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FRESHWATER ECOSYSTEM ASSESSMENT AS PART OF THE ENVIRONMENTAL AUTHORISATION PROCESS FOR FOUR PROPOSED SOLAR PHOTOVOLTAIC FACILITIES (SCAFFEL CLUSTER) NEAR SASOLBURG, FREE STATE PROVINCE

Prepared for

SLR Consulting

June 2021

PART C: DAMLAAGTE SOLAR PV FACILITY

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Report reference: SAS 220184
Date: 17th June 2021

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem assessment as part of the environmental impact assessment (EIA) and water use authorisation (WUA) processes for the proposed four solar photovoltaic (PV) facilities, which include the Damlaagte, Scaffel, Vlakfontein and Ilikwa solar PV facilities, collectively referred to the 'Scaffel Cluster development' throughout the report. The proposed Scaffel Cluster development also include infrastructure (substations and powerline corridors).

During the assessment, within the Damlaagte solar PV facility, no freshwater ecosystems were identified. Within the Scaffel solar PV facility, a single unchannelled valley bottom (UCVB 1) wetland was identified traversing the central portion of the area. At the Vlakfontein solar PV facility, a single depression wetland was identified along the south eastern boundary immediately adjacent to the N1 highway and within the Ilikwa solar PV facility, an unchannelled valley bottom (UCVB 2) was also identified and this forms part of a larger channelled valley bottom wetland system located within the investigation area. The UCVB 1 within the Scaffel area was defined as moderately modified and of moderate ecological importance. The UCVB 2 wetland within Ilikwa was defined as largely natural and of high ecological importance and sensitivity. The depression wetland within Vlakfontein was defined as largely modified and of low/marginal ecological importance and sensitivity.

The assessment of the risk posed by the proposed activities was not assessed as part of this report since the finalised layout for the PV solar facilities had not been received. In consideration of the assessment findings and the proposed activities, the following conclusions were made for each assessment area:

An impact assessment was applied to identify potential impacts that may affect any freshwater ecosystems in the vicinity of the proposed Scaffel Cluster development, specifically the proposed Damlaagte PV facility and the associated grid connection infrastructure. According to the findings, the proposed PV development within Damlaagte will have an impact (very low to low impact significance) on the delineated UCVB located downgradient the Damlaagte PV site if edge effects during the construction activities are not managed accordingly.

It is the opinion of the specialist that if mitigation measures to manage runoff to downgradient freshwater ecosystems are put in place and it is ensured that the footprint of the proposed activities remains within the boundaries of the Damlaagte site, the proposed PV facility and grid connection infrastructure within Damlaagte can be considered.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the environmental impact assessment (EIA) and authorisation process for the proposed four solar energy facilities, which include the Damlaagte, Scaffel, Vlakfontein and Ilikwa Solar PV facilities, collectively referred to the Scaffel Cluster throughout the report. The assessment also includes development of associated infrastructure (substations and powerline corridors). The Scafell Cluster and associated infrastructure is located approximately 19 km west of the town of Sasolburg, Free State Province on various farm portions hereafter referred to as the "study area".

To identify all freshwater ecosystems that may potentially be impacted by the proposed Scaffel Cluster development, a 500 m "zone of investigation" around the study area, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was used as a guide in which to assess possible sensitivities of the receiving environment. This 500 m "zone of investigation" will henceforth be referred to as the 'investigation area'.

During the assessment, within the Damlaagte solar PV facility, no freshwater ecosystems were identified. Within the Scaffel solar PV facility, a single unchannelled valley bottom (UCVB 1) wetland was identified traversing the central portion of the area. At the Vlakfontein solar PV facility, a single depression wetland was identified along the south eastern boundary immediately adjacent to the N1 highway and within the Ilikwa solar PV facility, an unchannelled valley bottom (UCVB 2) was also identified and this forms part of a larger channelled valley bottom wetland system located within the investigation area.

The Kromelmboogspruit is located south and the Vaal River was also identified north of the investigation area however they were not assessed in detail as part of the assessment due to of the extent of the system in relation to the extent of the catchment potentially affected by the proposed Scaffel Cluster development and the fact that sufficient databases exist from which the condition of the system could be defined. The UCVB 1 within the Scaffel area was defined as moderately modified and of moderate ecological importance. The UCVB 2 wetland within Ilikwa was defined as largely natural and of high ecological importance and sensitivity. The depression wetland within Vlakfontein was defined as largely modified and of low/marginal ecological importance and sensitivity.

The summary of the results are shown in the table below:

Table A: Summary of the results of the field assessment.

Wetland	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category (REC)/ Recommended Management Objective (RMO)/ Best Attainable State (BAS)
UCVB 1 Wetland	C (Moderately Modified)	Intermediate	Intermediate	C / Maintain / C
UCVB 2 Wetland	B (Largely Natural)	Moderately High	High	B / Improve / B
Depression Wetland	D (Largely Modified)	Intermediate	Low / Marginal	D / Maintain / D

In consideration of the ecological assessment findings, the potential impacts to the assessed freshwater ecosystems, the following statements were compiled to guide the proponent in terms of the development constraints and important ecological considerations from a freshwater ecosystem management and legislative point of view in light of the proposed Scaffel development. The statements were compiled to address these for each specific assessment PV facility:

Vlakfontein

During the site assessment, the Vlakfontein solar PV facility was assessed to be disturbed due to historical and current activities within the farm. The area was largely dominated by cultivated species for hale bales and as such considered of low sensitivity from a freshwater ecological perspective. Within south-eastern boundary of the site, a depression wetland was identified, although the wetland was considered of very high sensitivity according to the DEA screening tool, the wetland ecological importance and sensitivity was determined to be of low ecological importance and sensitivity based on the ground truthed results. Any proposed development within the Vlakfontein solar PV facility must avoid the encroaching within this wetland and its applicable 32m NEMA ZoR. In addition, edge effects must be avoided during all phases of the proposed Scaffel Cluster development.

Damlaagte

According to the DEA screening tool, the Damlaagte solar PV facility was considered of very low sensitivity, this was also confirmed during the field assessment. From a freshwater ecosystem management point of view, any proposed activities within the Damlaagte solar PV facility can be considered. An unchannelled valley bottom wetland was identified approximately 49 m from the western boundary of the Damlaagte solar PV facility, as such, edge effects from any proposed activities must be managed to maintain the ecological integrity and functionality of the wetland.

Scaffel

A large unchannelled valley bottom wetland delineated within the central portion of the Scaffel solar PV facility. This system bisects the Scaffel solar PV facility thus forming a significant development constraint. The wetland was considered important not only from a hydro-functional point of view (toxicant assimilation, erosion control and phosphate assimilation) but also an important movement corridor and habitat for the existing faunal assemblage and particularly avifaunal species considered to be of importance for species conservation (STS, 2021). Any proposed activities within the site are considered likely to impact on the ecological integrity of the UCVB 1 wetland, since the wetland would likely need to be crossed at various points during the construction activities and operational activities for maintenance of the solar PV facility purposes. This will likely result in the decreased ecological integrity of the wetland as a minimum the extent of the wetland and the associated 32 m NEMA ZoR should not be developed.

Ilikwa

Overall, the larger portion of the Ilikwa solar PV facility was considered modified as a result of current and historic cultivation and grazing by cattle. However, the UCVB 2 wetland located along the south west boundary of the Ilikwa solar PV facility was considered largely natural and is considered to be of high ecological importance and sensitivity. As such, any proposed activities within this study must avoid directly encroaching within this wetland or the 32 m NEMA ZoR associated with the wetland. In addition, edge effects must be avoided during all phases of the proposed activities associated with the Scaffel Cluster development. As such, planning of the layout for Ilikwa solar PV facility must consider this downgradient wetland and edge effect impact be avoided.

The SLR Impact Assessment Matrix was applied to identify potential impacts that may affect the any freshwater ecosystems in the vicinity of the proposed Scaffel Cluster development, **specifically the proposed PV facility and the associated grid connection within the Damlaagte development area.** The summary of the impact assessment is shown in Table B below:

Table B: Summary of impact significance on the UCVB wetland located downgradient of the Damlaagte development area.

PRE-CONSTRUCTION PHASE		
Impact	**Unmanaged Damlaagte**	**Managed Damlaagte**
1: Modification of wetland hydrological function		
PV Facility	L	VL
Grid Connection	VL	VL
2: Changes to wetland geomorphological processes		
PV Facility	L	VL
Grid Connection	VL	VL
3: Loss of wetland habitat and ecological integrity		
PV Facility	L	VL
Grid Connection	VL	VL
4: Impact on wetland biota		
PV Facility	L	VL
Grid Connection	VL	VL
CONSTRUCTION PHASE		
Impact	**Unmanaged Damlaagte**	**Managed Damlaagte**
1: Modification of wetland hydrological function		
PV Facility	L	VL
Grid Connection	VL	VL
2: Changes to wetland geomorphological processes		
PV Facility	L	VL
Grid Connection	VL	VL
3: Loss of wetland habitat and ecological integrity		
PV Facility	L	VL
Grid Connection	VL	VL
4: Impact on wetland biota		

PV Facility	L	VL
Grid Connection	VL	VL
OPERATIONAL AND MAINTENANCE PHASE		
Impact	**Unmanaged Damlaagte**	**Managed Damlaagte**
1: Modification of wetland hydrological function		
PV Facility	**VL**	**VL**
Grid Connection	**VL**	**VL**
2: Changes to wetland geomorphological processes		
PV Facility	**VL**	**VL**
Grid Connection	**L**	**VL**
3: Loss of wetland habitat and ecological integrity		
PV Facility	**VL**	**VL**
Grid Connection	**VL**	**VL**
4: Impact on wetland biota		
PV Facility	**VL**	**VL**
Grid Connection	**VL**	**VL**

Abbreviations: VL – Very Low; L – Low.

According to the findings, the proposed PV development within Damlaagte will have an impact (very low to low impact significance) on the delineated UCVB located downgradient the Damlaagte PV site if edge effects during the construction activities are not managed accordingly.

It is the opinion of the specialist that if mitigation measures to manage runoff to downgradient freshwater ecosystems are put in place and it is ensure that the footprint of the proposed activities remains within the boundaries of the Damlaagte site, the proposed PV facility and grid connection infrastructure within Damlaagte can be considered.

DOCUMENT GUIDE

The table below provides the specialist report requirements for the assessment and reporting of impacts on aquatic biodiversity in terms of Government Notice 320 as promulgated in Government Gazette 43110 of 20 March 2020 in line with the Department of Environmental Affairs screening tool requirements, as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998).

No.	Requirements	Section in report/Notes
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Cover Page and Annexure G.
2.2	Description of the preferred development site , including the following aspects-	
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns	Section 3 and 4
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified	Section 3: Table 1
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status	Section 3: Table 1
2.2.4	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.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater)	Section 3: Table 1
2.3	Identify any alternative development footprints within the preferred development site which would be of a “low” sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification	Entire study area considered low sensitivity.
2.4	Assessment of impacts – a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 5
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	No. Implementation of the proposed mitigation measures will minimise the impacts.
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regime (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. 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 d. Assessment of the risks associated with water use/s and related activities.	Section 5
2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system);	Section 5

	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); 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); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and f. 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).	
2.4.5	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 5
2.4.6	How will the 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?	Section 5
2.4.7	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: size of the estuary; availability of sediment; wave action in the mouth; protection of the mouth; beach slope; volume of mean annual runoff; and extent of saline intrusion (especially relevant to permanently open systems).	Section 5
3.	The report must contain as a minimum the following information:	
3.1	Contact detail of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae.	Annexure G
3.2	A signed statement of independence by the specialist.	Annexure G
3.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment.	Section 2
3.4	The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant.	Section 2, Annexure C and Annexure D
3.5	A description of the assumptions made any uncertainties or gaps in knowledge or data.	Section 1.3
3.6	The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant.	Section 4.5
3.7	Additional environmental impacts expected from the proposed development.	Section 5
3.8	Any direct, indirect and cumulative impacts of the proposed development on site.	Section 5
3.9	The degree to which impacts and risks can be mitigated.	Section 5
3.10	The degree to which impacts and risks can be reversed.	Section 5
3.11	The degree to which the impacts and risks can cause loss of irreplaceable resources.	Section 5
3.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 4.5
3.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 5
3.14	A motivation must be provided if there were development footprints identified as per paragraph 2.3 for reporting in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) that were identified as having a “low” aquatic biodiversity and sensitivity and that were not considered appropriate.	Ilikwa – Low Scaffel – Low Vlakfontein – Very High Damlaagte – Low
3.15	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.	Section 6
3.16	Any conditions to which this statement is subjected.	Section 6

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Endorheic	As it relates to a depression wetland: inward-draining with no transport of water into downstream systems via subsurface or surface flow. Water leaves via evapotranspiration and infiltration only.
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurrences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • 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
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
BAR	Basic Assessment Report
BESS	Battery Energy Storage Systems
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
m	Meter
MAP	Mean Annual Precipitation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NBA	National Biodiversity Assessment
NWA	National Water Act
PES	Present Ecological State
PV	Photovoltaic
REC	Recommended Ecological Category
RMO	Resource Management Objective
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SQR	Sub quaternary catchment reach
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WMS	Water Management System
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem assessment as part of the environmental impact assessment (EIA) and water use authorisation (WUA) processes for the proposed four solar photovoltaic (PV) facilities, which include the Damlaagte, Scaffel, Vlakfontein and Ilikwa solar PV facilities, collectively referred to the 'Scaffel Cluster development' throughout the report. The proposed Scaffel Cluster development also include infrastructure (substations and powerline corridors). The Scafell Cluster and associated infrastructure is located approximately 19 km west of the town of Sasolburg, Free State Province on various farm portions hereafter referred to as the "study area" (Figure 1). A detailed project description is provided in Section 1.1.1 below.

To identify all freshwater ecosystems that may potentially be impacted by the proposed Scaffel Cluster development, a 500 m "zone of investigation" around the study area, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was used as a guide in which to assess possible sensitivities of the receiving environment. This 500 m "zone of investigation" will henceforth be referred to as the 'investigation area'.

The purpose of this report is to define the ecology of the area in terms of freshwater ecosystems characteristics, including mapping of the freshwater ecosystems, discuss key ecological drivers and to define the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), as well as the socio-cultural and ecological service provision of the freshwater ecosystems utilising current industry "best practice" assessment methods in order to ascertain what, if any, impact the activities will have on the freshwater ecosystems associated with the study area. Additionally, this report aims to define the Recommended Management Objectives (RMO) and Recommended Ecological Category (REC) for the freshwater ecosystems.

The SLR Impact Assessment Matrix was applied to identify potential impacts that may affect the freshwater ecosystems in the vicinity of the proposed Scaffel Cluster development, specifically the proposed Damlaagte PV facility and the associated grid connection. The impact assessment also presents management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment.

The objective of the study is to provide detailed information when considering the existing activities in the vicinity of the freshwater ecosystems, to ensure the ongoing functioning of the ecosystem such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development.

This report, after consideration and a description of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), and the relevant specialist, by means of the presentation of results and recommendations, as to the final design of the layout for the proposed Scaffel Cluster development.

1.1.1 Project description

The study area is located in the Ngwathe Local Municipality which is an administrative area in the Fezile Dabi District Municipality of the Free State Province. The R59 is located approximately 3.5 km south of the study area, and the N1 is located along the eastern boundary of the study area. The proposed Scaffel cluster development will cover an area of approximately 839 ha.

The proposed Scaffel Cluster development consist of four (4) individual solar PV facilities (Figure 2 and 3):

- Scafell solar PV facility located on Portion 3 of the Farm Will Grange 246;
- Damlaagte solar PV facility located on the remaining extent (RE) of the Farm Damlaagtes 229;
- Vlakfontein solar PV facility located on portion 6 of the Farm Vlakfontein 161; and
- Iliwa solar PV facility located on portion 5 of the farm Proceederfontein 100.

