• Multiple temperature sensors for both the cells and air temperature;
• Automated shut down mechanism if temperatures get too high;
• Containers sealed and douse in case of fire to prevent the spread;
• Battery management system to prevent overuse and maintain good battery condition.</td></tr>
</table>

ANNEXURE F: WATERCOURSE RISK ASSESSMENT METHODOLOGY

Impact rating tables and calculation of significance

TABLE 1 - SEVERITY

How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat) ?

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5

Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.

TABLE 2 - SPATIAL SCALE

How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighboring areas (downstream within quaternary catchment)	3
National (impacting beyond seconday catchment or provinces)	4
Global (impacting beyond SA boundary)	5

TABLE 3 - DURATION

How long does the aspect impact on the resource quality?

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

PES and EIS (sensitivity) must be considered.

TABLE 4 - FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

TABLE 5 - FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the resource quality?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

TABLE 6 - LEGAL ISSUES

How is the activity governed by legislation?

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5

Located within the regulated areas

TABLE 7 - DETECTION

How quickly/easily can the impacts/risks of the activity be observed on the resource quality, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

TABLE 8: RATING CLASSES		
RATING	**CLASS**	**MANAGEMENT DESCRIPTION**
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence

A low risk class must be obtained for all activities to be considered for a GA

TABLE 9: CALCULATIONS
Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

Significance Rating Matrix

	CONSEQUENCE (Severity + Spatial Scale + Duration)														
LIKELIHOOD (Frequency of Activity + Frequency of Incident + Legal Issues + Detection)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165
	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180
	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195
	14	28	42	56	70	84	98	112	126	140	154	168	182	196	210
	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225
	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255
	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270
	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285
	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300

Level of confidence

Level of confidence	Contributing factors affecting confidence
Low	A low confidence level is attributed to a low-moderate level of available project information and somewhat limited data and/or understanding of the receiving environment.
Medium	The confidence level is medium, being based on specialist understanding and previous experience of the likelihood of impacts in the context of the development project with a relatively large amount of available project information and data related to the receiving environment.
High	The confidence level is high, being based on a sound understanding of the state, functioning and sensitivity of the receiving environment, high availability of project-related data and good understanding of similar impact scenarios.

ANNEXURE F: CURRICULUM VITAE

Craig Burne

Profession

Environmental Consultant

Qualifications

MSc (Dissertation): Freshwater Ecology

- *University of the Witwatersrand*
  2013-2015

BSc (Hons): Environmental Science

- *University of KwaZulu-Natal*
  2007

BSc: Zoology & Environmental Science

- *Rhodes University*
  2003-2005

Accredited SASS5 Practitioner

- *Departments of Water & Sanitation and Environmental Affairs*
  2019

Professional certification

Professional Natural Scientist (*Pr. Sci. Nat.*)

- *South African Council for Natural Scientific Professions (SACNASP)*
- *Membership no: 115213*

Short courses

Environmental Law

- *Centre for Environmental Management; 2010*

Lead Auditing Course: ISO 14001

- *DQS; 2010*

Years of experience

- 14 years

Key skills/knowledge areas

- Freshwater (aquatic and wetland) ecology
- Water quality assessment/reporting
- Freshwater macroinvertebrate assessment
- Aquatic assessment & biomonitoring
- Wetland assessment & monitoring
- Alien vegetation assessment & monitoring
- Environmental management (ISO14001)
- Environmental compliance monitoring
- Environmental risk assessment
- Environmental permitting/licensing
- Auditing & EMS implementation
- Scientific report writing
- Technical proposal writing
- Basic statistical techniques
- Basic mapping
- Applied and basic research

Personal Details

Gender: Male
Date of Birth: 26.10.1982
Nationality: South African
Drivers License: Code EB
Languages: English (native) Afrikaans (basic)

