SCIENTIFIC AQUATIC SERVICES

Reg No. 2003/078943/23
VAT Reg No. 4020235273
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
Email: admin@sasenvgroup.co.za
www.sasenvironmental.co.za

FRESHWATER ECOSYSTEM ASSESSMENT AS PART OF THE ENVIRONMENTAL AUTHORISATION (EA) AND WATER USE AUTHORISATION (WUA) PROCESSES FOR THE PROPOSED HALFGEWONNEN SOLAR PV FACILITY FOR DREAMWORKS HAVEN INVESTMENTS (PTY) LTD. IN MPUMALANGA PROVINCE.

Prepared for

CABANGA environmental

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Prepared by: Scientific Aquatic Services
Report author: S. Pillay
Report reviewers: S. van Staden (Pr. Sci. Nat)
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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Halfgewonnen Solar PV Facility project for Dreamworks Haven Investments (Pty) Ltd in Mpumalanga province, South Africa. The proposed development will generate approximately 80 Mega Watts (MW) of power for distribution into the National Grid, specifically for the benefit of mining and farming communities located closer to the proposed development. A high-voltage line (± 6.2 km) will connect the project main substation to the Ysterkop substation to feed into the national electrical supply grid.

A freshwater ecosystem assessment was undertaken on the 1st to the 3rd of February 2021. Eight wetlands were identified during the assessment which may be affected by the proposed development, specifically one Unchannelled valley bottom wetland (UCVB wetland 1), three pan wetlands (pans 1, 2 and 3), two Channelled valley bottom wetlands (CVB wetlands 1 and 2) and two seep wetlands (seep wetlands 1 and 2). In the initial stages of the project, the proposed Halfgewonnen Solar Photovoltaic (PV) Project was planned with a large portion of the footprint of the PV array in the wetland systems. Once this became evident, the project layout was revisited to reduce the risk to the receiving environment – based on recommendations from Scientific Terrestrial Services CC (STS) and Scientific Aquatic Services CC (SAS). Areas outside and adjacent to the study area that were highlighted as "Low Sensitivity" for the Plant Species Theme by the National Web Based Environmental Screening Tool were investigated as alternatives but were deemed unsuitable due to the various technical reasons highlighted further within the contents of this report. The results of the field assessment are summarised in the table below:

Table A: Summary of results of the field assessment as discussed in Section 4.

Freshwater ecosystem	PES	Ecoservices	EIS	REC / RMO / BAS
UCVB wetland 1	C	Intermediate	High	C/Maintain/C
Pan 1	B	Intermediate	Moderate	B/Maintain/B
Pan 2	C	Intermediate	Moderate	C/Maintain/C
Pan 3	C	Intermediate	Moderate	C/Maintain/C
CVB wetland 1	D	Moderately high	High	D/Maintain/D
CVB wetland 2	C	Intermediate	High	D/Maintain/D
Seep wetlands 1	C	Moderately low	Low	C/Maintain/C
Seep wetlands 2	D	Moderately low	Low	D/Maintain/D

Following the freshwater ecosystem assessment, the DWS Risk assessment Matrix (2016) was applied to determine the significance of impacts of the proposed development on the receiving freshwater environment. Whilst the proposed development was mostly optimised and moved outside of the delineated wetlands (with the exception of seep wetland 2 which is low ecological importance and sensitivity and limited in extent and level of integrity) in order to avoid impacts to the freshwater ecosystems, some indirect impacts relating to construction and operational phase activities was still considered likely to affect these wetlands and therefore, these impacts were assessed further. The risk significance posed to the directly affected (seep wetland 2) and indirectly affected (UCVB wetland 1, CVB wetlands 1 and 2, pans 1, 2 and 3 and seep wetland 1) is considered of "moderate" significance respectively, provided that the application of strict mitigation measures are adhered to, in line with the requirements of the mitigation hierarchy (DEA *et a*l., 2013). Key mitigation measures include ensuring that the delineated boundaries of the wetlands (UCVB wetland 1, pans 1, 2 and 3, CVB wetland 1 and 2 and seep wetlands 1 and 2 and 10 m construction and operational phase buffer zones must be demarcated as "no-go areas" from the proposed development as this will greatly reduce the significance of impacts which may occur. The freshwater ecosystems must also be cordoned off using a suitable barrier or geotextile material in order to control sedimentation and erosion control.

It is also advised that should encroachment within the freshwater ecosystems occur as a result of the proposed development, a suitable wetland rehabilitation plan is recommended, in order to minimise impacts and ensure that no net loss of biodiversity occurs as a result of the proposed development. It must be ensured that sufficient budget and management/supervisory support are catered for this as part of the proposed development.

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
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Appendix G
2.2	Description of the preferred development site, including the following aspects-	Section 1
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 4.3
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 3.1
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 3.1 and 3.2
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 4.3
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	Section 6 and 7
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 6
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 4.3 and Section 6
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 4.3
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 regimes (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.). d. Assessment of the risks associated with water use/s and related activities.	Section 4.3
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 4.3

	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 unchannelled 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); and e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).	
2.4.5	How will the development impact on the functionality of the aquatic feature including: a. 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) b. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland). c. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); d. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); e. The loss or degradation of all or part of any unique or important features (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soil, etc.) associated with or within the aquatic ecosystem.	Section 4.3
2.4.6	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 4.3
2.4.7	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 4.3
2.4.9	A motivation must be provided if there were development footprints identified as per paragraph 2.3 above that were identified as having a “low” biodiversity sensitivity and were not considered appropriate.	Section 7
3.	The report must contain as a minimum the following information:	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae;	Appendix A and H
3.2	A signed statement of independence by the specialist;	Appendix A
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 1 and 4.3
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Appendix C
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 6 and 7
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts;	Section 6
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 5
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 6
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being considered; and	Section 7
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Section 7

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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, animals 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".
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 soil).
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:	Soil 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 according to the International Union for Conservation of Nature (IUCN) Classification.
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 50 cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50 cm 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 soil, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

BAS	Best Attainable State
BGIS	Biodiversity Geographic Information Systems
CSIR	Council of Scientific and Industrial Research
CVB	Channelled Valley Bottom
UCVB	Unchannelled Valley Bottom
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EPL	Ecosystem Protection Level
ES	Ecological Sensitivity
ESA	Ecological Support Area
ETS	Ecosystem Threat Status
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
GA	General Authorisation
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IAIA	International Association of Impact Assessors
IUCN	International Union for Conservation of Nature
IWUL	Integrated Water Use License
mm	Millimetre
m.a.m.s.l	Metres above mean sea level
MAP	Mean Annual Precipitation
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
RHP	River Health Program
RMO	Resource Management Objective
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SAIAB	South Africa Institute of Aquatic Biodiversity
SAIIAE	South Africa Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SASSO	South African Soil Surveyors Association
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
WUA	Water Use Authorisation

1 INTRODUCTION

1.1 *Background*

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Halfgewonnen Solar PV Facility project for Dreamworks Haven Investments (Pty) Ltd in Mpumalanga province, South Africa. The proposed Halfgewonnen Solar PV Facility project will hereafter be referred to as the proposed development.

The site visit for the freshwater ecosystem assessment was undertaken from the 1st to the 3rd of February 2021 with some small areas briefly visited following the provision of the final proposed layout. Fieldwork was undertaken to obtain accurate ground-truthed results so as to guide the proposed development in relation to any potential freshwater ecosystems that may be affected directly or indirectly by the activities undertaken as part of the proposed development. To identify all possible freshwater ecosystems that may potentially be impacted, a 500 m "zone of investigation" around the footprint of the proposed development, in accordance with General Notice 509 (GN 509) of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA), was used as a guide to assess possible sensitivities of the receiving environment. This area – i.e. the 500 m zone of investigation around the footprint of the proposed development - will henceforth be referred to as the "investigation area".

1.1.1 Project description

The applicant (Dreamworks Haven Investments Pty Ltd) proposes to develop the Halfgewonnen Solar Photovoltaic (PV) Facilities (proposed development) which will generate approximately 80 Mega Watts (MW) of power for distribution into the National Grid, specifically for the benefit of mining and farming communities located closer the proposed development.