No detailed development layout was available at the time of compiling this report, nonetheless, each individual solar PV facility will include solar PV array, a Battery Energy Storage System (BESS), a substation and grid connection infrastructure (to facilitate grid connection between each solar PV facility and the existing Scafell Substation) (Figure 2).

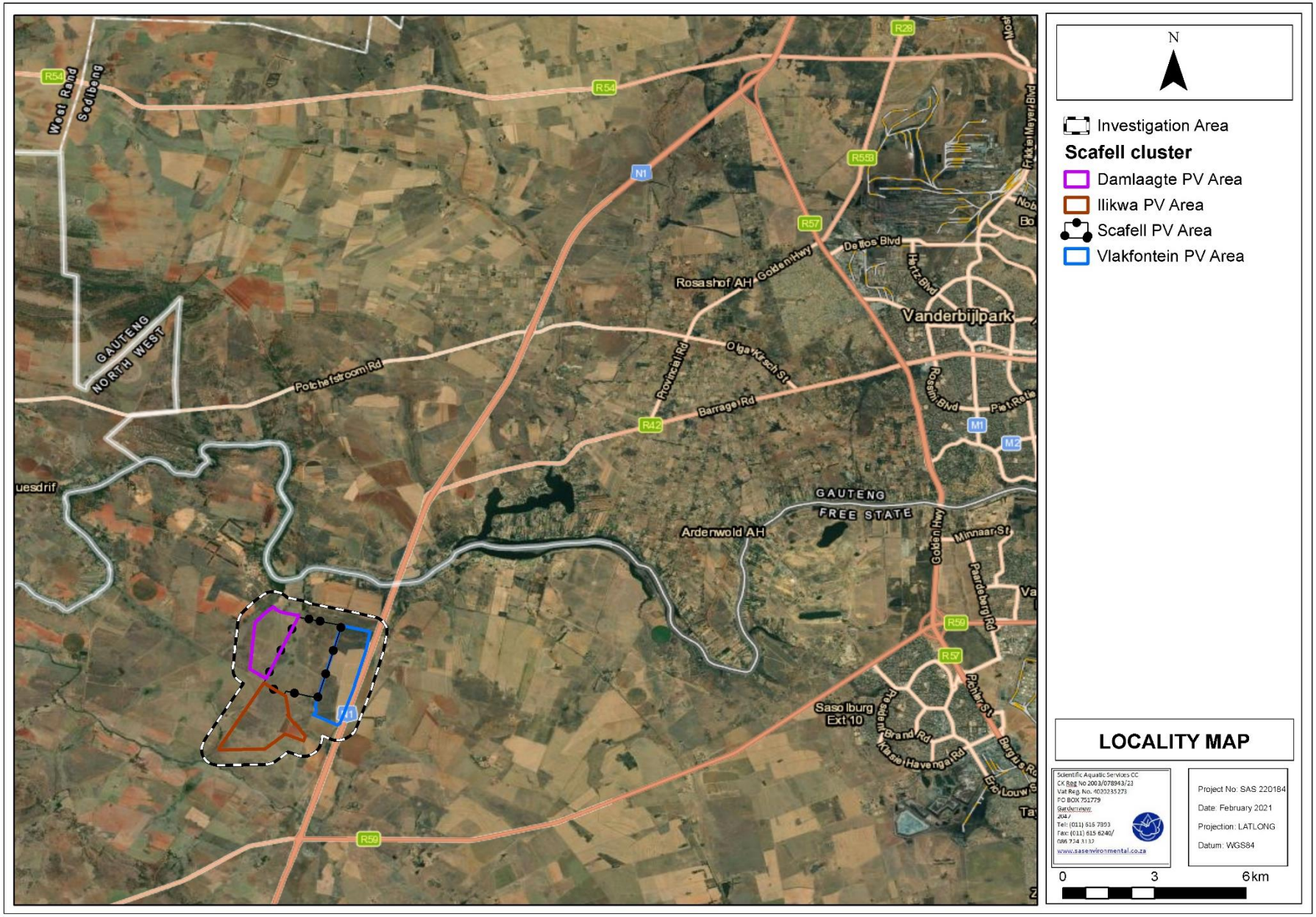

Figure 1: A digital satellite image depicting the location of the study and investigation areas in relation to the surrounding environment.

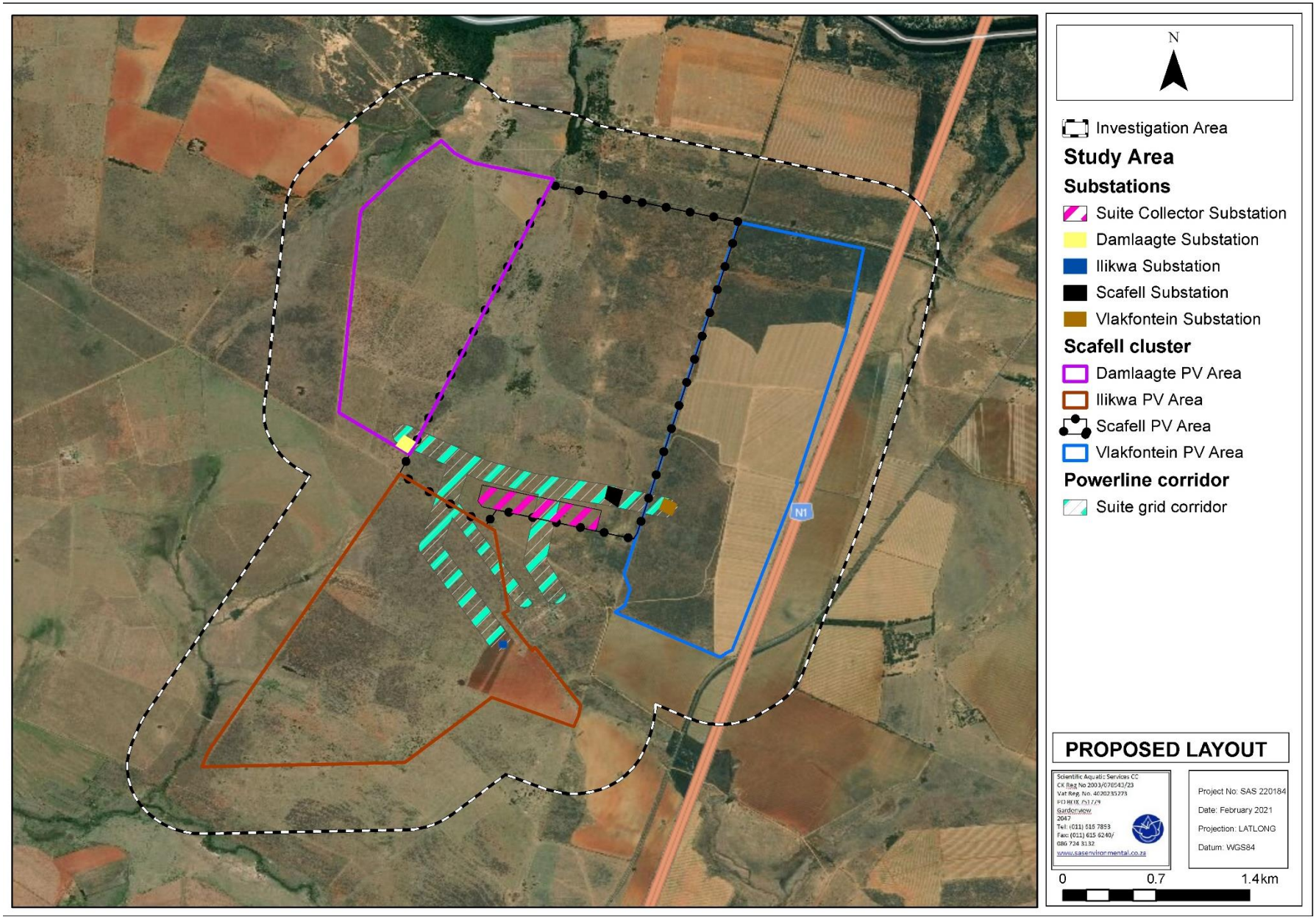

Figure 2: Layout of the proposed Scaffel cluster development in relation to the surrounding environment.

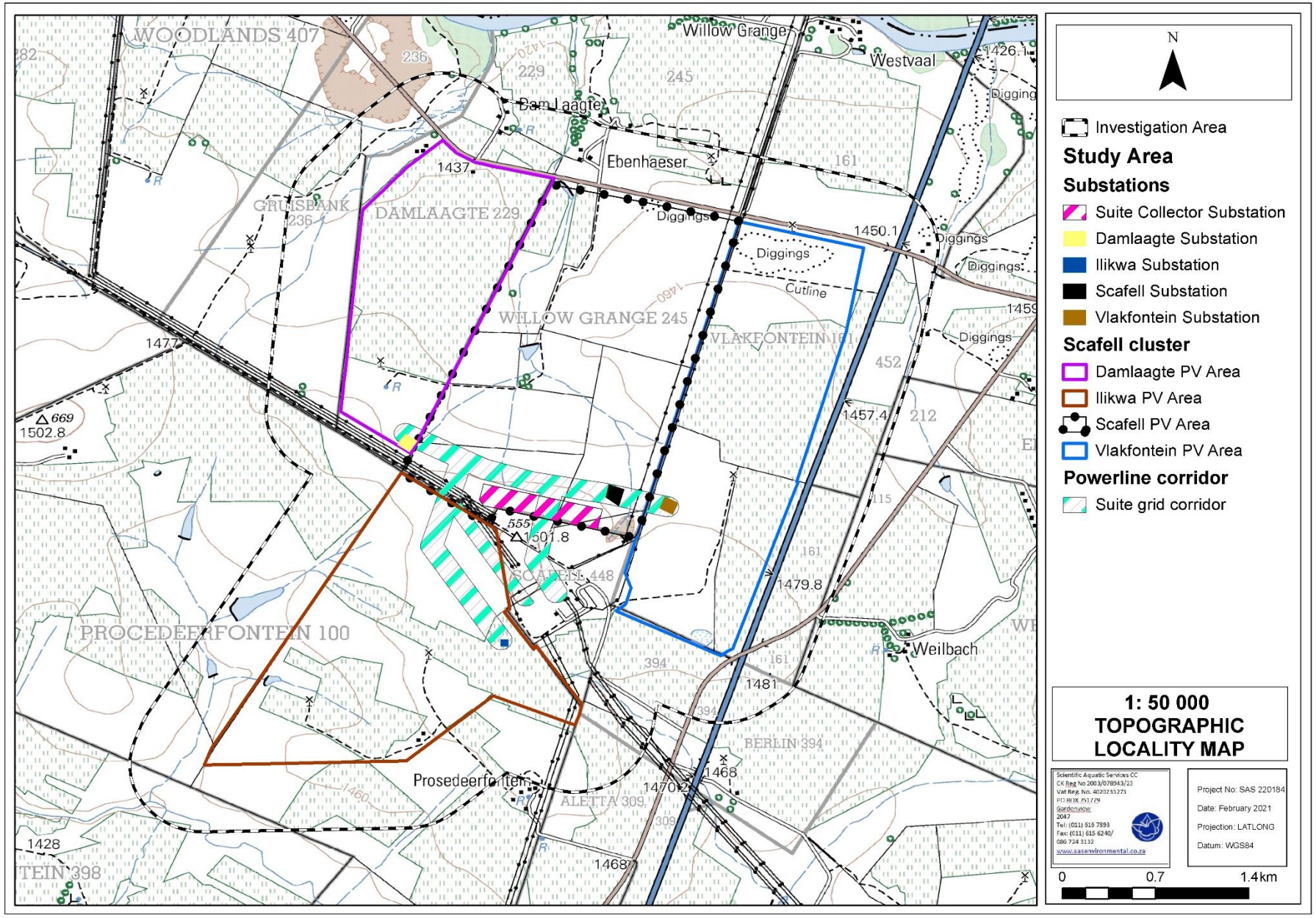

Figure 3: The study and investigation areas depicted on a 1:50 000 topographical map in relation to the surrounding area.

1.2 Scope of Work

Specific outcomes in terms of this report are outlined below:

- A background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA] 2011 database; the Department of Water and Sanitation Research Quality Information Services [DWS RQIS PES/EIS], 2014 database, and National Biodiversity Assessment (NBA) 2018 was undertaken to aid in defining the PES and EIS of the freshwater ecosystems;
- All freshwater ecosystems within the investigation area were delineated using desktop methods in accordance with GN509 of 2016 as it relates to activities as stipulated in the National Water Act, 1998 (Act No. 36 of 1998) and verified according to the "Department of Water Affairs and Forestry (DWAF)[1] (2005)[2]: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics, vegetation types and wetness were used to verify the freshwater ecosystems;
- The freshwater ecosystems classification assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- The EIS of the freshwater ecosystems were determined according to the method described by Rountree & Kotze*,* (2013);
- The PES of the freshwater ecosystems was assessed according to the resource directed measures guideline as advocated by Macfarlane *et al.* (2008);
- The freshwater ecosystems were mapped according to the ecological sensitivity of each hydrogeomorphic unit in relation to the study area. In addition to the freshwater ecosystems boundaries, the appropriate provincial recommended buffers and legislated zones of regulation were depicted where applicable; and
- Allocation of a suitable RMO, REC and Best Attainable State (BAS) to the freshwater ecosystems based on the results obtained from the PES and EIS assessments; and
- The SLR Impact Assessment Matrix was applied to identify potential impacts that may affect the any freshwater ecosystems in the vicinity of the proposed Scaffel

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA) and subsequently as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.
[2] Even though an updated manual is available since 2008 (Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas), this is still considered a draft document currently under review.

Cluster development, specifically the proposed Damlaagte PV facility and the associated grid connection.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The freshwater report presents the baseline results of the freshwater assessment for the entire study area as depicted in figure 1; however, for the impact assessment, this report only includes impact assessment for the Damlaagte PV facility (SAS 220184, 2021c). Impact assessments for the remaining Scaffel Cluster sites are presented in the following reports:
    - SAS 220184, 2021a. Freshwater ecosystem assessment as part of the environmental authorisation process for four proposed solar photovoltaic facilities (Scaffel cluster) near Sasolburg, free state province. **Part A: Freshwater Ecological Assessment for the Scaffel PV Facility.**
    - SAS 220184, 2021c. Freshwater ecosystem assessment as part of the environmental authorisation process for four proposed solar photovoltaic facilities (Scaffel cluster) near Sasolburg, free state province. **Part B: Freshwater Ecological Assessment for the Vlakfontein PV Facility.**
    - SAS 220184, 2021c. Freshwater ecosystem assessment as part of the environmental authorisation process for four proposed solar photovoltaic facilities (Scaffel cluster) near Sasolburg, free state province. **Part D: Freshwater Ecological Assessment for the Ilikwa PV Facility.**
- All freshwater ecosystems within 500 m of the study area were delineated in fulfilment of GN509 of the NWA using various desktop methods including use of topographic maps, historical and current digital satellite imagery and aerial photographs. Desktop delineations were ground-truthed where feasible;
- The delineations as presented in this report are regarded as a best estimate of the temporary boundaries based on the site conditions present at the time of assessment;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater ecosystems will need to be surveyed and pegged according to surveying principles and with survey equipment;
- Due to high levels of disturbance within the investigated freshwater ecosystems due cultivation activities, vegetation was not always a reliable indicator to determine the presence or delineated extent of freshwater ecosystems throughout the study area. As such, in highly disturbed areas, use was made of other indicators (such as soil and/or topography) and the delineations were refined using available digital satellite imagery;

- Linked to the above, identification of the outer boundary of the temporary zone of the freshwater ecosystems proved difficult in some areas. Therefore, the delineations as presented in this report are regarded as a best estimate of the boundaries based on the site conditions present, as observed during the site assessment. These delineations are, however, deemed accurate enough to guide the authorisation process;
- Wetland, riparian and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundary may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results;
- With regards to data sources used to provide background information on the sensitivity of the assessed areas, it is important to note that although all data sources provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the study area's actual site characteristics at the scale required to inform the environmental authorisation processes;
- This report does not include a DWS risk assessment/ impact assessment as a final detailed development layout is not available as yet. An impact discussion and assessment of all potential pre-construction, construction, operational and maintenance phase impacts will be completed when a finalised layout of the proposed Scaffel Cluster development has been received; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. A more reliable assessment of the biota would require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions. However, it is expected that the existing activities have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of aquatic, riparian and wetland ecology.