NCC Environmental Services (Pty) Ltd

Feb 2008 – present

Previous and current roles and responsibilities

Aquatic & water quality assessments, aquatic biomonitoring, delineation and assessment of freshwater resources, compilation of river rehabilitation & alien vegetation management plans, river rehabilitation monitoring, alien vegetation monitoring & environmental/risk assessment. Participation in the coordination of environmental assessments, EMPRs & environmental license/permit applications. Undertaking environmental legal compliance monitoring & implementation functions on various projects across South Africa. Compilation & implementation of environmental method statements, site-specific rehabilitation plans, environmental risk assessments (ERAs) & construction work procedures. Preparing, undertaking & reviewing customised environmental audits for various projects/clients, stakeholder & authority engagement, public participation facilitation, management; mentoring & advice to internal staff on multiple projects, conducting rehabilitation assessments & cost estimates post-construction, closure reporting, coordination of waste management & recycling programmes on civil & building construction sites, management & resourcing of sub-contractors.

Consulting Projects

- Thembalethu School Basic Assessment, KZN – 2021-current
- Freshwater & Risk Assessment for Thembalethu & Amaoti Schools, KZN – 2021-2022
- Kwamancinza township sensitivity and verification screening, KZN - 2021
- Freshwater Assessment (wetland and aquatic) and risk assessment for the upgrade of provincial road D4407 between Hluvukani and Timbavati, Mpumalanga - 2020
- Freshwater Assessment (wetland and aquatic) and risk assessment for the proposed Modelkloof X18 Township Development, KZN - 2020
- Freshwater assessment and risk assessment for proposed hydroponic facility on farm Klein Dassenberg 39/20, Western Cape - 2019-2020
- Seasonal Aquatic Biomonitoring Mhlathuze River, KZN - 2019-2020
- EMPr for hydroponic facility on farm Klein Dassenberg 39/20, Western Cape - 2019-2020
- Wetland rehabilitation monitoring, aquatic habitat assessment, wetland assessment, aquatic biomonitoring (fish and macroinvertebrates) and water quality monitoring for N2 Road Upgrade, KZN - 2017-2020
- Sabi Game Reserve Watercourse Risk Assessment, Mpumalanga - 2019
- Surface water verification assessment for erf 803 and 804 in the Newcastle Local Municipality, KZN - 2019
- Thembinkosi Primary School Basic Assessment, KZN - 2019-2020
- SANS 241-1:2015 drinking water quality assessment, monitoring & reporting in the Port of Durban - 2019-2021
- Water resource use licensing & SANS water interpretation for 'Rocking the Daisies 2018', W. Cape - 2018
- Environmental screening/feasibility assessment Kalahari Films, N. Cape - 2017
- Participation in basic assessment for D281 road upgrade, Mpumalanga - 2015-2016

Compliance Monitoring Projects

- Melkhout-Dieprivier 132kV distribution line water use license audit, Eastern Cape - 2022
- Taweni-Mfinizo 132kV distribution line, Eastern Cape - 2021-current
- Haga Haga Wind Energy Facility - 2021
- Makaula 132kV substation, Eastern Cape, 2020-2021
- Dube Tradeport Corporation (DTPC) Agrizone, KZN - 2018-2020
- DTPC Hlawe/Tongaat Trunk Sewer Line, KZN - 2018-2019
- Daggakraal D281 Road Upgrade, Mpumalanga -2018-2019
- Cornubia Sigma and Cornubia II, Durban, KZN - 2018-2019
- Crown Cornubia Cold Storage Facility, Durban, KZN - 2017
- Ingula Pumped Storage Scheme, KZN - 2016
- Everest-Merapi 400kV transmission line construction, Free State - 2016
- Lower Thukela Bulk Water Supply Scheme, KZN - 2016
- SANBI Botanical Garden Upgrade, Durban & Pietermaritzburg, KZN - 2015-2017
- Cornubia BFS Cold Storage Facility, Durban, KZN - 2015
- NCC Team Manager for Eskom and Transnet Infrastructure Projects - 2012-2017
- Medupi 400kV Transmission Integration: Phase Alpha, Limpopo & NW - 2010-2012
- Majuba-Mfolozi 765kV transmission line construction, KZN - 2009
- Mercury 765kV Substation, Free State - 2008
- VRESAP Bulk Water Pipeline, Gauteng and Mpumalanga - 2008
- VRESAP Bulk Water Pump Station, Vaal Dam, Gauteng - 2008