The proposed development comprises of two components:

1. Solar PV 1 will generate approximately 20 MW and will address the electricity requirements for the immediately surrounding and adjacent mines. Construction is expected to take approximately 10 months. The total proposed development footprint is approximately 34 hectares (Ha).
2. Solar PV 2 will generate approximately 60 MW, forming part of the Department of Mineral Resources and Energy (DMRE) renewable energy independent power

producer procurement programme (REIPPP). Construction is expected to take approximately 12 months. The total footprint of the proposed development is expected to comprise approximately 88 Ha.

The surface infrastructure component of the proposed development will thus, include the PV 1 (anticipated 34 Ha) and PV 2 panels (anticipated 88 Ha), the main substation (± 0.3 Ha), additional buildings (± 0.3 Ha), and the battery storage area (± 3.3 Ha). The linear component of the proposed development will include water supply for the development and a high-voltage line (± 6.2 km) that is recommended to connect the main substation to the Ysterkop substation.

In the initial stages of the project, the proposed Halfgewonnen Solar Photovoltaic (PV) Project was planned with a large portion of the footprint of the PV array in the wetland systems. Once this became evident, the project layout was revisited to reduce the risk to the receiving environment – based on recommendations from Scientific Terrestrial Services CC (STS) and Scientific Aquatic Services CC (SAS). Areas outside and adjacent to the study area that were highlighted as “Low Sensitivity” for the Plant Species Theme by the National Web Based Environmental Screening Tool were investigated as alternatives but were deemed unsuitable due to the various technical reasons below:

- These areas were property where land-use and access agreements have not been reached between the developer and land-owner;
- These were areas already approved for expansion of the Halfgewonnen Mine;
- The current Halfgewonnen coal processing plant - incompatible with solar PV development due to dust and land availability; and
- These were previously mined areas and were deemed not suitable to develop the PV array and areas identified as wetland habitat as per the recommendations of SAS were avoided as far as possible.

The final layout prepared was thus put forward as the only alternative, noting that some ecological impacts cannot be avoided any further. This layout, thus forms the basis of the impact assessment of this study. For a depiction of the proposed development layout, refer to Figure 3, below.

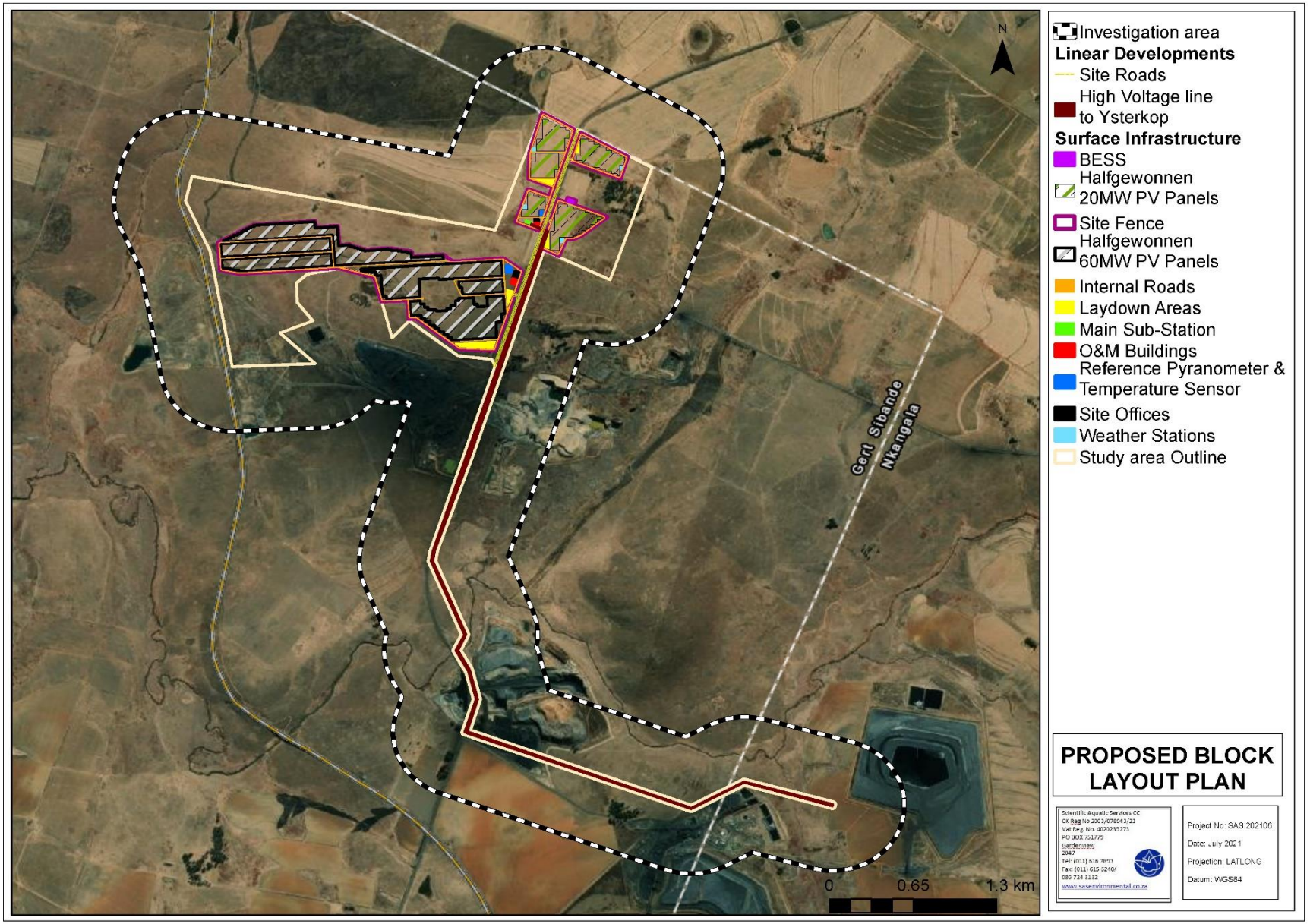


Figure 1: A digital satellite image depicting the location of the proposed development and associated investigation area in relation to the surrounding area.