1.4 Legislative Requirements and Provincial Guidelines

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- Constitution of the Republic of South Africa, 1996;
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);

- The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA);
- The National Environmental Management: Biodiversity Act, 2014 (Alien and Invasive Species Regulations, 2014); and
- The Department of Environmental Affairs (DEA), National Screening Tool.

2 ASSESSMENT APPROACH

2.1 Freshwater Ecosystem Definition

Freshwater ecosystems are defined by Wentzel (2001) in the Encyclopaedia of Biodiversity as "interactive systems within which biotic species and their growth and adaptation, and associated biological productivity, nutrient cycling, and energy flows among inland aquatic microbial, plant, and animal communities, are integrated with their environment. These inland waters include lakes, reservoirs, rivers, streams, and wetlands."

The National Water Act, 1998 (Act No. 36 of 1998) is aimed at the protection of the country's water resources, defined in the Act as "a watercourse, surface water, estuary or aquifer". According to the National Water Act, 1998 (Act No. 36 of 1998):

A **watercourse** means:
(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.

Wetland habitat is "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."

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

Thus, for the purposes of this investigation, the definition of a freshwater ecosystem is considered to be synonymous with the definition of a watercourse as per the National Water Act, 1998 (Act No. 36 of 1998).

2.2 Freshwater Ecosystem Field Verification

As mentioned in Section 1.3 use was made of historical aerial photographs, historical and current digital satellite imagery, topographic maps, and available provincial and national wetland databases to aid in the delineation of those portions of the watercourses located within the study area following the field assessment. The following was taken into consideration when utilizing the above during delineation:

- Linear features: since water flows/moves through the landscape, watercourses often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;
- Vegetation associated with watercourses: a distinct increase in density as well as shrub size near flow paths;
- Hue: with water flow paths often show as white/grey or black and outcrops or bare soil displaying varying chroma created by varying vegetation cover, geology and soil conditions. Changes in the hue of vegetation with watercourse vegetation often indicated on black and white images as areas of darker hue (dark grey and black). In colour imagery these areas mostly show up as darker green and olive colours or brighter green colours in relation to adjacent areas where there is less soil moisture or surface water present; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

The watercourse delineation was verified in the field at pre-selected points, and this delineation took place according to the method presented in the “Updated manual for the identification and delineation of wetland and riparian resources” (DWAF, 2008). The foundation of the method is based on the fact that watercourses have several distinguishing factors including the following:

- Landscape position;
- The presence of water at or near the ground surface;
- Distinctive hydromorphic soil;
- Vegetation adapted to saturated soil; and
- The presence of alluvial soil in stream systems.

A field assessment was undertaken in January 2020, during which the presence of any riparian or wetland characteristics as defined by DWAF (2008) and by the National Water Act, 1998 (Act No 36 of 1998) were noted (please refer to Section 4 of this report). In addition to the delineation process, detailed assessments of the delineated watercourses were undertaken, at which time, factors affecting the integrity of the watercourses were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the watercourses. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.3 Sensitivity Mapping

All watercourses associated with the study area were delineated on a desktop basis, with these delineations being ground-truthed in the field at certain pre-selected points where possible with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project these features onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 5 should guide the design and layout of proposed Scaffel Cluster development.

2.4 Impact Assessment

The SLR Impact Assessment Matrix was applied to identify potential impacts that may affect the any freshwater ecosystems in the vicinity of the proposed Scaffel Cluster development, specifically the proposed PV facility and the associated grid connection. The impact assessment also presents management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment. **The impact assessment presented in the report was specifically prepared for activities proposed within the Damlaagte site.** Please refer to Appendix E for the full SLR impact assessment methodology applied in the study.

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 Analyses of Relevant Databases

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard style” report (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible to allow for integration of results by the reader to take place. Where required, further discussion and interpretation is provided.

It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the study area’s actual site characteristics at the scale required to inform the environmental authorisation and/or water use licensing application processes. Nevertheless, this information is considered useful as background information to the study, is important in legislative contextualisation of risk and impact, and was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance. It must, however, be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision-making process. Actual site conditions at the time of the assessment may differ to the background information provided by various datasets. Please refer to Section 4 for details pertaining to the site investigation.

Table 1: Desktop data relating to the character of the watercourses associated with the study area and surrounding region.

Aquatic ecoregion and sub-regions in which the study area is located			Detail of the study area in terms of the National Freshwater Ecosystem Priority Area (NFEPA, 2011) database	
Ecoregion	Highveld		FEPACODE	The study area and investigation areas are located within a SubWMA not considered to be important in terms of River or Fish conservation (FEPACODE = 0).
Catchment	Vaal			
Quaternary Catchment	C23B			
WMA	Upper Vaal			
subWMA	Downstream of the Vaal Dam			
Dominant characteristics of the Highveld Aquatic Ecoregion Level 2 (Kleynhans *et al.*, 2007)	Highveld (11.01) Ecoregion level 2	Highveld (11.03) Ecoregion level 2	NFEPA Wetlands (Figure 4)	According to the NFEPA database (2011) there is one artificial channelled valley bottom wetland situated towards the south west of the Ilikwa solar PV facility of the Scafell Cluster development, two artificial channelled valley bottom wetlands towards the west and north west of the Scafell solar PV facility of the Scafell Cluster development and one natural depression wetland towards the south of the Vlakfontein solar PV facility of the Scafell Cluster development. All three artificial channelled valley bottom wetlands are considered to be in a severely degraded ecological condition (Class Z3) whilst the depression wetland is considered to be in a moderately modified ecological condition (Class C).
Dominant primary terrain morphology	Plains, low relief	Plains, low relief, Plains and moderate relief.		
Dominant primary vegetation types	Rocky Highveld Grassland Mixed Bushveld	Moist Cool Highveld Grassland		
Altitude (m a.m.s.l)	1300 to 1900	1300 – 2100		
MAP (mm)	500 to 700	400 – 800		
The coefficient of Variation (% of the MAP)	20 to 34	20 – 34		
Rainfall concentration index	55 - 64	45 - 64	Wetland Vegetation Type	The study area is situated within the Mesic Highveld Grassland Group 3 Wetland Vegetation Type considered least threatened and not protected according to Mbona *et al.* 2015.
Rainfall seasonality	Early to mid-summer	Early to late Summer		
Mean annual temp. (°C)	14 to 18	12 - 18		
Winter temperature (July)	0 to 14	-2 – 18	NFEPA Rivers (Figure 4)	According to the NFEPA database the Kromelmboogspruit River is located approximately 400 m south and downgradient of the Ilikwa solar PV facility of the Scafell Cluster development, within the investigation area. According to the NFEPA (2011) and the PES 1999 databases, the Kromelmboogspruit River is in a largely modified ecological condition (Class D) and is not classified as a River FEPA.
Summer temperature (Feb)	12 to 30	10 – 28		
Median annual simulated runoff (mm)	20 to 60	5 – 10 (limited); 10 – 150		
Ecological Status of the most proximal sub-quaternary reach (DWS, 2014) (Figure 6)				
Sub-quaternary reach	C23A-01811 (Kromelmboogspruit)	C23-01731 (Vaal River)	National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Figure 5)	According to the NBA (2018): SAIIAE there is one depression wetland situated within the Ilikwa solar PV facility of the Scafell Cluster development and one unchanneled valley bottom wetland within the investigation area, approximately 150 m north of the Damlaagte solar PV facility of the Scafell Cluster development. These wetlands are considered to be in heavily to critically modified (Class DEF). The Ecosystem Threat Status (ETS) and Ecosystem Protection Level (EPL) of the depression wetland is least concern and poorly protected whilst the ETS and EPL of the unchanneled valley bottom wetland is critical and not protected. In addition, the NBA (2018) database indicates that the Kromelmboogspruit is situated approximately 420 m
Proximity to study area	±5.2 km north of the study area	±28.2 km south of the study area		
Assessed by expert?	Yes	Yes		
PES Category Median	Moderately modified	Largely modified		
Mean Ecological Importance (EI) Class	High	Moderate		
Mean Ecological Sensitivity (ES) Class	High	High		
Stream Order	1	5		

Default Ecological Class (based on median PES and highest EI or ES mean)	B	B		downgradient of the Ilikwa solar PV facility of the Scafell Cluster development whist the Vaal River is located approximately 1 km north of the Damlaagte portion of the Scafell Cluster development. The Kromelmboogspruit and Vaal Rivers are considered largely modified (Class D) and the EPL and ETS is considered critical and poorly protected.
National Web Based Environmental Screening Tool (2021)				
The Screening Tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. This assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas.	• Damlaagte solar PV facility – Entire site was considered low sensitivity and an area outside the project area was considered of high sensitivity. • Scaffel and Ilikwa solar PV facility – The entire site was considered to be of low sensitivity. • Vlakfontein solar PV facility – The larger extent of the site was considered to be of low sensitivity, while a smaller area (less than 10% of the total area) was considered to be of very high sensitivity.			

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; MBSP = Municipal Biodiversity Summary Project; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State WMA = Water Management Area

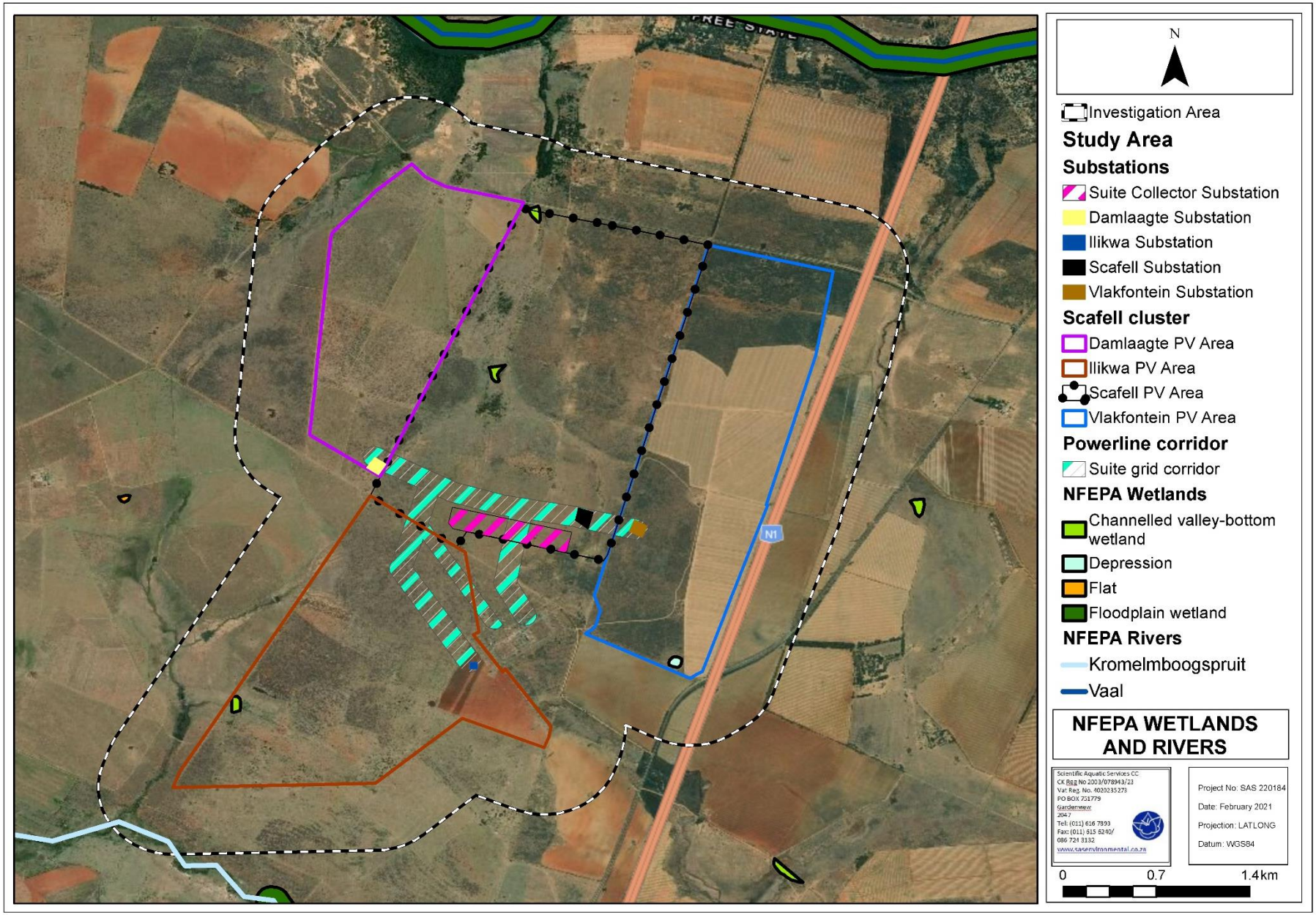

Figure 4: The wetland hydrogeomorphic units and rivers associated with the study and investigation areas (NFEPA, 2011).

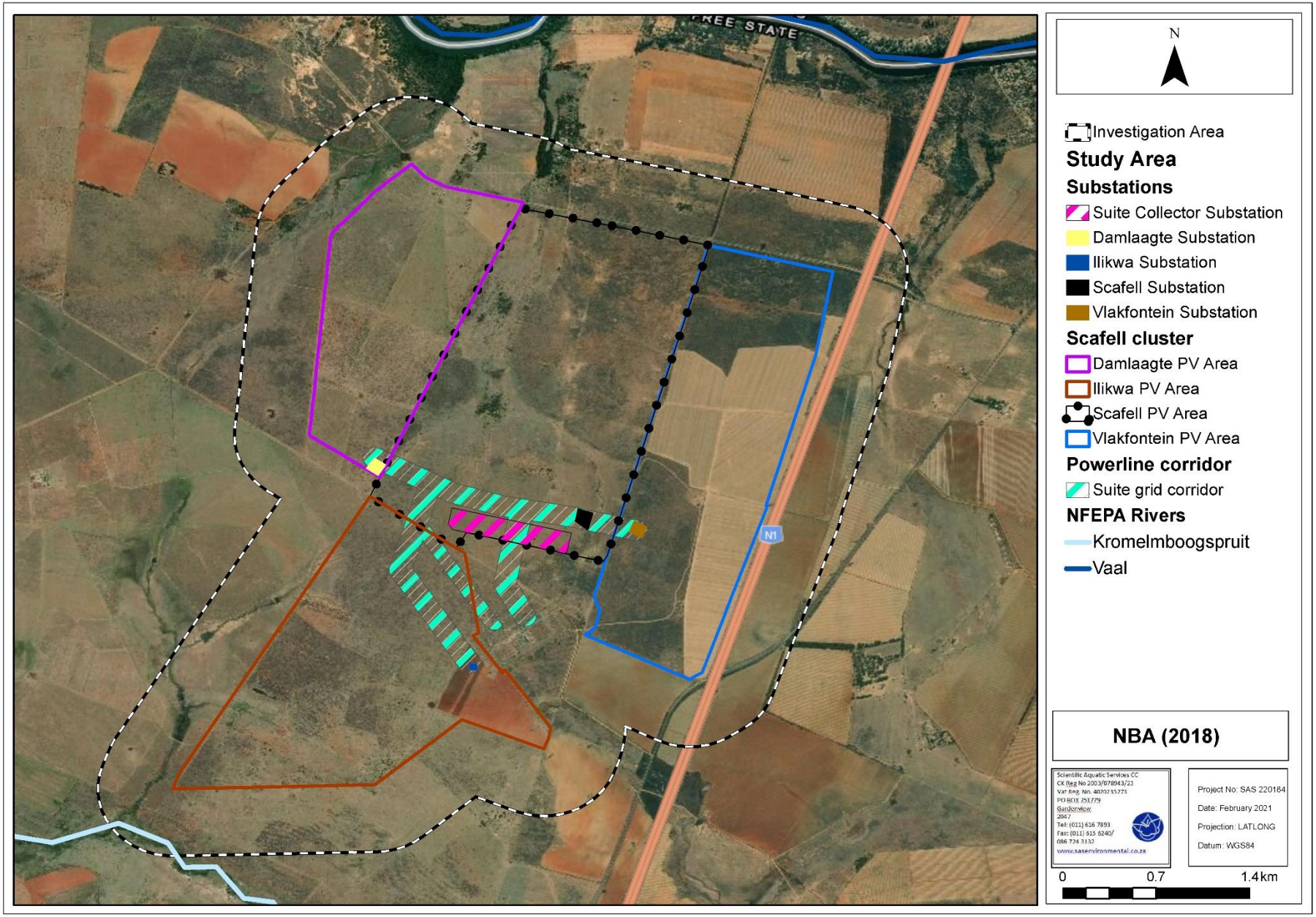

Figure 5: Hydrogeomorphic (HGM) unit indicated by the National Biodiversity Assessment (NBA, 2018).