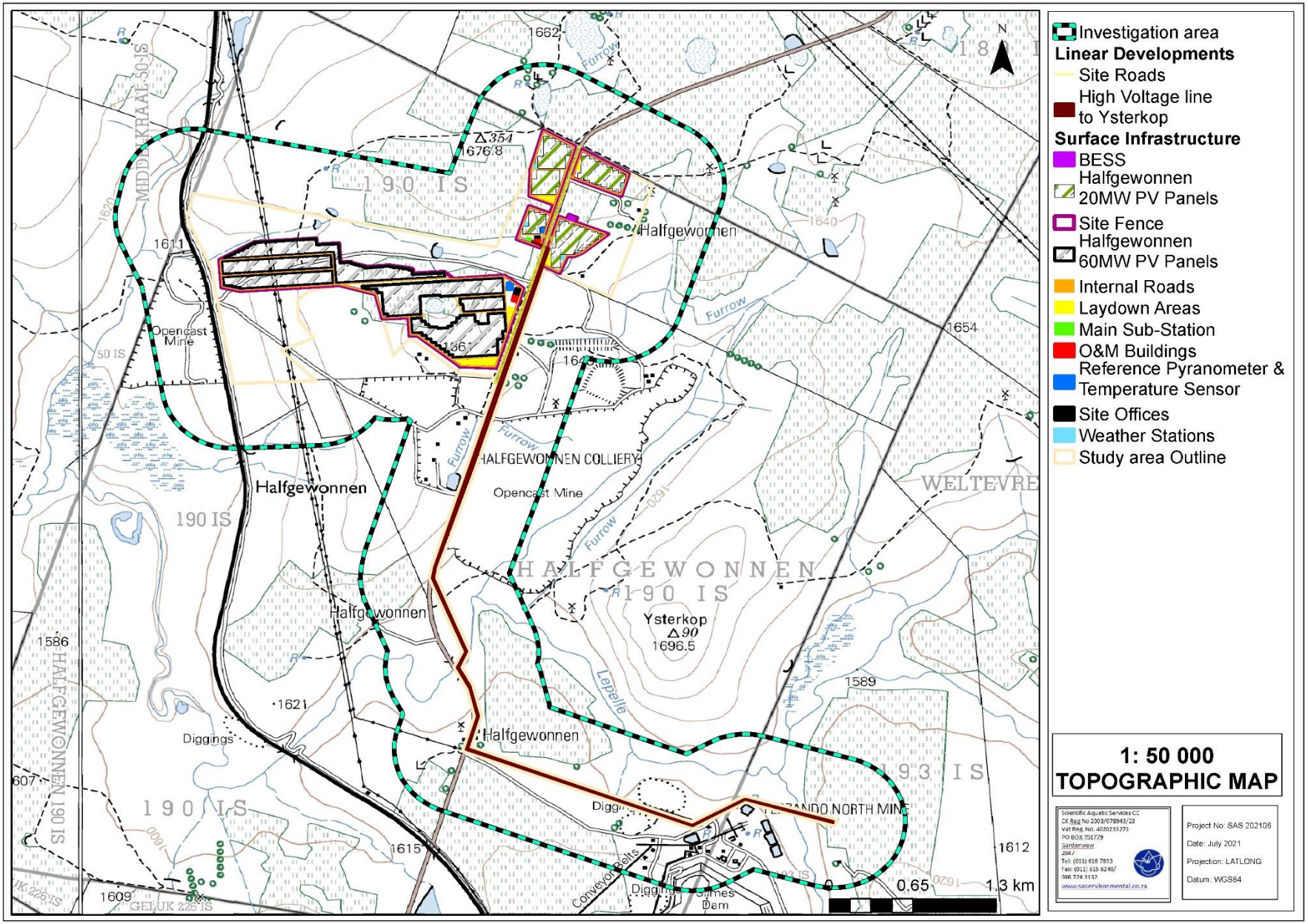


Figure 2: The proposed development and investigation area depicted on a 1:50 000 topographic map in relation to the surrounding area.

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, National Biodiversity Assessment (NBA) (2018), and the Mpumalanga Biodiversity Spatial Planning (2014), were undertaken to aid in defining the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the freshwater ecosystems;
- All freshwater ecosystems within the footprint of the proposed development and investigation area were delineated using desktop methods in accordance with GN 509 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] (2008)[2]: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics and wetness along with vegetation types were used to verify the freshwater ecosystems;
- The freshwater ecosystem 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 Present Ecological State (PES) of the freshwater ecosystem were assessed according to the resource directed measures guideline as advocated by Macfarlane *et al.* (2008);
- The Ecological Importance and Sensitivity (EIS) of the freshwater ecosystems were determined according to the method described by Rountree and Kotze, (2013);
- The Ecoservices of the freshwater ecosystems were assessed according to "A technique for rapidly assessing ecosystem services supplied by wetlands" (Kotze et al., 2009);
- The freshwater ecosystem boundaries, the appropriate provincial recommended buffers and legislated zones of regulation were depicted for the freshwater ecosystems, where applicable;
- Allocation of a suitable Recommended Management Objective (RMO), Recommended Ecological Category (REC) and Best Attainable State (BAS) of the freshwater

[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.

ecosystems were assigned based on the results obtained from the PES and EIS assessment's;

- The Department of Water and Sanitation (DWS) Risk Assessment Matrix (2016) was applied to identify potential impacts that may affect the freshwater ecosystems as a result of the proposed development, and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact of the proposed development on the receiving environment.

1.3 *Assumptions and Limitations*

The following assumptions and limitations are applicable to this report:

- The determination of the freshwater ecosystem boundaries and the assessment thereof, is confined to the freshwater ecosystems that will be traversed by the footprint of the proposed development and associated 500 m investigation area. As a result, the freshwater ecosystems within the footprint of the proposed development were delineated in fulfilment of Regulation GN 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) using the method advocated by DWAF (2008) and augmented with various desktop methods including use of topographic maps, historical and current digital satellite imagery, 5 m contours as well as aerial photographs, where necessary. Freshwater ecosystems within the investigation area were, however, primarily considered on a desktop level only;
- 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 actual site characteristics associated with the proposed development at the scale required to inform the EA/WUA processes. The information is however, considered to be useful as background information to the freshwater ecosystem assessment;
- During the site visit as undertaken on the 1st to the 3rd of February 2021, torrential rains related to cyclone Eloise were experienced within many parts of the country (including the provinces of Mpumalanga, Limpopo, KwaZulu-Natal, Free-State, Gauteng and Northern Cape). This excessive rainfall resulted in saturated soil throughout the footprint of the proposed development and associated investigation area. As a result, the saturation indicator was relied upon less, specifically within portions which have been historically transformed and inadvertently reduced reliance on the soil saturation and soil morphology/form indicator within disturbed soil profiles. These limitations

confounded the accurate delineation of the freshwater ecosystems that are situated within the footprint of the proposed development and investigation area, to some degree, although the overall end result when considered in relation to digital satellite imagery is considered sufficiently accurate to allow for informed decision making;

- Numerous portions within the footprint of the proposed development and investigation area have undergone historical transformation including agricultural lands, mining areas and associated ancillary activities such as excavation and stockpiling areas. As a result, numerous areas within the footprint of the proposed development displayed transformed topography and soil profiles resulting in alteration of the natural hydrology, geomorphology and vegetation communities. The disturbances have likely resulted in changes to the hydroperiod of the freshwater ecosystems within the surrounding area, presenting some challenges in the delineation process and thus, some discrepancies may exist;
- 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 the use of surveying equipment;
- Wetland, riparian and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative hydrophytic species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. It is, however, expected that the freshwater ecosystems that may be affected by the proposed development activities area have been accurately assessed and considered, based on the site observations undertaken in terms of the freshwater ecosystem ecology.

1.4 *Legislative Requirements*

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 (GN 509) as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);
- Mpumalanga Biodiversity Sector Plan Handbook (2014).

2 ASSESSMENT APPROACH

2.1 *Freshwater Ecosystem definition*

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 a watercourse.

The Act further provides definitions of wetland and riparian habitats as follows:
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*

Where limitations to on-site delineations were experienced, use was made of historical and current digital satellite imagery, topographic maps and available provincial and national

databases to aid in the delineation of the freshwater ecosystems following the site assessment. The following were taken into consideration when utilising the above desktop methods:

- Linear features: since water flows/moves through the landscape, freshwater ecosystems often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;
- Vegetation associated with freshwater ecosystems: a distinct increase in density as well as shrub size near flow paths;
- Hue: with water flow paths often showing as white/grey or black and outcrops or bare soils 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 which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the freshwater ecosystems.

The site assessment was undertaken in February 2021 (mid-summer), to delineate the freshwater ecosystems and undertake a detailed freshwater ecosystem assessment. The delineation of the freshwater ecosystems took place as far as possible, 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 freshwater ecosystems 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.

In addition to the delineation process, a detailed assessment of the delineated freshwater ecosystems was undertaken. Factors affecting the integrity of the freshwater ecosystems were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the freshwater ecosystems. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.3 *Sensitivity Mapping*

The freshwater ecosystems associated with the study area were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project the freshwater ecosystems onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 5 presents the layout of the proposed development in relation to the freshwater ecosystems.

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” report below (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, and information that was considered of importance was emboldened.

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 areas actual site characteristics at the scale required to inform the EA/ WUA 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 assessment 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. The information contained in the dashboard report below is intended to provide background to the landscape of the study area. 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 indicating the characteristics of the freshwater ecosystems associated with the proposed development and investigation area.

Aquatic ecoregion and sub-regions in which the study and investigation areas are to be located.			Details of the study and investigation area in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database (Figure 5).	
Ecoregion	Highveld		FEPACODE	According to the NFEPA (2011) database, the study and investigation area are not indicated as Freshwater Ecosystem Protected Areas (FEPAs). The study and investigation area fall within a sub quaternary catchment not considered important in terms of fish or watercourse conservation.
Catchment	Olifants-North			
Quarternary Catchment (Figure 3)	B11A			
WMA	Olifants		NFEPA Wetlands (Figure 5)	According to the NFEPA (2011) database, there are two natural depressions, four natural and one artificial wetland flats, two natural seeps and three natural channelled valley bottom (CVB) wetlands associated with the surface infrastructure and linear development components of the proposed development and investigation area. The depression and seep wetlands range from moderately modified (WETCON C) to heavily modified condition (WETCON Z1), The CVB wetlands range from largely natural (WETCON AB) to moderately modified condition (WETCON C) whilst the wetland flats are indicated to be in a moderately to heavily modified condition (WETCON C to Z1). In addition, two artificial seep wetlands are situated on the footprint of the surface infrastructure (PV 2 panels) and indicated to be in a critically modified ecological condition (WETCON Z3).
subWMA	Upper Olifants			
Dominant characteristics of the Highveld (11.02) Ecoregion Level 2 (Kleynhans *et al.,* 2007).				
Dominant primary vegetation types	Moderately undulating plains and pans.			
Dominant primary terrain morphology	Moist Sandy Highveld Grassland			
Altitude (m a.m.s.l)	1300 to 1900			
MAP (mm)	500 to 800		Wetland Vegetation Type	The study and investigation area fall within the Mesic Highveld Grassland Group 4 wetland vegetation type. This vegetation group is considered "least threatened" and "poorly protected", according to Mbona *et al*. (2015).
Coefficient of Variation (% of MAP)	20 to 29			
Rainfall concentration index	55 to 64		NFEPA Rivers	The Olifants River traverses the linear development component of the proposed development and is associated with the floodplain and channelled valley bottom wetlands as indicated by the NBA (2019) and NFEPA (2011) databases. The Olifants River is considered moderately modified (Class C) according to the PES 1999 database and NFEPA (2011) database.
Mean annual temp. (°C)	12 to 18			
Winter temperature (July)	0 to 20			
Summer temperature (Feb)	10 to 26			
Median annual simulated runoff (mm)	20 to 80; 80 to 100 (limited); 100 to 150; 150 to 200 (limited)		Mpumalanga Biodiversity Sector Plan (MBSP, 2014) (Figure 6).	
Mpumalanga Highveld Wetlands (MHW), (2014) (Figure 3).			Critical Biodiversity Areas	According to the MBSP (2014) freshwater database, there are two CBA wetlands associated with the proposed development, one situated north of the surface infrastructure component along the boundary of the investigation area and one traversed by the linear development (High voltage line to Ysterkop) component, respectively. The CBA wetlands correspond with the seep wetland and channelled valley bottoms that are indicated by the NFEPA (2011) database.
The MHW identified three depressions, one seep and two channelled valley bottom wetlands associated with the study area of the proposed development. These wetlands largely correspond with the wetlands identified by the NFEPA (2011) database. The MHW database (2014) identifies the depression wetlands as being moderately to seriously modified (WETCON Class C to Z) whilst the seep and channelled valley bottom wetland was identified as being natural to largely natural (WETCON Class AB).			Ecological Support Area (ESA) Wetlands	According to the MBSP (2013) freshwater database, there are six Ecological support area (ESA's) wetlands situated within the footprint of the proposed development and investigation area. These are wetlands that although not considered FEPA wetlands, still maintain the hydrological functioning of rivers, water tables and freshwater biodiversity, as well as offer various ecosystem services. The ESA wetlands largely correspond with some of the Floodplain, CVB wetland, wetland flats and depression wetlands as identified by the NFEPA (2011) and NBA (2018) databases.
Ecological Status of the most proximal sub-quaternary reach (DWS, 2014) (Figure 4).				
Sub-quaternary reach	B11A-01331 (Leeufonteinspruit)	B11A-01369 (Olifants River)		
Proximity to study area	4.7 km north of the study area.	10.6 km south-east of the study area.	Heavily Modified	A large majority of the remaining portions traversing the proposed development and investigation areas are considered Heavily Modified, meaning the area is currently modified
Assessed by expert?	Yes	Yes		

PES Category Median	Largely Modified (Class D)	Moderately Modified (Class C)		to such an extent that any valuable biodiversity and ecological function has already been lost.
Mean Ecological Importance (EI) Class	Moderate	High		
Mean Ecological Sensitivity (ES) Class	High	High	Other Natural Areas	The remaining areas associated with the Halfgewonnen Solar PV facility and investigation areas are indicated as "Other Natural Areas". These are areas that are not currently identified as priority areas, however most of the natural characteristics are retained and various biodiversity and ecological infrastructural functions are performed.
Stream Order	1	1		
Default Ecological Class (based on median PES and highest EI or ES mean)	B	B		
National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Figure 7).				
According to the NBA 2018: SAIIAE there are four artificial and one natural channelled valley bottom wetlands, two natural depression wetlands, two natural seep wetlands and one natural floodplain wetland associated with the proposed development and investigation area. The channelled valley bottom wetlands are considered moderately modified to heavily to critically modified (WETCON C to D/E/F) and have an ecosystem threat status (ETS) of critical and Ecosystem protection level (EPL) of "not protected". The depression wetlands are considered heavily to critically modified (WETCON D/E/F) with an ETS and EPL of "poorly protected" and "least concern". Both the floodplain and seep wetlands are also considered heavily to critically modified (WETCON D/E/F) and both have a ETS of "critically endangered" and EPL of "not protected" and "poorly protected" for both wetlands, respectively.				
National Web Based Environmental Screening Tool (2020).				
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.			The aquatic sensitivity for the study area has a very high sensitivity due to the presence of a wetland, namely the pan which is situated towards the south-eastern portion of the study and investigation area.	

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; NBA = National Biodiversity Assessment; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; SAIIAE = South African Inventory of Inland Aquatic Ecosystems; WMA = Water Management Area

3.2 *Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database*

The study area falls within the Highveld Aquatic Ecoregion and within the B11A 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 points (B11A-01331) and (B11A-01369) are located approximately 4.7 km and 10.6 km north and south of the proposed development, respectively. The following macro-invertebrate taxa has previously been reported from SQR B11A-01331(Leeufonteinspruit) and B11A-01369 (Olifants River):

Table 2: Macro-invertebrate families recorded at SQR B11A-01331(Leeufonteinspruit) and B11A-01369 (Olifants River):

Macro-Invertebrates	B11A-01331 (Leeufonteinspruit)	B11A-01369 (Olifants River)
Aeshnidae	X	X
Ancylidae	X	X
Baetidae 1 Sp.		
Baetidae 2 Sp.	X	X
Belostomatidae	X	X
Bulininae	X	
Caenidae	X	X
Ceratopogonidae	X	X
Chironomidae	X	X
Coenagrionidae	X	X
Corbiculidae	X	X
Corduliidae		
Corixidae	X	X
Crambidae	X	X
Culicidae	X	X
Dixidae	X	X
Dytiscidae	X	X
Ecnomidae		X
Elmidae		
Gerridae	X	X
Gomphidae	X	X
Gyrinidae	X	X
Hirudinea	X	X
Hydracarina	X	X
Hydraenidae	X	X
Hydrometridae	X	X
Hydrophilidae	X	X
Hydropsychidae 1 sp.		
Hydropsychidae 2 sp.		X
Hydroptilidae		X
Leptoceridae	X	X
Leptophlebidae		X
Lestidae		
Libellulidae		X
Lymnaeidae	X	X

Macro-Invertebrates	B11A-01331 (Leeufonteinspruit)	B11A-01369 (Olifants River)
Muscidae	X	X
Naucoridae	X	X
Nepidae	X	X
Notonectidae	X	X
Oligochaeta	X	X
Physidae	X	X
Planorbinae	X	X
Pleidae	X	X
Potamonautidae	X	X
Psychodidae	X	X
Simuliidae		X
Sphaeridae	X	X
Tabanidae	X	X
Tipulidae	X	X
Turbellaria	X	X
Unionidae		X
Veliidae/Mesoveliidae	X	X

The following fish species has previously been reported from SQR B11A-01331(Leeufonteinspruit) and B11A-01369 (Olifants River):

Table 3: Fish species recorded at the SQR B11A-01331(Leeufonteinspruit) and B11A-01369 (Olifants River):

Fish species	B11A-01331 (Leeufonteinspruit)	B11A-01369 (Olifants River)
Austroglanis sclateri		
Clarias gariepinus	X	X
Enteromius anoplus	X	X
Enteromius neefi	X	X
Enteromius paludinosus	X	X
Enteromius kimberleyensis		
Enteromius paludinosus		
Enteromius trimaculatus		
Labeobarbus aeneus		
Labeo capensis		
Labeo polylepis		X
Labeo umbratus		
Pseudocrenilabrus philander	X	X
Tilapia sparrmanii	X	X

Table 4: Summary of the ecological status of the SQR B11A-01331(Leeufonteinspruit) and SQR B11A-01369 (Olifants River) according to the DWS RQS PES/EIS database.