3.2 Ecological status of sub-quaternary catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS database]

The PES/EIS database, as developed by the DWS RQIS department, was utilised to obtain additional background information on the study area. The information from this database is based on information at a sub-quaternary catchment reach (SQR) level. Descriptions of the aquatic ecology is based on information collated by the DWS RQIS department from available sources of reliable information, such as SA RHP sites, Ecological Water Requirements (EWR) sites and Hydro Water Management system (WMS) sites.

The study area falls within the Highveld Aquatic Ecoregion and within the C23B quaternary catchment. According to the PES/EIS database, as developed by the DWS RQIS department, the following sub-quaternary catchment reaches (SQR) are applicable. The SQR monitoring point C23A-01811 and C23B-01731 are located approximately 5.4 km and 28.3 km north and south of the study area, respectively. The following macro-invertebrate taxa has previously been reported from SQR C23A-01811(Kromelmboogspruit) and C23B-01731 (Vaal River):

Table 2: Fish species recorded at the SQR C23A-01811 (Kromelmboogspruit) and C23B-01731 (Vaal River):

Fish species	C23A-01811(Kromelmboogspruit)	C23B-01731 (Vaal River)
Austroglanis sclateri		X
Labeobarbus aeneus	X	X
Enteromius anoplus	X	X
Enteromius pallidus	X	
Enteromius kimberleyensis		X
Enteromius paludinosus	X	X
Enteromius trimaculatus	X	X
Clarias gariepinus	X	X
Labeo capensis	X	X
Labeo umbratus	X	X
Pseudocrenilabrus philander	X	X
Tilapia sparrmanii	X	X

Table 3: Macro-invertebrate families recorded at SQR C23A-01811 (Kromelmboogspruit) and C23B-01731 (Vaal River).

Macro-Invertebrates	C23A-01811(Kromelmboogspruit)	C23B-01731 (Vaal River)
Aeshnidae	X	
Ancylidae	X	X
Baetidae 1 Sp		
Baetidae 2 Sp	X	X
Belostomatidae	X	X
Caenidae		X
Ceratopogonidae	X	X
Chironomidae	X	X
Coenagrionidae	X	X
Corbiculidae	X	X
Corduliidae		
Corixidae	X	X
Culicidae	X	
Dytiscidae	X	X
Elmidae	X	X
Gerridae	X	X
Gomphidae	X	X
Gyrinidae	X	X
Hydracarina	X	X
Hirudinea	X	X
Hydrometridae	X	X
Hydrophilidae	X	X
Hydropsychidae 1 sp		X
Hydropsychidae 2 sp.	X	
Hydroptilidae		X
Leptoceridae	X	X
Leptophlebidae	X	
Lestidae		
Libellulidae	X	X
Lymnaeidae	X	
Muscidae	X	X
Naucoridae	X	X
Nepidae		X
Notonectidae	X	X
Oligochaeta	X	X
Physidae	X	X
Planorbinae	X	X
Pleidae	X	X
Potamonautidae	X	X
Simuliidae	X	
Sphaeridae	X	X
Tabanidae	X	
Tipulidae	X	
Turbellaria	X	
Veliidae/Mesoveliidae	X	X

Table 4: Summary of the ecological status of the sub-quaternary catchment (SQ) reaches associated with the study area based on the DWS RQS PES/EIS database.

PESEIS Data	C23A-01811(Kromelmboogspruit)	C23B-01731 (Vaal River):
Synopsis		
PES Category Median	Moderately modified	Largely modified
Mean EI class	High	Moderate
Mean ES class	High	High
Length	107.24	27.52
Stream order	1	5
Default EC[4]	B	B
PES Details		
Instream habitat continuity MOD	Small	Large
RIP/wetland zone continuity MOD	Moderate	Large
Potential instream habitat MOD activities	Large	Large
Riparian/wetland zone MOD	Large	Large
Potential flow MOD activities	Moderate	Serious
Potential physico-chemical MOD activities	Small	Serious
EI Details		
Fish spp/SQ	10	11
Fish average confidence	4.20	4.82
Fish representivity per secondary class	Very High	Very High
Fish rarity per secondary class	Very High	Very High
Invertebrate taxa/SQ	42	35
Invertebrate average confidence	3.95	1.91
Invertebrate representivity per secondary class	High	High
Invertebrate rarity per secondary class	Very High	High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	Very High	High
Habitat diversity class	High	Low
Habitat size (length) class	Very High	Low
Instream migration link class	Very High	Moderate
Riparian-wetland zone migration link	High	Moderate
Riparian-wetland zone habitat integrity class	High	Moderate
Instream habitat integrity class	Moderate	Moderate
Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m	Very High	Moderate
Riparian-wetland natural vegetation rating based on expert rating	Low	Low
ES Details		
Fish physical-chemical sensitivity description	High	High
Fish no-flow sensitivity	High	High
Invertebrates physical-chemical sensitivity description	Very High	Moderate
Invertebrates velocity sensitivity	Very High	Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Very High	Very High
Stream size sensitivity to modified flow/water level changes description	Low	Low
Riparian-wetland vegetation intolerance to water level changes description	High	High

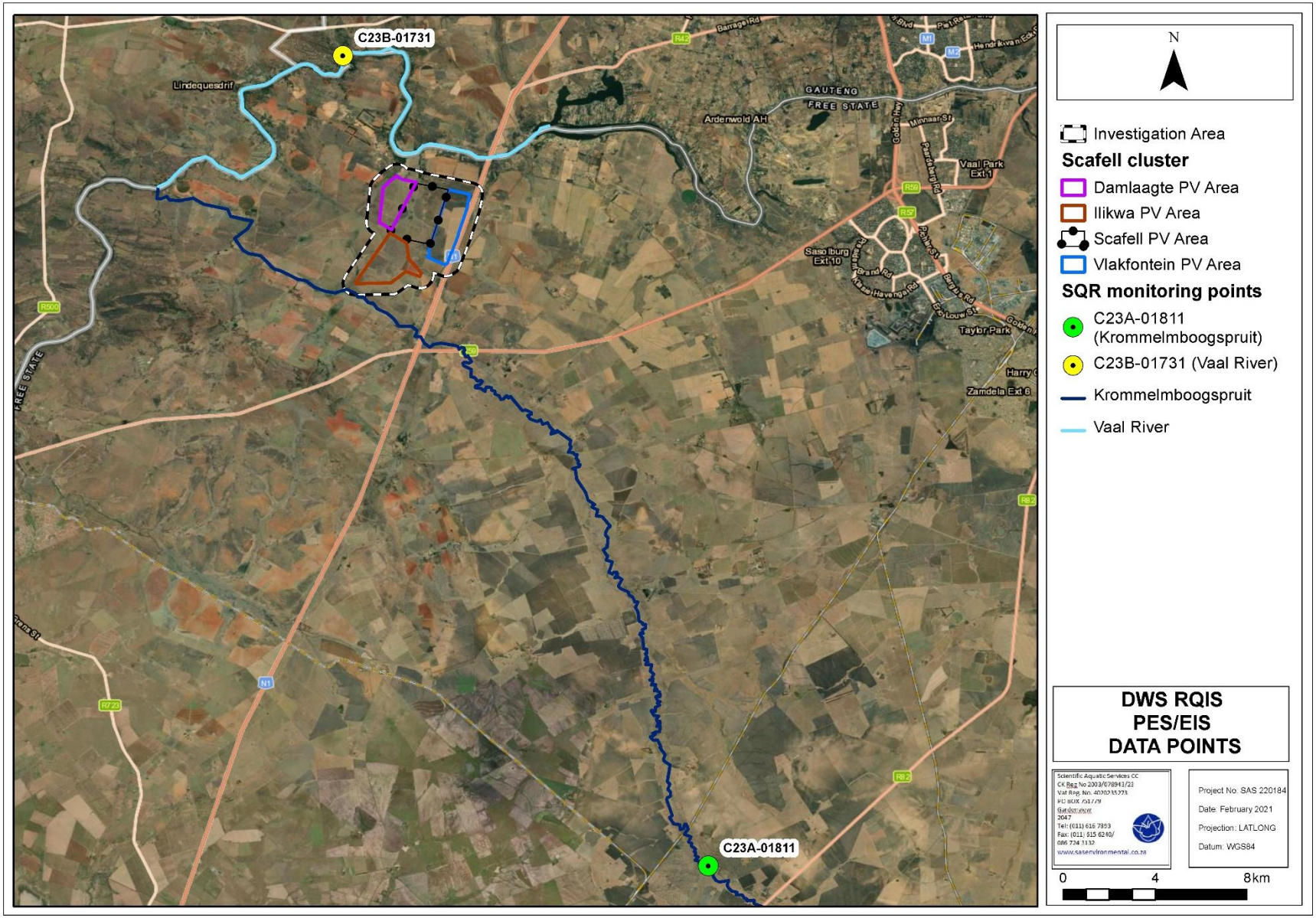

Figure 6: Relevant SQR Monitoring Points associated with the proposed Scafell Cluster development (DWS, 2014).

4 RESULTS: FRESHWATER ECOSYSTEM ASSESSMENT

4.1 Freshwater Ecosystem Delineation

As noted in Section 2.1, the freshwater ecosystems within the study area was initially delineated using desktop methods (use of aerial photographs, digital satellite imagery and topographical maps), and refined in the field by ground-truthing the desktop delineation at certain pre-selected points. The delineation as presented in this report is thus regarded as a best estimate of the freshwater ecosystem boundaries based on the site conditions present at the time of assessment. As discussed in further detail in Section 4.3, only wetlands were identified within the study area, no riparian watercourses were identified.

The following indicators were used to delineate the boundaries of the temporary zones associated with the identified wetlands:

- Terrain units were utilised as the primary determinant to ascertain in which parts of the landscape the watercourse would be likely to occur;
- Where feasible, vegetation indicators were utilised. Due to the historical and current (cultivation) activities the vegetation community composition has been notably transformed;
- Where observed, surface water ponding was used as an indicator; and
- The soil form indicator was used to determine the presence of soils that are associated with prolonged and frequent saturation with key indicators including gleying, mottling, organic streaking and increased clay content.

4.2 Analyses of Historical Aerial Imagery

Aerial photographs of the study area were obtained from the Department of Rural Development and Land Reform's (DRDLR) National Geo-spatial Information database (http://cdngiportal.co.za/cdngiportal/) to further aid in the identification and delineation of the various features identified during the site assessment. In addition, historical aerial photography and digital satellite imagery are considered useful tool in showing how land has been transformed due to anthropogenic activities within a landscape. Figure 7 below shows land transformation between 1968 to 1996. In addition, the change in the area of the wetland (indicated by arrow) can be observed.

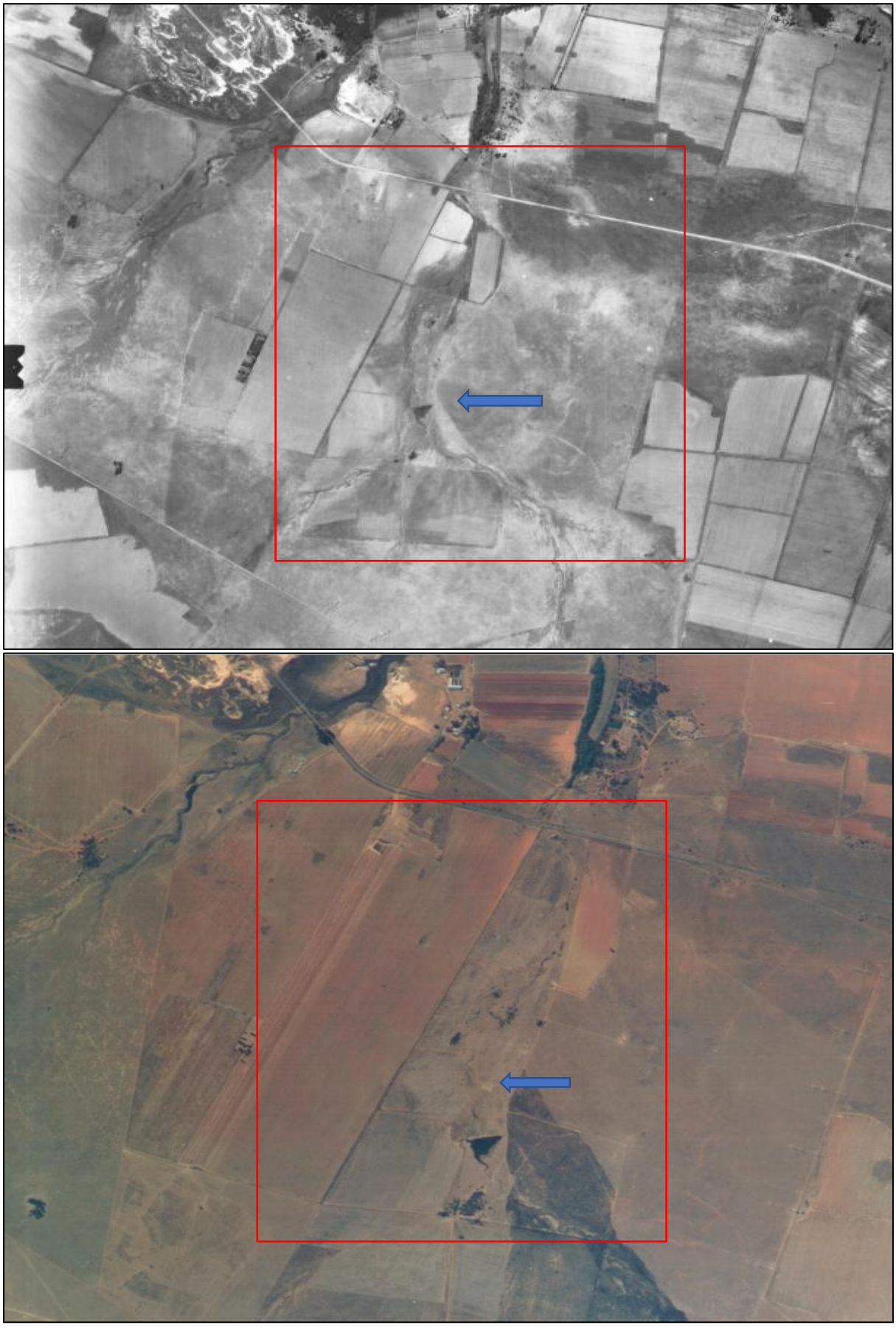

Figure 7: Representative photographs showing the land transformation between 1968 to 1996. In addition, the change in the area of the wetland (Indicated by arrow) can be observed.

4.3 Characterisation of the wetlands

In preparation for the field assessment, aerial photographs, digital satellite imagery and provincial and national wetland databases (as outlined in Section 2 of this report) were used to identify areas of interest at a desktop level. All possible measures were undertaken to ensure all freshwater ecosystems which may be affected by the proposed Scaffel Cluster development were identified, delineated and assessed.