PESEIS Data	B11A-01331 (Leeufonteinspruit)	B11A-01369 (Olifants River)
Synopsis		
PES Category Median	(D) Largely modified	Moderately modified
Mean EI class	Moderate	High
Mean ES class	High	High
Length	19.00	55.00
Stream order	1	1
Default EC[4]	B	B
PES Details		
Instream habitat continuity MOD	Large	Moderate
RIP/wetland zone continuity MOD	Moderate	Small
Potential instream habitat MOD activities	Large	Moderate
Riparian/wetland zone MOD	Small	Moderate
Potential flow MOD activities	Large	Moderate
Potential physico-chemical MOD activities	Moderate	Moderate
EI Details		
Fish spp/SQ	6	7
Fish average confidence	2.33	1.00
Fish representivity per secondary class	Low	Low
Fish rarity per secondary class	Low	Moderate
Invertebrate taxa/SQ	42	48
Invertebrate average confidence	2.62	2.58
Invertebrate representivity per secondary class	High	High
Invertebrate rarity per secondary class	Very High	Very High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	Very Low	High
Habitat diversity class	Low	Low
Habitat size (length) class	Low	Very High
Instream migration link class	Moderate	High
Riparian-wetland zone migration link	High	Very High
Riparian-wetland zone habitat integrity class	Very High	High
Instream habitat integrity class	Moderate	High
Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500 m	High	High
Riparian-wetland natural vegetation rating based on expert rating	High	High
ES Details		
Fish physical-chemical sensitivity description	High	High
Fish no-flow sensitivity	High	High
Invertebrates physical-chemical sensitivity description	Very High	Very High
Invertebrate velocity sensitivity	Very High	Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	High	High
Stream size sensitivity to modified flow/water level changes description	Very High	High
Riparian-wetland vegetation intolerance to water level changes description	High	High

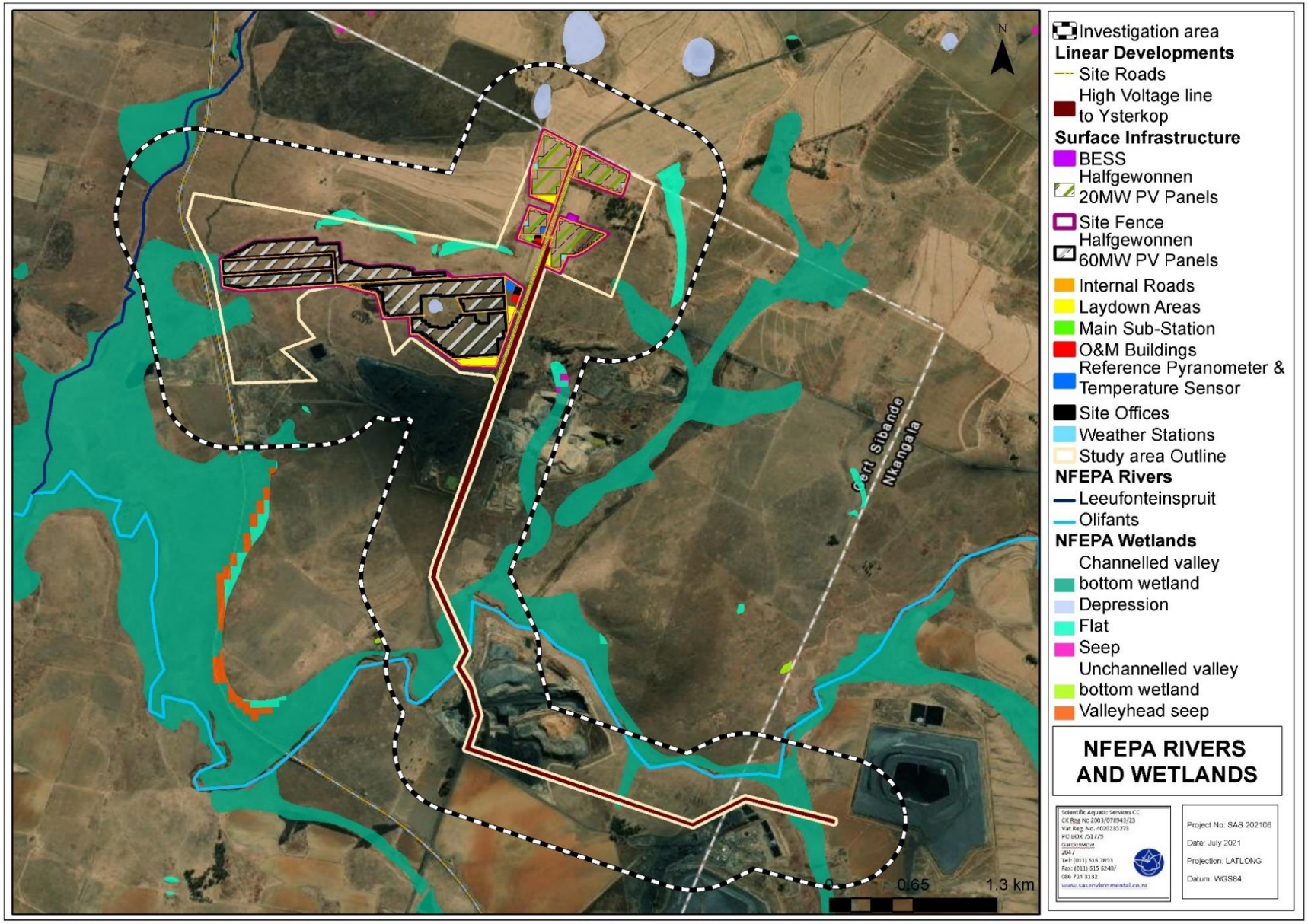


Figure 3: Wetlands and rivers associated with the proposed development and investigation area according to the NFEPA (2011) database.

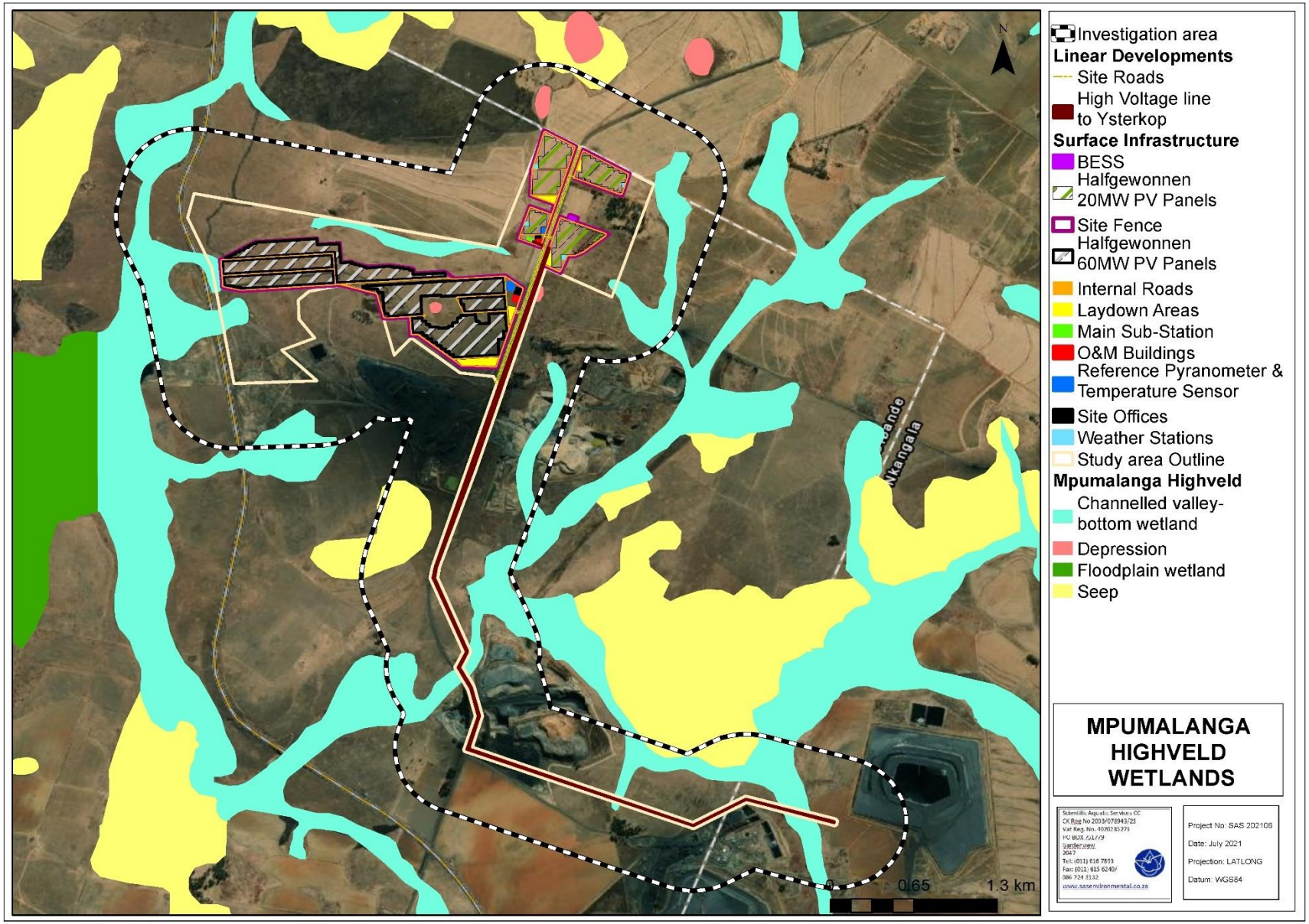


Figure 4: Wetlands associated with the proposed development and investigation area according to Mpumalanga Highveld wetlands database (2014).

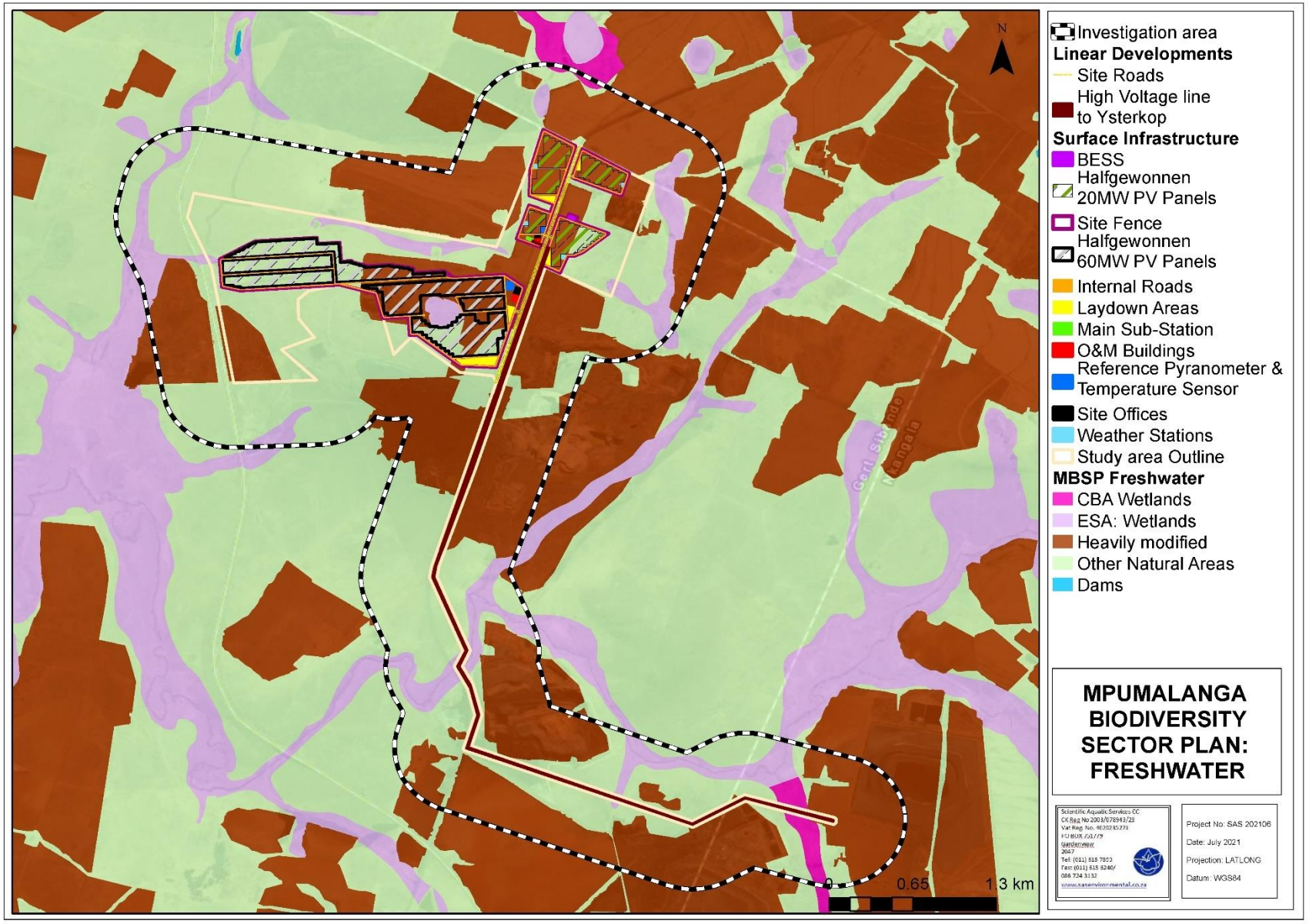


Figure 5: Wetlands associated with the proposed development and investigation area according to the Mpumalanga Spatial Biodiversity Plan (MBSP, 2014) database.