During the assessment, within the Damlaagte solar PV facility, no freshwater ecosystems were identified. Within the Scaffel solar PV facility, a single unchannelled valley bottom (UCVB 1) wetland was identified traversing the central portion of the area. At the Vlakfontein solar PV facility, a single depression wetland was identified along the south eastern boundary immediately adjacent to the N1 highway and within the Ilikwa solar PV facility, an unchannelled valley bottom (UCVB 2) was also identified and this forms part of a larger channelled valley bottom wetland system located within the investigation area.

The Kromelmboogspruit is located in the southern portion of the investigation area. The Vaal River is located outside the northern boundary of the investigation area (approximately 420 m from the study area boundary). These systems were however not assessed in detail as part of the assessment due to of the extent of the system in relation to the extent of the catchment potentially affected by the proposed Scaffel Cluster development and the fact that sufficient databases exist from which the condition of the system could be defined. The delineated freshwater ecosystems depicted in Figure 8 were classified according to the classification system (Ollis *et. al.,* 2013) as Inland Systems, falling within the Highveld Aquatic Ecoregion, and the Mesic Highveld Grassland Group 3 Wetland Vegetation type. These freshwater ecosystems were further classified at Level 3 and Level 4 of the classification system as summarised in Table 5 below.

Table 5: Characterisation of the watercourses associated with the proposed Scaffel Cluster development within the study area according to the Classification System (Ollis *et. al*., 2013).

Freshwater Ecosystem	Applicable solar PV facility	Level 3: Landscape unit	Level 4: HGM Type
Unchannelled Valley Bottom Wetland 1 and 2		**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**Unchannelled valley bottom:** A valley-bottom wetland without a river channel running through it.
Depression Wetland		Plain: an extensive area of low relief. These areas are generally characterised by relatively level, gently undulating or uniformly sloping land with a very gentle gradient that is not located within a valley. Gradient is typically less than 0.01 or 1:100	**Depression:** A wetland or aquatic ecosystem with closed (or near closed) elevation contours which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates.

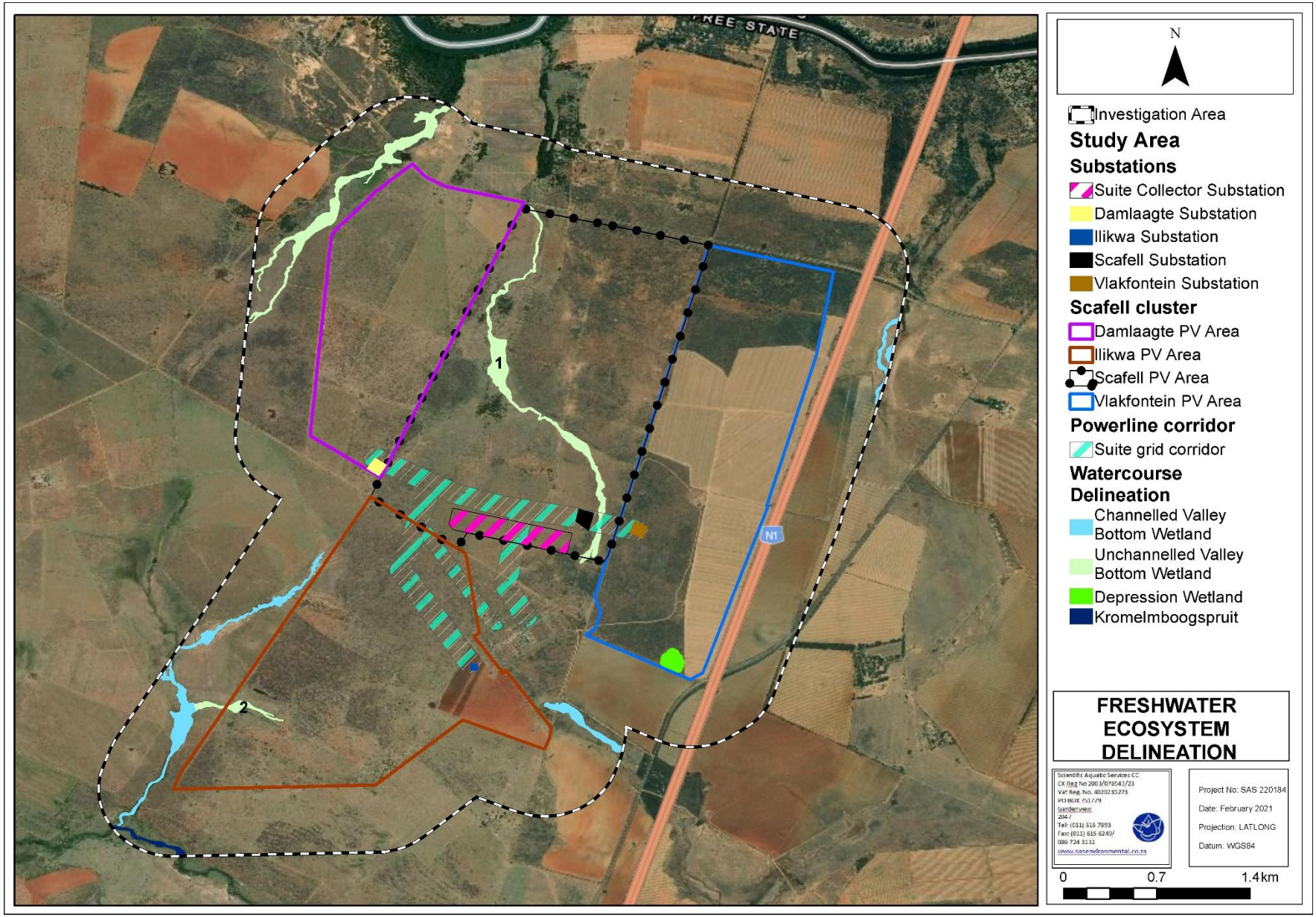

Figure 8: The location of the delineated watercourse in relation to the study area associated with the proposed Scaffel Cluster development.

4.4 Field Verification Results

Following the site visit, various assessments were undertaken to determine the PES, EIS, and ecological service provision of the identified wetlands as well as to assign an appropriate REC, RMO and BAS as described in Section 1.2 of this report. These assessments were conducted for the UCVB 1, 2 wetlands within the Scaffel and Ilikwa solar PV facilities respectively and the depression wetland located within Vlakfontein solar PV facility.

According to the Resource Quality Information Services database (DWS, 2014), the Vaal River is considered to be in a largely modified ecological condition (Class D) and it is considered to be of high ecological importance and sensitivity. The Kromelmboogspruit according to the database is moderately modified ecological condition (Class C) and of high ecological importance and sensitivity (Section 3.2).

Table 6: Summary of the assessment of the unchannelled valley bottom wetland 1 within the Scaffel solar PV facility associated with the proposed Scaffel Cluster development.

Ecological & socio-cultural service provision graph:

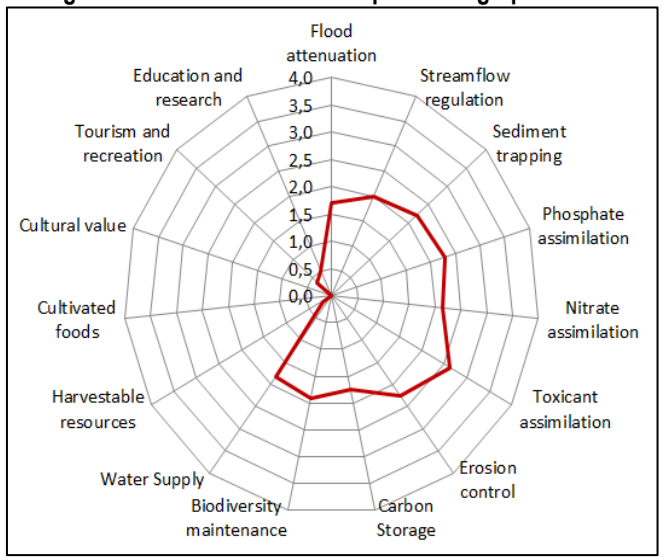

Figure 9: Representative photographs of the unchannelled valley bottom which traverses the central portion of the Scaffel solar PV facility. Indicated on the photograph on the left is the impoundment within the valley bottom system and the dashed yellow line approximates the outer boundary of the wetland.

PES discussion	**PES Category: Moderately Modified** The UCVB 1 wetland ecological integrity has been moderately modified as a result of the current and historical impacts associated with cultivation activities within the wetland as well as its local catchment. An impoundment was identified within the wetland, and the presence of this feature has potentially resulted in the reduction of the functional extent of the wetland especially given that UCVB wetlands are largely driven by upstream surface and subsurface flows. The presence of various roads crossing the wetland has resulted in increased sediment delivery to the wetland and a localised decrease in infiltration capacity as a result of the compaction of soil associated with the road crossings.	**Ecoservice provision**	**Ecoservices: Intermediate** The ecological service provision of the UCVB 1 wetland was defined as intermediate. Impacts to the ecological integrity of the system have resulted in loss of functionality within portions of the wetland, however, certain areas still function at an intermediate level. Such ecological services include toxicant assimilation, sediment trapping, phosphate assimilation and erosion control. Additionally, biodiversity support has decreased to a degree as a result of historical cultivation activities however, habitat provisioning has been maintained around the impounded area particularly for waterfowl species. In terms of direct human benefits to local communities, the wetland provides little to no benefits, largely because of the restricted access to this wetland.

EIS discussion	**EIS Category: Moderate** The wetland EIS is considered moderate for its hydro-functional importance such as flood attenuation and trapping sediment. The presence of intact habitat around the impounded area for waterfowl species has improved the ecological importance of the wetland to a degree. The wetland sensitivity was considered limited due to the wetland vegetation group (Mesic Highveld Grassland Group 3) which is considered to be least threatened according to Mbona *et al*. (2015).	**REC, RMO & BAS Category**	**REC Category: C** **BAS: C (Maintain)** **RMO: C (Maintain)** According to the Recommended Management Objective (RMO), the ecological integrity of the UCVB 1 wetland must be maintained at a moderately modified ecological class. The proposed activities within the study area must be planned and managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that the RMO is achieved. Where any impacts are likely to occur, rehabilitation measures be applied must ensure that the wetland is able to provide important hydrological and sediment balancing services such as attenuating floods which will be significant for the protection of any planned infrastructure within the study area.

Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):

The hydrological regime of the wetland is considered moderately modified due to various road crossings which have impeded flows and limit the hydrological connectivity between the upstream and downstream reaches of the wetland. Construction of the impoundment wall has impacted on the natural distribution and retention of flows within the wetland and likely decreased functional areas of the wetland below the impoundment.

The water quality was assessed at a single point within the system and specific *in-situ* parameters measured included pH, temperature and Electrical Conductivity (EC). According to the *in-situ* findings, the dissolved salts were measured to be 37.2 mS/m which is within the acceptable range limit DWAF (1996). The pH was to be 6.61 at 24.1 ˚C which refer to acceptable water quality for aquatic ecosystems.

Geomorphological processes of the wetland have been impacted by various informal roads which have resulted in compaction of soil, small scale vegetation clearing and in addition topsoil disturbances within the wetland. This has also reduced infiltration rates and increased sediment laden runoff reporting to the wetland which is expected to have an impact during periods of high rainfall. In addition, the presence of the instream impoundment has led to slight reduction in sediment and flow inputs downstream, however no significant erosion was present downstream of the impoundment and the system is largely in balance.

The vegetation community and diversity within the wetland is considered moderately intact, however, several alien and invasive plant (AIP) species have encroached into sections of the wetland. Dominant species within the wetland included *Eragrostis lehmanniana, Miscanthus junceus, Aristida congesta subsp. congesta*. Some of the alien and invasive species identified within the wetland include *Cosmos bipinnata, Circium vulgare, Campuloclinium macrocephalum* and *Verbena bonariensis* (STS, 2021). Despite the presence of several alien and invasive species, the wetland habitat within the Scaffel solar PV facility is still considered to provide important ecological functions in the area to a degree.

Potential Impacts & Business Case:

The UCVB 1 wetland traversing the central portion of the Scaffel solar PV facility is considered moderately modified and, in addition, of moderate ecological importance and sensitivity. The delineated extent of the wetland is considered a no-go area for any new infrastructure and a suitable buffer must be maintained around the wetland in line with the legislative requirements (Section 4.5.1). Considering that this wetland is located in the central portion of the study area, it is assumed that direct road crossings through this wetland may be required which will result in direct negative impacts to the ecological functioning of this wetland. It is highly recommended that only existing wetland road crossings be utilised to avoid the development of new wetland road crossings. Once the detailed Scaffel Cluster development layout becomes available, including the layout of all the internal road infrastructure, the DWS Risk Assessment and an impact assessment will be applied to determine the significance of the proposed development on the wetland, which will also guide the proposed development in terms of the required legislative requirements.

Table 7: Summary of the assessment of the unchannelled valley bottom wetland 2 within the Ilikwa solar PV facility associated with the proposed Scaffel Cluster development.

Ecological & socio-cultural service provision graph:

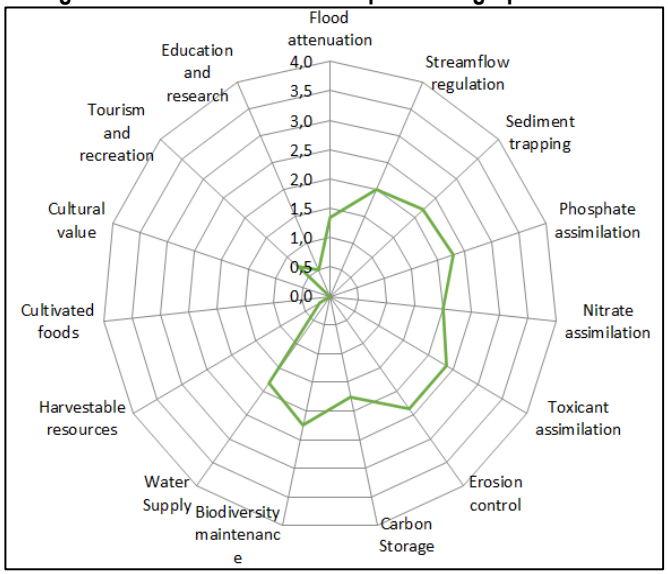

Figure 10: Representative photographs of the unchannelled valley bottom wetland located along the south westerly portion of the Ilikwa solar PV facility. Indicated on the photograph on the left is the impoundment within the valley bottom system which was found to be important habitat for *Pyxicephalus adspersus* (African bullfrog) species. Soil sample augured within the permanent zone of the wetland (right).

PES discussion	**PES Category: Largely natural** The reach of the UCVB 2 wetland assessed considered largely natural with few modifications during the assessment. Some impacts on the system identified include construction of an instream impoundment which has impacted on the natural distribution and retention of flows within the wetland. The sediment balance has also been slightly impacted by cattle trampling and trails which have resulted in the formation of areas preferred flow, however given the intact vegetation basal cover this has not resulted in significant soil erosion.	**Ecoservice provision**	**Ecoservices: High** The wetland ecological service provision is considered high. This is due to an area, particularly around the instream impoundment, was observed to provide diverse habitat suitable for waterfowl species. *Pyxicephalus adspersus* (African Bullfrog) species was also identified during the faunal assessment (STS, 2021) and this significantly increased the importance of this wetland for maintaining biodiversity. Other important ecological services provided by the wetland at a largely intermediate levels include toxicant assimilation, sediment trapping, phosphate assimilation and erosion control.
EIS discussion	**EIS Category: High** The ecological importance and sensitivity of the UCVB 2 wetland was assessed to be high due to its significance for maintaining biodiversity particularly for a rare and endangered species and its water quality enhancement (toxicant assimilation, sediment trapping, phosphate assimilation and erosion control).	**REC, RMO & BAS**	**REC Category: B** **BAS: B (Maintain)** **RMO: A/B (Maintain)** The recommended Management Objective for the UCVB 2 wetland based on the largely natural ecological integrity and its high ecological service provision is to maintain the current ecological class. As such, layout planning must ensure that the wetland is not encroached and that is not subject to any impacts from edge effects.

Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):
The hydraulic regime of the UCVB 2 wetland has remained largely natural, however, some alterations to the runoff pattern and timing of water within the landscape was deemed likely due to the presence of an informal road crossing within the lower reaches of the system and presence of an instream impoundment. The water quality was assessed at a single point on the impoundment and specific *in-situ* parameters measured included pH, temperature and EC. According to the in-situ findings, the dissolved salts were measured to be 13.9 mS/m which is within the ideal natural range limit DWAF (1996). The pH measured to be 6.61 at 22.5 ˚C and these parameters are considered to be of acceptable water quality for aquatic ecosystems. As such, no impacts on the water quality were measured during the assessment. Natural sediment distribution and retention within the wetland has been likely impacted by instream impoundment. Sediments which would naturally flow towards the lower reaches of the wetland are likely deposited within the impoundment. Cattle trampling and tracks have also slightly impacted on the sediment balance within the wetland although this was not considered severe. The vegetation basal cover within the UCVB 2 wetland was a considered to be intact, limiting vulnerability of the system to soil erosion. The wetland was considered important since it provides breeding habitat for *Pyxicephalus adspersus* (African bullfrog) species which is considered threatened due to significant habitat transformation.
Potential Impacts & Business Case:
The UCVB 2 wetland located along the south westerly portion of the Ilikwa solar PV facility was assessed to be largely natural and of high ecological importance and sensitivity. Considering the small extent of this wetland located on the south western boundary of the Ilikwa solar PV facility, it is deemed essential that no infrastructure or internal roads as part of the proposed Scaffel Cluster development are located within this wetland. A suitable natural buffer around this wetland must also be maintained in line with the legislative processes, which will ensure that the RMO and REC are maintained.

Table 8: Summary of the assessment of the depression wetland within the Vlakfontein solar PV facility associated with the proposed Scaffel Cluster development.

Ecological & socio-cultural service provision graph:

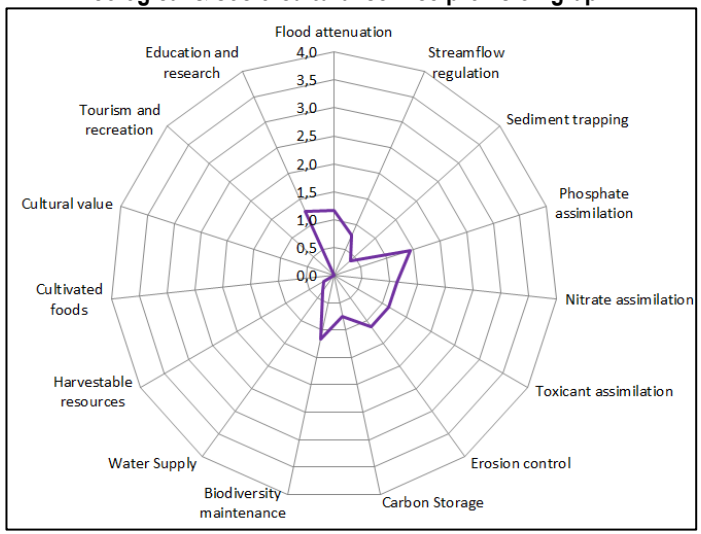

Figure 11: Representative photographs of the depression wetland located within the south-east boundary of the Vlakfontein solar PV facility. Due to recent rain received prior to the assessment, the wetland hosted standing surface water and is well vegetated.

PES discussion	**PES Category: Largely Modified** The depression wetland within the Vlakfontein solar PV facility is considered largely modified during the assessment. The catchment of the system is surrounded by crop cultivation activities (maize) which have infringed on the boundaries of the wetland and as such resulted in the alteration of the natural hydrological and geomorphological regime. The wetland is also surrounded by informal roads, the N1 highway and a Boundary Road which has resulted in fragmentation and further alteration of the ecological integrity of the wetland.	**Ecoservice provision**	**Ecoservices: Moderately Low** The ecological integrity of the depression was deemed to have a moderately low capacity to provide ecological services. The depression provides services including phosphate assimilation, toxicant assimilation, phosphate assimilation and biodiversity maintenance, to a lesser degree. Socio-cultural services such as tourism and recreation, harvestable resources and cultural value that scored low given that the freshwater system is within an access-controlled area.

EIS discussion	**EIS Category: Low/Marginal** The EIS of depression is considered 'Low/Marginal', largely due to the water quality enhancement importance (i.e. provisioning of services such as phosphate assimilation, erosion control and toxicant assimilation). In addition, it is also considered important on a local scale due to the cumulative loss of wetlands within the quaternary catchment.	**REC, RMO & BAS**	**REC Category: D** **BAS: D (Maintain)** **RMO: D (Maintain)** The recommended management objective (RMO) for the depression wetland based on the PES and EIS scores is to maintain the ecological category of Class D. The planned activities within the study area must be planned and managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that the RMO is achieved and avoid further degradation of the wetland to an ecologically unacceptable ecological state (PES Category E/F) despite the wetland being considered of low ecological importance.
Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):			
The primary alterations to the hydraulic regime of depression include alterations of the runoff patterns, timing and flow of water within the landscape as a result of the surrounding transformed cultivation activities the wetland catchment. Additional surface water inputs from runoff of surrounding hardened surfaces (N1 highway and Boundary Road) have increased recharge, altering the hydroperiod. Surface water present within the wetland was likely from the recent rainfall that had been received within the area and as such, the water quality was therefore not assessed during the assessment as this would not be representative. Under normal circumstances impact from surrounding catchment land uses on water quality such as increased hydrocarbons from roadways and potential impact from the stormwater was deemed likely. While some impact to the sediment balance within the wetland may have occurred historically given the surrounding activities, this is considered limited due to the well vegetated (largely dominated by *Setaria sp.*) nature of the depression and the gentle gradient of the surrounding landscape.		
Potential Impacts & Business Case:			
It is recommended that the ecological integrity of the depression be maintained in order to sustainably manage and ensure the ongoing functionality and ecological health of the wetland and ensure no further degradation and to improve management of the pattern, flow and timing of water in the greater landscape, especially since PES categories E/F (severely modified) are considered ecologically unacceptable. Given the limited sensitivity of the system, it is considered likely that avoiding direct impacts on the wetland and its respective 32 m NEMA Zone of Regulation will limit impacts which would result in the continued loss of ecological functioning of the wetland and limit loss of runoff which is potentially the major driver of the freshwater system.		

4.5 Sensitivity Mapping

4.5.1 Legislative requirements, national and provincial guidelines pertaining to the application of buffer zones

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone. However, in summary, it is considered to be "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted, however, that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

The definition and motivation for a regulated zone of activity for the protection of the watercourses can be summarised as follows:

Table 9: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998).	**General Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998)** In accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21c and 21i is defined as: • 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; • in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation, as well as General Notice no. 509 of 2016 as it relates to the NWA.
Listed activities in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) EIA Regulations (2014), as amended must be taken into consideration if any activities (for example, access roads) are to take place within the	**Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act 107 of 1998) EIA regulations, 2014 (as amended) states that: *The development of:* *(xii) Infrastructure or structures with a physical footprint of 100 square meters or more;*

Regulatory authorisation required	Zone of applicability
applicable zone of regulation. This must be determined by the EAP in consultation with the relevant authorities.	*Where such development occurs—* *a) Within a watercourse;* *b) In front of a development setback; or* *c) If no development setback has been adopted, within **32 meters of a watercourse**, measured from the edge of a watercourse.*

The delineated UCVB 1, UCVB 2 and depression wetlands are depicted in Figure 12 below. In addition, the applicable Zones of Regulation (ZoR) in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), and GN509 of 2016 as they relate to the National Water Act, 1998 (Act No. 36 of 1998) are conceptually depicted in Figure 12. These zones of regulation must be taken into consideration during the layout planning phase of the proposed Scaffel Cluster development, in line with the mitigation hierarchy as advocated by the Department of Environmental Affairs (DEA) *et. al*, 2013. The relevant authorisations will need to be obtained prior to the commencement of any activities within the regulated areas shown.

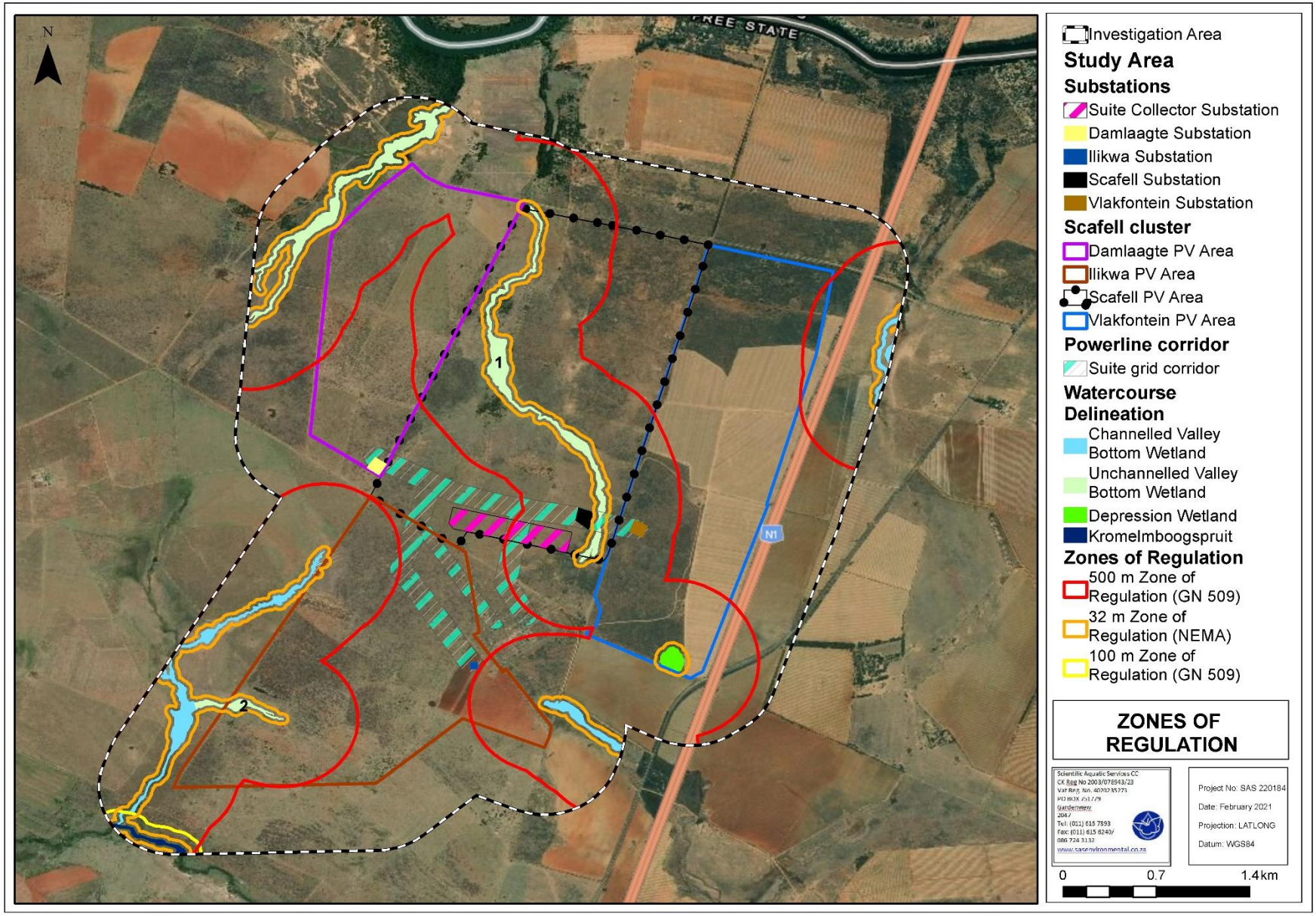

Figure 12: Conceptual presentation of the zones of regulation in terms of NEMA and GN509 of 2016 as it relates to the NWA in relation to the delineated wetlands.

5 IMPACT ASSESSMENT

5.1 Impact Method

The identification and assessment of environmental impacts is a multi-faceted process, using a combination of quantitative and qualitative descriptions and evaluations. It involves applying scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The process involves consideration of, inter alia: the purpose and need for the project; views and concerns of interested and affected parties (I&APs); social and political norms, and general public interest. The impact determination according to the SLR methodology involves two (2) process:

- Identification and the description of impacts; and
- Evaluation of Impacts and Mitigation measures.

Identification and description of impacts: Identified impacts are described in terms of the nature of the impact, compliance with legislation and accepted standards, receptor sensitivity and the significance of the predicted environmental change (before and after mitigation). Mitigation measures may be existing measures or additional measures that were identified through the impact assessment and associated specialist input. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation.

Evaluation of Impacts and Mitigation measures: The assessment of impacts is based on determining the following aspect: impact intensity, duration, extent, consequence, and the impact probability.

5.2 Impact Assessment

An impact discussion and assessment of all potential i) Planning Phase (Pre-construction and Planning), ii) Construction, and iii) Operational & Maintenance Phase impacts associated with the **Damlaagte Solar PV Facility** are provided below the impact assessment table. All mitigatory measures required to minimise the perceived impacts are also discussed.

Proposed Activity Description:

The proposed infrastructure development will entail the development of the following infrastructure:

- Damlaagte PV Facility; and
- Grid Corridor connections.

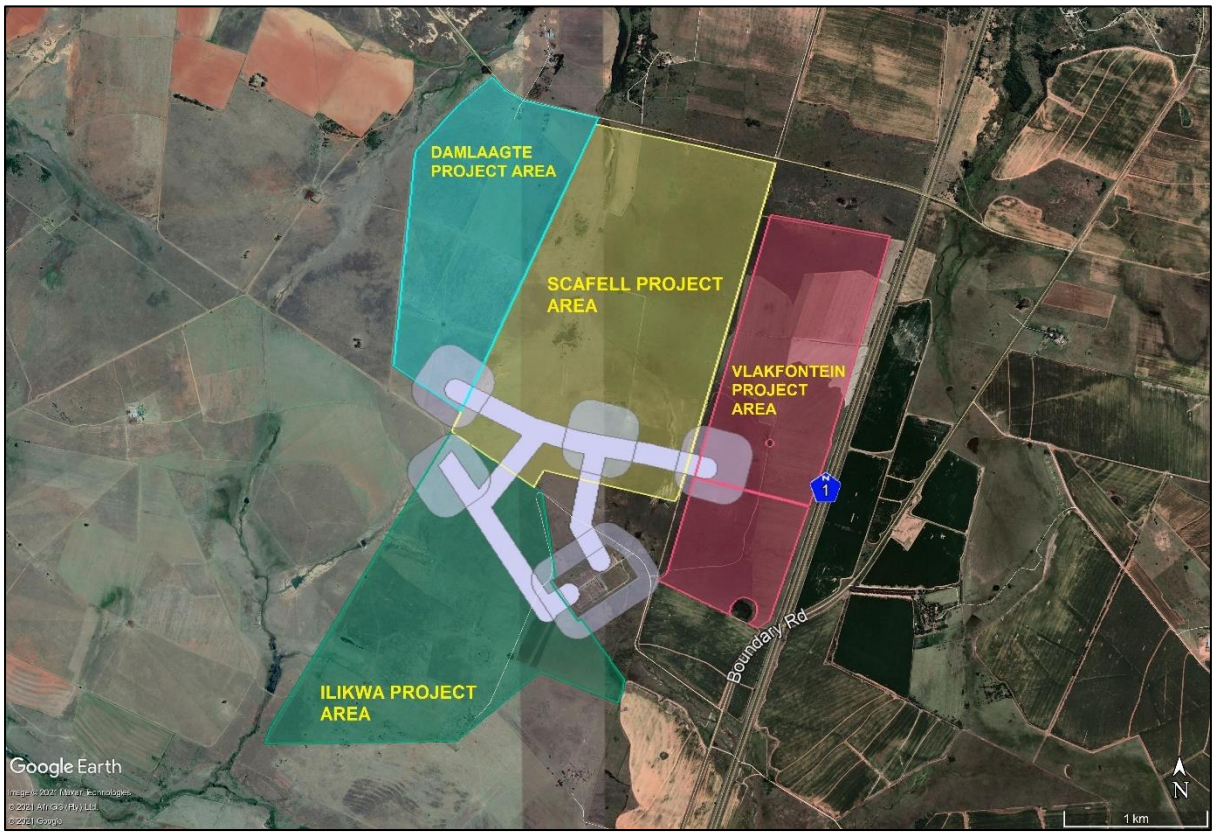

Figure 13: Updated development layout map for the study area on which the impact assessment is based.