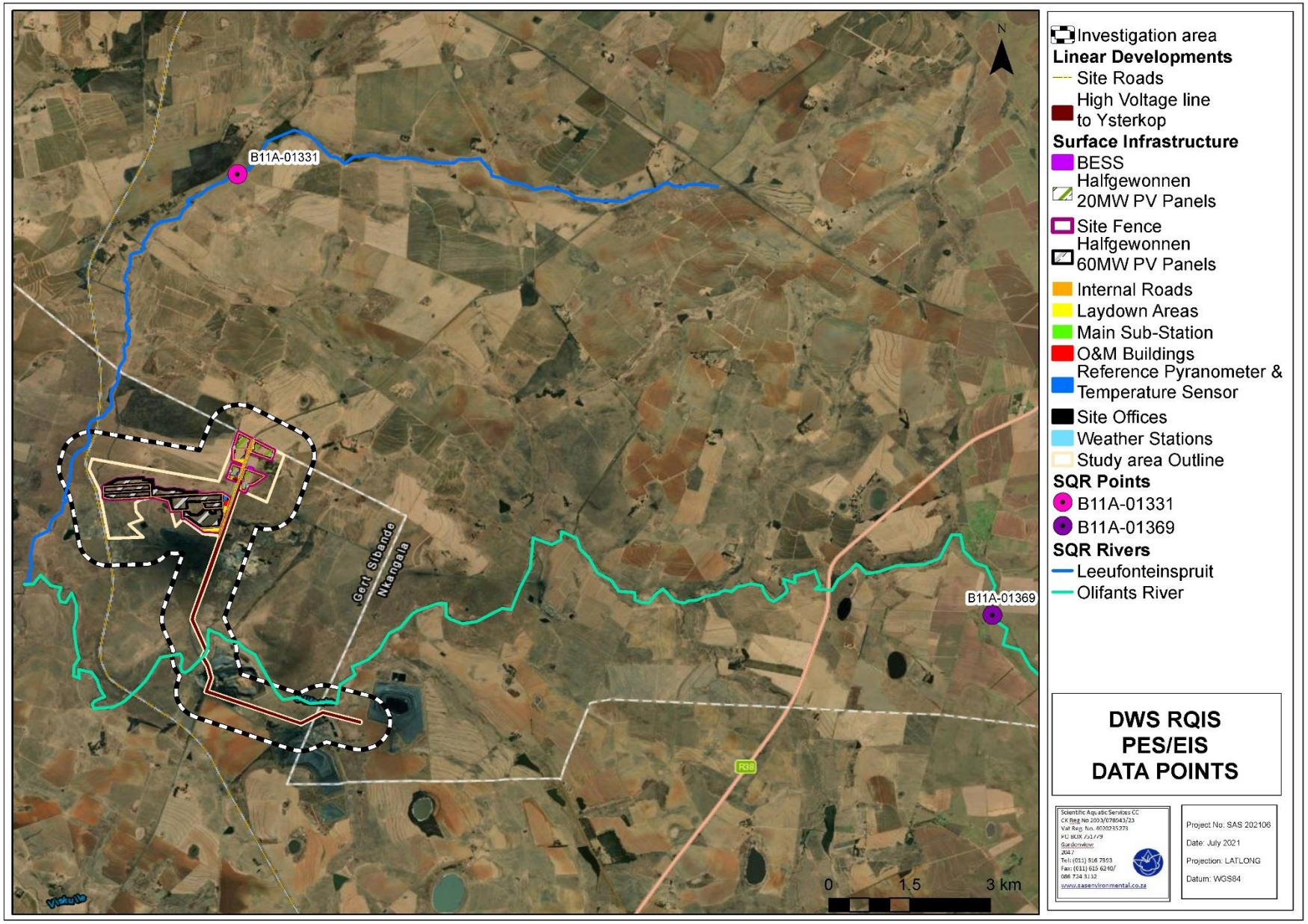


Figure 6: Relevant Sub-Quaternary Catchment Reach (SQR) associated with the proposed development and investigation area.

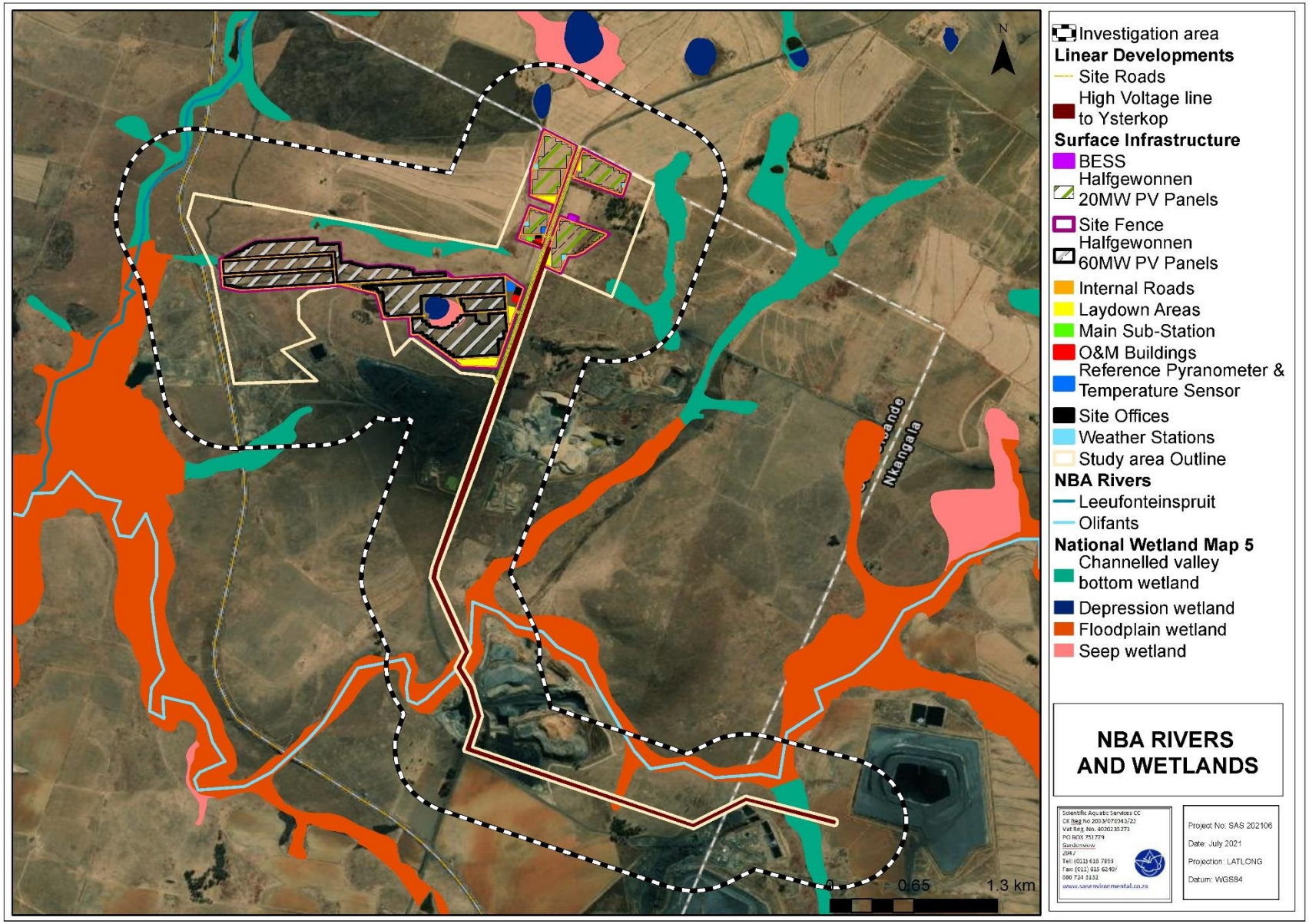


Figure 7: Wetlands and rivers associated with the proposed development and investigation area according to the National Biodiversity Assessment: South African Inventory of Inland Aquatic Ecosystems (NBA: SAIIAE, 2018).

3.3 *Consultation of Historical Aerial imagery*

In order to ascertain conditions of the landscape prior to significant alteration and changes to the natural hydrology and topography, the Department of Rural Development and Land Reform (DRDLR, 2021) database was consulted to obtain historical aerial photographs (Figure 9). On review of the proposed development footprint, significant changes to the surrounding environment can be discerned when comparing historical aerial imagery dated 1954 and 1965 with current digital satellite imagery (2021) (Figure 8). Modifiers include historical and ongoing mining, rehabilitation and agricultural activities. These activities have transformed the landscape and topography over time as well as altered the natural vegetation and soil profiles within numerous portions of the proposed development footprint. .

Figure 8: Representative photographs showing the land transformation associated with the proposed development over time from (left) 1954, (middle) 1968, and (right) present day, available imagery from 2021.

4 RESULTS: FRESHWATER ECOSYSTEM ASSESSMENT

4.1 *Freshwater Ecosystem Delineation*

As noted in Section 1.2, the freshwater ecosystem assessment was limited to the proposed development footprint and associated investigation area as provided by the proponent. It was noted during the site assessment that various mining and agricultural activities have occurred within the proposed development footprint, investigation area and immediate surrounds. As a result, changes to the topography, soil and vegetation profiles were evident (specifically along the boundaries of the Unchannelled valley bottom (UCVB), Seeps and Channelled valley bottom (CVB) wetlands (as discussed in section 4.3). In addition, heavy rainfall related to cyclone Eloise was experienced during the site assessment (February 2021) which affected the accuracy of indicators used in the delineation process, to some degree. Thus, where necessary, delineations were refined and augmented with the use of digital satellite imagery, historical aerial imagery and 5 m contours to improve the accuracy of the delineation. The delineations as presented in this report, are nevertheless deemed the best estimate of the freshwater ecosystem boundaries based on site conditions present at the time of the assessment and are considered sufficiently adequate to allow for informed decision-making.