The impact assessment was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat, and biota) of the delineated freshwater ecosystems which may be potentially impacted by the proposed PV development within the Damlaagte site. The points below summarise the considerations made when applying the impact assessment:

- Based on the baseline assessment findings (Section 4.4), no freshwater ecosystems were identified within the Damlaagte site and according to Figure 13, no freshwater ecosystems will be traversed by the proposed PV facility and grid connection infrastructure;
- An unchannelled valley bottom is located approximately 50 m downgradient of the Damlaagte PV site.

The tables below indicate the perceived risks to unchannelled valley bottom wetland located downgradient of the Damlaagte PV site.

IMPACT 1: MODIFICATION OF WETLAND HYDROLOGICAL FUNCTION

Table 10: Activities register leading to impact on hydrology and water quality.

Planning	Construction	Operation and Maintenance
Planning of infrastructure within wetland and the potential for edge effects on surrounding wetlands.	Site preparation (vegetation clearing) prior to construction activities	Operation of the PV facility and associated PV infrastructure.
-	Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing) within the wetland.	Potential maintenance of the PV facility and associated PV infrastructure.
-	Construction of the proposed substations and associated support tower infrastructure.	-
-	Stockpiling of removed soil and vegetation within the wetlands.	-

Table 11: Aspects of modification of wetland hydrological function and water quality.

Construction	Operation and Maintenance
Potential smothering of wetland habitat from stockpiled sediment and vegetation and increased potential for AIP proliferation resulting in decreased habitat for biota.	Disturbance to soil and ongoing erosion as a result of periodic maintenance activities.
Loss of wetland hydrological connectivity due to groundwater clearing.	Altered water quality (if surface water is present) as a result of increased availability of pollutants.
-	Increased hardened surfaces within the wetland resulting in increased sediment and flow delivery to within the system.

IMPACT 2: CHANGES TO THE WETLAND GEOMORPHOLOGICAL PROCESSES (SEDIMENT BALANCE, EROSION AND SEDIMENTATION)

Table 12: Activities register leading to changes to the wetlands geomorphological processes and sedimentation.

Planning	Construction	Operation and Maintenance
Planning of infrastructure within wetland and the potential for edge effects on surrounding wetlands.	Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing) within the wetland.	Operation of the PV facility and associated PV infrastructure.
-	Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
-	Earth works involving removal of topsoil and creation of soil stockpiles	Ineffective small-scale rehabilitation which may lead to disturbed landscapes vulnerable to erosion.
-	Altered runoff patterns, leading to increased erosion and sedimentation of the episodic drainage line.	-

Table 13: Aspects of changes to the wetland geomorphological processes.

Construction	Operation and Maintenance
Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.	Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Increased sediment loads reporting to wetlands and rivers from disturbed areas.	Increased soil erosion as a result of desiccated wetland.

IMPACT 3: LOSS OF WETLAND HABITAT AND ECOLOGICAL INTEGRITY

Table 14: Activities register leading to the loss of wetland habitat.

Planning	Construction	Operation and Maintenance
Potential smothering of wetland habitat from stockpiled sediment and vegetation and increased potential for AIP proliferation resulting in decreased habitat for biota.	Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing) within the wetland.	Operation of the PV facility and associated PV infrastructure.
Site clearing and the removal of vegetation leading to increased runoff and erosion.	Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
Movement of construction vehicles adjacent to wetland areas and the potential indiscriminate movement of construction vehicles within wetland.	Earth works involving removal of topsoil and creation of soil stockpiles	Ineffective small-scale rehabilitation which may lead to disturbed landscapes vulnerable to erosion.
-	Altered runoff patterns, leading to increased erosion and sedimentation of the episodic drainage line.	-

Table 15: Aspects of the loss of wetland habitat.

Construction	Operation and Maintenance
Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.	Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Increased sediment loads reporting to wetlands and rivers from disturbed areas.	Increased soil erosion as a result of desiccated wetland.

IMPACT 4: IMPACT ON WETLAND BIOTA

Table 16: Activities register leading to the loss of wetland biota.

Planning	Construction	Operation and Maintenance
Potential smothering of wetland habitat from stockpiled sediment and vegetation and increased potential for AIP proliferation resulting in decreased habitat for biota.	Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing) within the wetland.	Operation of the PV facility and associated PV infrastructure.
Site clearing and the removal of vegetation leading to increased runoff and erosion.	Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
Movement of construction vehicles adjacent to wetland areas and the potential indiscriminate movement of construction vehicles within wetland.	Earth works involving removal of topsoil and creation of soil stockpiles	Ineffective small-scale rehabilitation which may lead to disturbed landscapes vulnerable to erosion.

Table 17: Aspects of the loss of wetland habitat.

Construction	Operation and Maintenance
Loss of indigenous and sensitive wetland vegetation.	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment.
Potential loss of recharge affecting wetland vegetation with a specific requirement of wetland recharge	Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Earthworks in the vicinity of wetland and riparian areas leading to disturbance of wetland habitat.	Increased soil erosion as a result of desiccated wetland.

5.3 Cumulative Impacts

Cumulative impacts are activities and their associated impacts on the past, present and foreseeable future. The cumulative impacts of this project is considered to be of low significance on the freshwater environment since the proposed development does not encroach within any freshwater ecosystem and as such direct impacts will be avoided. Additional cumulative impacts include potential edge effects, increased hardened surfaces in the vicinity of the identified wetland which may potentially change the volume and velocity of runoff that enters the system during rainfall events. Therefore, it is recommended that any stormwater generated within the proposed Damlaagte PV facility and associated infrastructure must be suitably managed according to a site-specific stormwater management plan. Any water to be released into the receiving environment from any associated infrastructure must be released in a suitably diffuse manner.

Table 18: Impact significance on the UCVB wetland located downgradient of the Damlaagte proposed development site.

Ecological Drivers and Receptors	UNMANAGED						MANAGED					
	Intensity	Duration	Extent	Consequence	Probability	Significance	Intensity	Duration	Extent	Consequence	Probability	Significance
PRE-CONSTRUCTION PHASE												
Modification of wetland hydrological function												
PV Facility	M	M	L	L	DE	**Low**	L	S	L	VR	PR	**Very Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Changes to wetland geomorphological processes												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Loss of wetland habitat and ecological integrity												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Impact on wetland biota												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
CONSTRUCTION PHASE												
Modification of wetland hydrological function												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Changes to wetland geomorphological processes												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**

Loss of wetland habitat and ecological integrity												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Impact on wetland biota												
PV Facility	M	M	L	L	DE	**Low**	L	L	L	L	PR	**Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
OPERATIONAL AND MAINTENANCE PHASE												
Modification of wetland hydrological function												
PV Facility	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Changes to wetland geomorphological processes												
PV Facility	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Loss of wetland habitat and ecological integrity												
PV Facility	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Impact on wetland biota												
PV Facility	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**
Grid Connection	L	S	L	VR	DE	**Very Low**	L	S	L	VR	PR	**Very Low**

***Intensity: L – Low; M – Medium; H – High | Duration: S – short term; M – Mid-term; L – Long term; P – Permanent | Extent : L – Local ; R – Regional ; N – National ; IN – International | Probability : DE: Definite ; PR – Probable ; PO – Possible ; IM – Improbable.**

5.4 Integrated Impact Assessment

Based on the findings of the freshwater ecosystem assessment and impact assessment, several recommendations are made to minimise the impact on the surrounding receiving freshwater environment, particularly the UCVB wetland located approximately 50 m downgradient of the Damlaagte site delineated wetland ecology of the area, should the proposed Damlaagte PV project proceed:

- It is imperative that all construction works near the delineated wetland be undertaken during the dry, winter months when surface flow is very low within the freshwater ecosystem to avoid runoff of sediment to downgradient freshwater ecosystems;
- It should be feasible to utilise existing roads to gain access to the construction area. This will limit edge effects, erosion and sedimentation of the delineated surrounding wetlands during the construction phase;
- All footprint areas must remain as small as possible and vegetation clearing to be limited to what is absolutely essential to ensure as much indigenous vegetation is retained;
- All stockpiles may not be higher than 2 m. Stockpiling of removed materials may only be temporary (may only be stockpiled during the period of construction) and should be disposed of at a registered waste disposal facility;
- All exposed soil, including stockpiles, must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent excessive dust generation, erosion and sedimentation of the receiving freshwater environment;
- All excavated areas must be compacted to natural soil compaction levels to prevent the formation of preferential surface flow paths and subsequent erosion. Conversely, areas compacted as a result of construction activities must be loosened to natural soil compaction levels under the guidance of the ECO; and
- Any remaining soil following the completion of backfilling of the pits are to be spread out thinly surrounding the installed pylon (outside the identified features) to aid in the natural reclamation process;
- During operation of the facility, regular inspection of the area surrounding the surface infrastructure (proposed PV facility and grid connection) should occur to monitor the establishment of vegetation, prevent the establishment of alien and invasive vegetation species, and their potential spread into the surrounding freshwater ecosystem;
- Should alien and invasive plant species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation; and

- No water may be directly released from the proposed PV facility and other surface infrastructures into the receiving freshwater environment. A stormwater management plan for the proposed PV facility be consulted in this regard.

6 CONCLUSION

SAS was appointed to conduct a freshwater ecosystem assessment as part of the environmental processes for the Scaffel Cluster development, consisting of four (4) solar PV facilities.

During the assessment, within the Damlaagte solar PV facility, no freshwater ecosystems were identified. Within the Scaffel solar PV facility, a single unchannelled valley bottom (UCVB 1) wetland was identified traversing the central portion of the area. At the Vlakfontein solar PV facility, a single depression wetland was identified along the south eastern boundary immediately adjacent to the N1 highway and within the Ilikwa solar PV facility, an unchannelled valley bottom (UCVB 2) was also identified and this forms part of a larger channelled valley bottom wetland system located within the investigation area.

The results of the ecological assessment is summarised in the table below.

Table 19: Summary of the results of the field assessment.

Wetland	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category / Recommended Management Objective / Best Attainable State
UCVB 1 Wetland	C (Moderately Modified)	Intermediate	Intermediate	C / Maintain / C
UCVB 2 Wetland	B (Largely Natural)	Moderately High	High	B / Improve / B
Depression Wetland	D (Largely Modified)	Intermediate	Low / Marginal	D / Maintain / D

In consideration of the ecological assessment findings, the potential impacts to the assessed freshwater ecosystems, the following statements were compiled to guide the proponent in terms of the development constraints and important ecological considerations from a freshwater ecosystem management and legislative point of view in light of the proposed Scaffel Cluster development. The statements were compiled to address these for each specific assessment site:

Vlakfontein solar PV facility

During the site assessment, the Vlakfontein solar PV facility was assessed to be disturbed due to historical and current activities within the farm. The area was largely dominated by cultivated species for hale bales and as such considered of low sensitivity from a freshwater

ecological perspective. Within south eastern boundary of the site, a depression wetland was identified, although the wetland was considered of very high sensitivity according to the DEA screening tool, the wetland ecological importance and sensitivity was determined to be of low ecological importance and sensitivity based on the ground truthed results. Any proposed development within the Vlakfontein solar PV facility must avoid the encroaching within this wetland and its applicable 32m NEMA ZoR. In addition, edge effects must be avoided during all phases of the proposed Scaffel Cluster development.

Damlaagte solar PV facility

According to the DEA screening tool, the Damlaagte solar PV facility was considered of very low sensitivity, this was also confirmed during the field assessment. From a freshwater ecosystem management point of view, any proposed activities within the Damlaagte solar PV facility can be considered. An unchannelled valley bottom wetland was identified approximately 49 m from the western boundary of the Damlaagte solar PV facility, as such, edge effects from any proposed activities must be managed to maintain the ecological integrity and functionality of the wetland.

Scaffel solar PV facility

A large unchannelled valley bottom wetland delineated within the central portion of the Scaffel solar PV facility. This system bisects the Scaffel solar PV facility thus forming a significant development constraint. The wetland was considered important not only from a hydro-functional point of view (toxicant assimilation, erosion control and phosphate assimilation) but also an important movement corridor and habitat for the existing faunal assemblage and particularly avifaunal species considered to be of importance for species conservation (STS, 2021). Any proposed activities within the site are considered likely to impact on the ecological integrity of the UCVB 1 wetland, since the wetland would likely need to be crossed at various points during the construction activities and operational activities for maintenance of the solar PV facility purposes. This will likely result in the decreased ecological integrity of the wetland as a minimum the extent of the wetland and the associated 32 m NEMA ZoR should not be developed.

Ilikwa solar PV facility

Overall, the larger portion of the Ilikwa solar PV facility was considered modified as a result of current and historic cultivation and grazing by cattle. However, the UCVB 2 wetland located along the south west boundary of the Ilikwa solar PV facility was considered largely natural and is considered to be of high ecological importance and sensitivity. As such, any proposed activities within this study must avoid directly encroaching within this wetland or the 32 m

NEMA ZoR associated with the wetland. In addition, edge effects must be avoided during all phases of the proposed activities associated with the Scaffel Cluster development. As such, planning of the layout for Ilikwa solar PV facility must consider this downgradient wetland and edge effect impact be avoided.

The SLR Impact Assessment Matrix was applied to identify potential impacts that may affect the any freshwater ecosystems in the vicinity of the proposed Scaffel Cluster development, specifically the proposed Damlaagte PV facility and the associated grid connection infrastructure. According to the findings, the proposed PV development within Damlaagte will have an impact (very low to low impact significance) on the delineated UCVB located downgradient the Damlaagte PV site if edge effects during the construction activities are not managed accordingly.

It is the opinion of the specialist that if mitigation measures to manage runoff to downgradient freshwater ecosystems are put in place and it is ensure that the footprint of the proposed activities remains within the boundaries of the Damlaagte site, the proposed PV facility and grid connection infrastructure within Damlaagte can be considered.

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APPENDIX A – Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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APPENDIX B – Legislation

LEGISLATIVE REQUIREMENTS

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act (NEMA) (Act No. 107 of 1998)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
The National Water Act (NWA) (Act No. 36 of 1998)	The National Water Act (NWA) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
National Environmental Management: Biodiversity Act (2004) (Act 10 of 2004) (NEMBA)	**Ecosystems that are threatened or in need of protection** (1) (a) The Minister may, by notice in the Gazette, publish a national list of ecosystems that are threatened and in need of protection. *(b)* An MEC for environmental affairs in a province may, by notice in *the Gazette,* publish a provincial list of ecosystems in the province that are threatened and in need of protection. (2) The following categories of ecosystems may be listed in terms of subsection (1): *(a)* critically endangered ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation; *(b)* endangered ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems; (c) vulnerable ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and *(d)* protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed in terms of paragraphs *(a), (b)* or (c).
Government Notice 598 Alien and Invasive Species Regulations (2014), including the Government Notice 864 Alien Invasive Species List as published in the Government Gazette 40166 of 2016, as it relates to the National	NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. This act in terms of alien and invasive species aims to: ➢ Prevent the unauthorized introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur, ➢ Manage and control alien and invasive species, to prevent or minimize harm to the environment and biodiversity; and ➢ Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Environmental Management Biodiversity Act, 2004 (Act No 10 of 2004)	Alien species are defined, in terms of the NEMBA as: (a) A species that is not an indigenous species; or (b) An indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention. Categories according to NEMBA (Alien and Invasive Species Regulations, 2017): ➢ **Category 1a:** Invasive species that require compulsory control; ➢ **Category 1b:** Invasive species that require control by means of an invasive species management programme; ➢ **Category 2:** Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread; and ➢ **Category 3:** Ornamentally used plants that may no longer be planted.
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: 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 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
National Environmental Management: Waste Act, No 59 of 2008 (NEMWA)	NEMWA, which reforms the law regulating waste management in order to protect the health and the environment by providing reasonable measures for the prevention of pollution; provides for national norms and standards for regulating the management of waste by all spheres of government, and provides for the licensing and control of waste management activities.

APPENDIX C – Method of Assessment

WATERCOURSE METHOD OF ASSESSMENT

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the watercourses present or in close proximity of the study area are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA, 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of or within the study area.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa

The watercourses encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013), hereafter referred to as the "Classification System". A summary of Levels 1 to 4 of the classification system are presented in Table C1 and C2, below.

Table C1: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Unit for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[3] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

[3] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the National Freshwater Ecosystem Priority Areas (NFEPA) project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting

At Level 3 of the Classification System, for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table C2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa.

Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

3. WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

Level of Evaluation
Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment
A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment
Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

Quantification of Present State of a wetland
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 State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores, and Present State categories are provided in the table below.

Table C3: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	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	B
Moderate	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	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6-7.9	E

Impact category	Description	Impact score range	Present State category
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

Assessing the Anticipated Trajectory of Change
As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (table below).

Table C4: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland
Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

4. Watercourse Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[4] The assessment of the ecosystem services supplied by the identified watercourses was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the watercourses. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the watercourses.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

5. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purposed of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C6) of the wetland system being assessed.

Table C6: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate	>1 and <=2	C

EIS Category	Range of Mean	Recommended Ecological Management Class
Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.		
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

6. Recommended Management Objective (RMO) and Recommended Ecological Category (REC) Determination

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the watercourse (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourse in order to ensure continued ecological functionality.

Table C7: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unacceptable (Malan and Day, 2012) and therefore, should a watercourse fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A watercourse may receive the same class for the REC as the PES if the watercourse is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the watercourse.

Table C8: Description of Recommended Ecological Category (REC) classes.

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

7. Watercourse delineation

The watercourse delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" published by DWAF in 2008. The

foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

APPENDIX D – Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES) AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the WET-Health assessment applied to the UCVB 1, UCVB 2 and depression wetlands.

Wetland	Hydrology		Geomorphology		Vegetation		Overall Score	Overall PES Category
	Impact Score & (PES Category)	Trajectory of Change	Impact Score & (PES Category)	Trajectory of Change	Impact Score & (PES Category)	Trajectory of Change		
Unchannelled Valley Bottom Wetland 1	3.5	-1.0	1.4	-1.0	6.8	-1.0	3.9	C (Moderately Modified)
Unchannelled Valley Bottom Wetland 2	1.0	-1.0	0.5	-1.0	3.2	-1.0	1.6	B (Largely Natural)
Depression Wetland	6.0	-1.0	4.6	-1.0	4.6	-1.0	4.0	D (Largely Modified)

Table E2: Presentation of the results of the Ecoservices assessment applied to the UCVB 1, UCVB 2 and depression wetlands.

Ecosystem service	Unchannelled Valley Bottom Wetland 1	Unchannelled Valley Bottom Wetland 2	Depression Wetland
Flood attenuation	1.7	1.3	1.2
Streamflow regulation	2.0	2.0	0.8
Sediment trapping	2.2	2.2	0.4
Phosphate assimilation	2.3	2.3	1.4
Nitrate assimilation	2.1	2.0	1.1
Toxicant assimilation	2.6	2.4	1.1
Erosion control	2.3	2.4	1.1
Carbon Storage	1.8	1.8	0.8
Biodiversity maintenance	1.9	2.3	1.2
Water Supply	1.8	1.8	0.3
Harvestable resources	0.2	0.2	0.2
Cultivated foods	0.0	0.0	0.0
Cultural value	0.0	0.0	0.0
Tourism and recreation	0.4	0.8	0.0
Education and research	0.5	0.5	1.3
SUM	**21.8**	**21.9**	**10,9**
Average score	**1.5**	**1.5**	**0,7**

Table E3: Presentation of the results of the EIS applied to the unchannelled valley bottom 1 wetland.

FRESHWATER FEATURE:			UCVB 1	Confidence (1-5)
Ecological Importance and Sensitivity			Score (0-4)	Score (0-4)
Biodiversity support			A (average)	A (average)
			1.33	3,00
Presence of Red Data species			1	3
Populations of unique species			1	3
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	B (average)
			1.20	3,00
Protection status of the wetland			1	3
Protection status of the vegetation type			0	3
Regional context of the ecological integrity			1	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	C (average)
			2.00	3,00
Sensitivity to changes in floods			2	3
Sensitivity to changes in low flows/dry season			2	3
Sensitivity to changes in water quality			2	3
ECOLOGICAL IMPORTANCE & SENSITIVITY			Max of (A, B or C)	Max of (A, B or C)
Fill in highest score			C	2.00
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.				
Hydro-Functional Importance			Score (0-4)	Score (0-4)
Regulating & supporting benefits	Flood attenuation		2	3
	Streamflow regulation		2	3
	Water Quality Enhanceme	*Sediment trapping*	2	3
		Phosphate assimilation	2	3
		Nitrate assimilation	1	3
		Toxicant assimilation	2	3
		Erosion control	1	3
	Carbon storage		0	3
HYDRO-FUNCTIONAL IMPORTANCE (average score)			2	3
Direct Human Benefits			Score (0-4)	Score (0-4)
Subsistence benefits	*Water for human use*		0	3
	Harvestable resources		1	3
	Cultivated foods		0	3
Cultural benefits	*Cultural heritage*		0	3
	Tourism and recreation		1	3
	Education and research		1	3
DIRECT HUMAN BENEFITS (average score)			0.50	3

Table E4: Presentation of the results of the EIS applied to the unchannelled valley bottom 2 wetland.

FRESHWATER FEATURE:			UCVB 2	Confidence (1-5)
Ecological Importance and Sensitivity			Score (0-4)	Score (0-4)
Biodiversity support			A (average)	A (average)
			3.00	3,00
Presence of Red Data species			4	3
Populations of unique species			2	3
Migration/breeding/feeding sites			3	3
Landscape scale			B (average)	B (average)
			1.20	3,00
Protection status of the wetland			1	3
Protection status of the vegetation type			0	3
Regional context of the ecological integrity			1	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	C (average)
			2.00	3,00
Sensitivity to changes in floods			2	3
Sensitivity to changes in low flows/dry season			2	3
Sensitivity to changes in water quality			2	3
ECOLOGICAL IMPORTANCE & SENSITIVITY			Max of (A, B or C)	Max of (A, B or C)
Fill in highest score			C	3.00
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.				
Hydro-Functional Importance			Score (0-4)	Score (0-4)
Regulating & supporting benefits	Flood attenuation		2	3
	Streamflow regulation		2	3
	Water Quality Enhancement	*Sediment trapping*	2	3
		Phosphate assimilation	2	3
		Nitrate assimilation	1	3
		Toxicant assimilation	2	3
		Erosion control	1	3
	Carbon storage		0	3
HYDRO-FUNCTIONAL IMPORTANCE (average score)			2	3
Direct Human Benefits			Score (0-4)	Score (0-4)
Subsistence benefits	*Water for human use*		0	3
	Harvestable resources		1	3
	Cultivated foods		0	3
Cultural benefits	*Cultural heritage*		0	3
	Tourism and recreation		1	3
	Education and research		1	3
DIRECT HUMAN BENEFITS (average score)			0.50	3

Table E5: Presentation of the results of the EIS applied to the depression wetland.

FRESHWATER FEATURE:			Depression	Confidence (1-5)
Ecological Importance and Sensitivity			Score (0-4)	Score (0-4)
Biodiversity support			A (average)	A (average)
			0.33	3,00
Presence of Red Data species			0	3
Populations of unique species			0	3
Migration/breeding/feeding sites			1	3
Landscape scale			B (average)	B (average)
			0.80	3,00
Protection status of the wetland			1	3
Protection status of the vegetation type			0	3
Regional context of the ecological integrity			1	3
Size and rarity of the wetland type/s present			1	3
Diversity of habitat types			1	3
Sensitivity of the wetland			C (average)	C (average)
			0.67	3,00
Sensitivity to changes in floods			0	3
Sensitivity to changes in low flows/dry season			1	3
Sensitivity to changes in water quality			1	3
ECOLOGICAL IMPORTANCE & SENSITIVITY			Max of (A, B or C)	Max of (A, B or C)
Fill in highest score			C	2.33
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.				
Hydro-Functional Importance			Score (0-4)	Score (0-4)
Regulating & supporting benefits	Flood attenuation		1	3
	Streamflow regulation		0	3
	Water Quality Enhanceme	*Sediment trapping*	1	3
		Phosphate assimilation	1	3
		Nitrate assimilation	0	3
		Toxicant assimilation	0	3
		Erosion control	0	3
	Carbon storage		1	3
HYDRO-FUNCTIONAL IMPORTANCE (average score)			0.63	3
Direct Human Benefits			Score (0-4)	Score (0-4)
Subsistence benefits	*Water for human use*		0	3
	Harvestable resources		0	3
	Cultivated foods		0	3
Cultural benefits	*Cultural heritage*		0	3
	Tourism and recreation		0	3
	Education and research		0	3
DIRECT HUMAN BENEFITS (average score)			0	3

APPENDIX E – Impact Assessment

○ E1: Introduction

Impacts are assessed using SLR's standard convention for assessing the significance of impacts, a summary of which is provided below. In assigning significance ratings to potential impacts before and after mitigation the approach presented below is to be followed.

1. **Determine the impact consequence rating:** This is a function of the "intensity", "duration" and "extent" of the impact (see Section E2). The consequence ratings for combinations of these three criteria are given in Section E3.
2. **Determine impact significance rating:** The significance of an impact is a function of the consequence of the impact occurring and the probability of occurrence (see Section E2). Significance is determined using the table in Section E4.
3. **Modify significance rating (if necessary):** Significance ratings are based on largely professional judgement and transparent defined criteria. In some instances, therefore, whilst the significance rating of potential impacts might be "low", the importance of these impacts to local communities or individuals might be extremely high. The importance/value which interested and affected parties attach to impacts will be highlighted, and recommendations should be made as to ways of avoiding or minimising these perceived negative impacts through project design, selection of appropriate alternatives and / or management.
4. **Determine degree of confidence of the significance assessment:** Once the significance of the impact has been determined, the degree of confidence in the assessment will be qualified (see Section E2). Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact.

○ E2: Criteria for Impact Assessment

The criteria for impact assessment are provided below.

Criteria	Rating	Description
Criteria for ranking of the INTENSITY (SEVERITY) of environmental impacts	**ZERO TO VERY LOW**	Negligible change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected. People / communities are able to adapt with relative ease and maintain pre-impact livelihoods.
	LOW	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable or there is no perceptible change to people's livelihood.
	MEDIUM	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way. People/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
	HIGH	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease. Affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.
Criteria for ranking the DURATION of impacts	**SHORT TERM**	< 5 years.
	MEDIUM TERM	5 to < 15 years.
	LONG TERM	> 15 years, but where the impact will eventually cease either because of natural processes or by human intervention.

Criteria	Rating	Description
	PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.
Criteria for ranking the EXTENT / SPATIAL SCALE of impacts	**LOCAL**	Impact is confined to project or study area or part thereof, e.g. limited to the area of interest and its immediate surroundings.
	REGIONAL	Impact is confined to the region, e.g. catchment, municipal region, etc.
	NATIONAL	Impact is confined to the country as a whole, e.g. South Africa, etc.
	INTERNATIONAL	Impact extends beyond the national scale.
Criteria for determining the PROBABILITY of impacts	**IMPROBABLE**	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
	POSSIBLE	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
	PROBABLE	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
	DEFINITE	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	**LOW**	≤ 35% sure of impact prediction.
	MEDIUM	> 35% and ≤ 70% sure of impact prediction.
	HIGH	> 70% sure of impact prediction.
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED - the degree to which an impact can be reduced / enhanced	**NONE**	No change in impact after mitigation.
	VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
	LOW	Where the significance rating drops by one level, after mitigation.
	MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
	HIGH	Where the significance rating drops by more than three levels, after mitigation.
Criteria for LOSS OF RESOURCES - the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable	**LOW**	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
	MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
	HIGH	Where the activity results in an irreplaceable loss of a resource.
Criteria for REVERSIBILITY - the degree to which an impact can be reversed	**IRREVERSIBLE**	Where the impact is permanent.
	PARTIALLY REVERSIBLE	Where the impact can be partially reversed.
	FULLY REVERSIBLE	Where the impact can be completely reversed.

- **E3: Determining Consequence**

Consequence attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity. The ratings and description for determining consequence are provided below.

Rating	Description *
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER:

Rating	Description *
	of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.*** OR **Zero to very low intensity** with any combination of extent and duration.

* Note: For any impact that is considered to be “Permanent” or “International” apply the “Long-Term” and “National” ratings, respectively.

- **E4: Determining Significance**

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	**POSSIBLE**	**PROBABLE**	**DEFINITE**
CONSEQUENCE	**VERY LOW**	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	LOW	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	MEDIUM	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	HIGH	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**
	VERY HIGH	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

In certain cases it may not be possible to determine the significance of an impact. In these instances the significance is **UNKNOWN**.

APPENDIX F – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Nqobile Lushozi	MSc (Geoinformatics) (Stellenbosch University)

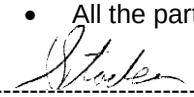
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Natural Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health Practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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 particulars furnished by me in this form are true and correct



Signature of the Specialist

I, Christel du Preez, declare that -

- I act as the 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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 particulars furnished by me in this form are true and correct

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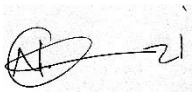
Signature of the Specialist

I, Nqobile Lushozi, declare that -

- I act as the 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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 particulars furnished by me in this form are true and correct



Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Senior Scientist Watercourse ecology
Joined SAS Environmental Group of Companies	2016

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional member of the South African Council for Natural Scientific Professions (SACNASP – Reg No. 120240)
Member of the Western Cape Wetland Forum (WCF)
Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2017
BSc Hons Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

Short Courses

Wetland and Aquatic plant Identification presented by Carin van Ginkel	2019
Wetland Management: Introduction and Delineation presented by the Centre of Environmental Management University of the Free State	2018
Tools for Wetland Assessment presented by Prof. F. Ellery and Rhodes University	2017
Basic Principles of ecological rehabilitation and mine closure presented by the Centre for Environmental Management North West University	2015

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Limpopo, Western Cape, Northern Cape, Eastern Cape

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF NQOBILE LUSHOZI

PERSONAL DETAILS

Position in Company	Junior Field Ecologist Wetland and Aquatic Ecology
Joined SAS Environmental Group of Companies	2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the International Affiliation for Impact Assessments (IAIAsa) South Africa

EDUCATION

Qualifications

MSc Geoinformatics (Cum laude) (Stellenbosch University)	2019
BSc (Hons) Environmental Sciences (University of KwaZulu-Natal)	2015
BSc Environmental Sciences (University of KwaZulu-Natal)	2014

Short Courses

Grass Identification Course (African Land Use Training)	2021
Tools for Wetland Assessments (Rhodes University)	2020

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Northern Cape, Free State

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans

Aquatic Ecological Assessment and Water Quality Studies

- Toxicological Analysis
- Surface and groundwater quality Monitoring
- Screening Test
- Mass and salt balance determination