During the site assessment, the following indicators were used to delineate the boundaries of the freshwater ecosystems:

- Terrain units were used as the primary indicator. Despite transformation of the landscape associated with the proposed development, the terrain provided an indication of low-lying areas where water is likely to collect and/or move through the landscape;
- Soil wetness indicator, duration and frequency of saturation in the soil profile is a diagnostic indicator, since it influences the colour change in the soil. Low chroma (grey and muted colours) as well as mottles are more prominent in soil which have higher saturation frequency. Moist soil also indicates an increased hydroperiod and thus the potential presence of hydromorphic characteristics. This was utilised with soil morphology and vegetation as the secondary indicator; where feasible (due to heavy rainfall experienced during the site assessment which has reduced reliance on this indicator);
- Soil morphological characteristics (Figure 9) typically associated with wetland conditions, such as gleying or mottling were utilised in conjunction with saturation as the secondary indicator. This indicator was especially prominent in verifying the

boundary of the UCVB wetland and pan in which numerous excavations and mining related activities have occurred along the wetland boundaries;

- Vegetation was utilised in conjunction with the soil indicators associated with wetland systems, where feasible. The distinction between obligate, facultative, and terrestrial vegetation was relatively discernible, except in areas in which extensive agricultural cropland and excavation has occurred and resulted in cleared and altered vegetation communities along wetland boundaries. The vegetation indicator was especially useful in delineating the boundary of the pans and UCVB wetlands, in which transformation of the landscape has occurred and soil morphology and saturation of soil could not be accurately utilised.

Figure 9: (Left) representative soil auger samples taken within UCVB wetland 1 indicating soil saturation, gleyed soil and mottling which serve as key indicators of a fluctuating water table.

4.2 *Freshwater Ecosystem Characterisation*

The site assessment confirmed the presence of numerous Hydrogeomorphic (HGM) units, eight of which are at risk from the proposed development and were classified as follows:

- One Unchannelled valley Bottom (UCVB) wetland;
- Two Channelled valley bottom (CVB) wetlands;
- Three depression wetlands (pans); and
- Two seep wetlands.

The wetlands identified within the investigation area were classified according to the Classification System (Ollis *et al.*, 2013) as Inland Systems. The wetlands fall within the Highveld Aquatic Ecoregion and the Highveld Grassland Group 4 WetVeg (wetland vegetation) group, classified by Mbona *et al.* (2015) as “Least Threatened”. At Levels 3 (Landscape Unit) and 4 (HGM Type) of the Classification System, the systems were classified as per the summary in Table 5, below.

Table 5: Characterisation at Levels 3 and 4 of the Classification System (Ollis *et al*., 2013) of the wetlands associated with the proposed development within the study and investigation area.

Location	Level 3: Landscape unit	Level 4: HGM Type
UCVB wetland 1 is situated within the surface infrastructure component of the proposed development.	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.
Three pans are identified to be affected by the proposed development. Pans 1 and 2 are situated within the surface infrastructure component of the proposed development whilst Pan 3 is situated approximately 60 m north and upgradient of the surface infrastructure component of the proposed development.	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.
Two CVB wetlands are to be traversed by the linear development component of the proposed development. CVB wetland 1 is associated with the Olifants River and will be traversed along the central portion of the linear development component whilst CVB wetland 2 will be traversed along the southern most reaches of the linear development component of the proposed development.	Valley floor: The base of a valley, situated between two distinct valley side-slopes.	Channelled valley bottom: A valley bottom wetland with a river channel running through it.
Two seep wetlands are to be traversed by the proposed development. Seep wetland 1 will be traversed by the southern extent of the linear development component whilst seep wetland 2 will be overlayed by the surface infrastructure component of the proposed development.	Slope: An inclined stretch of ground typically located on the side of a mountain, hill or valley, not forming part of a valley floor. Includes scarp slopes, mid-slopes and foot-slopes.	Seep: A wetland located on gently to steeply sloping land and dominated by colluvial (i.e gravity-driven) unidirectional movement of water and material down-slope.

The delineated wetlands are conceptually depicted in Figures 10 to 12, below.

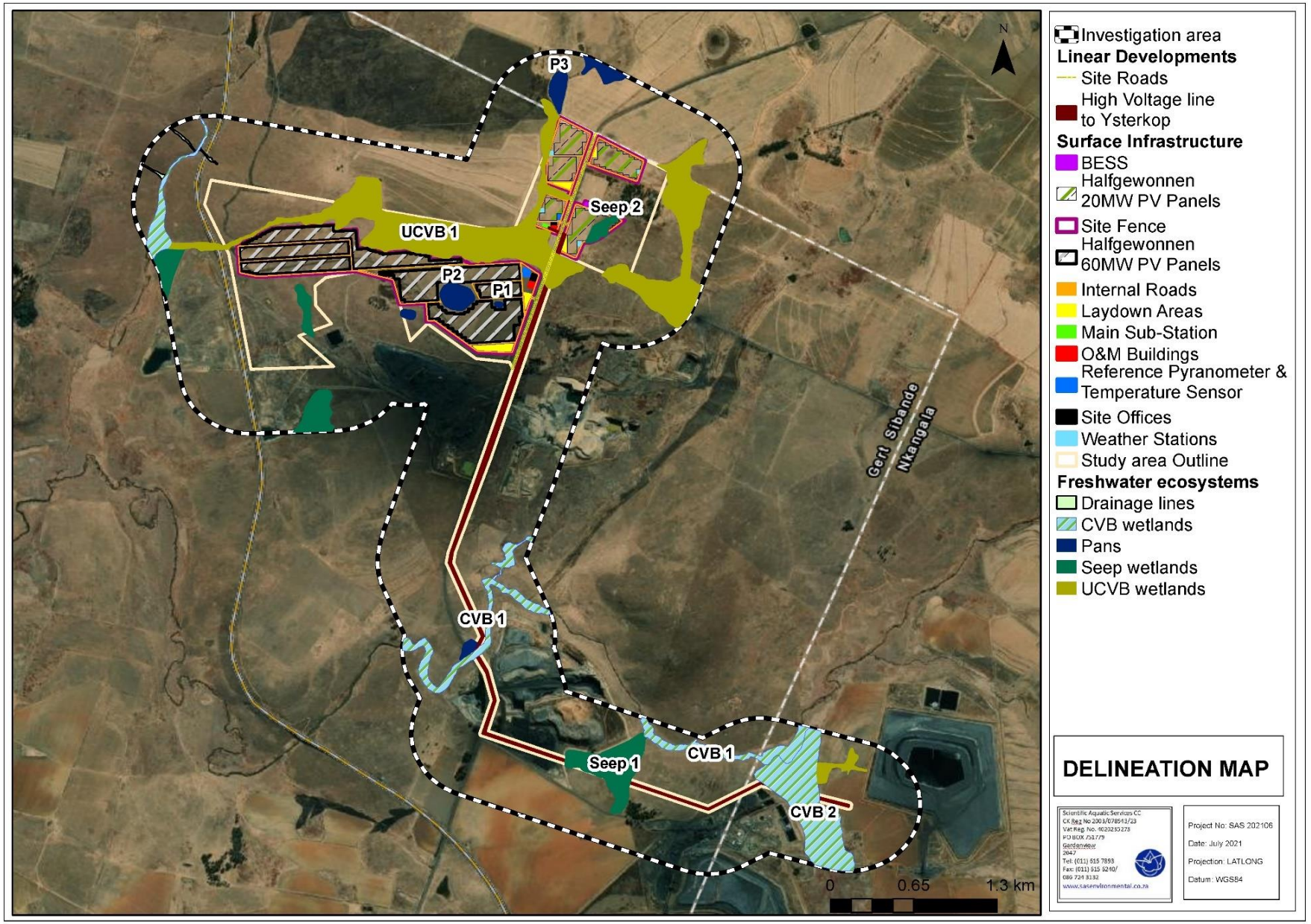


Figure 10: Location of the wetlands associated with the proposed development and associated investigation area.

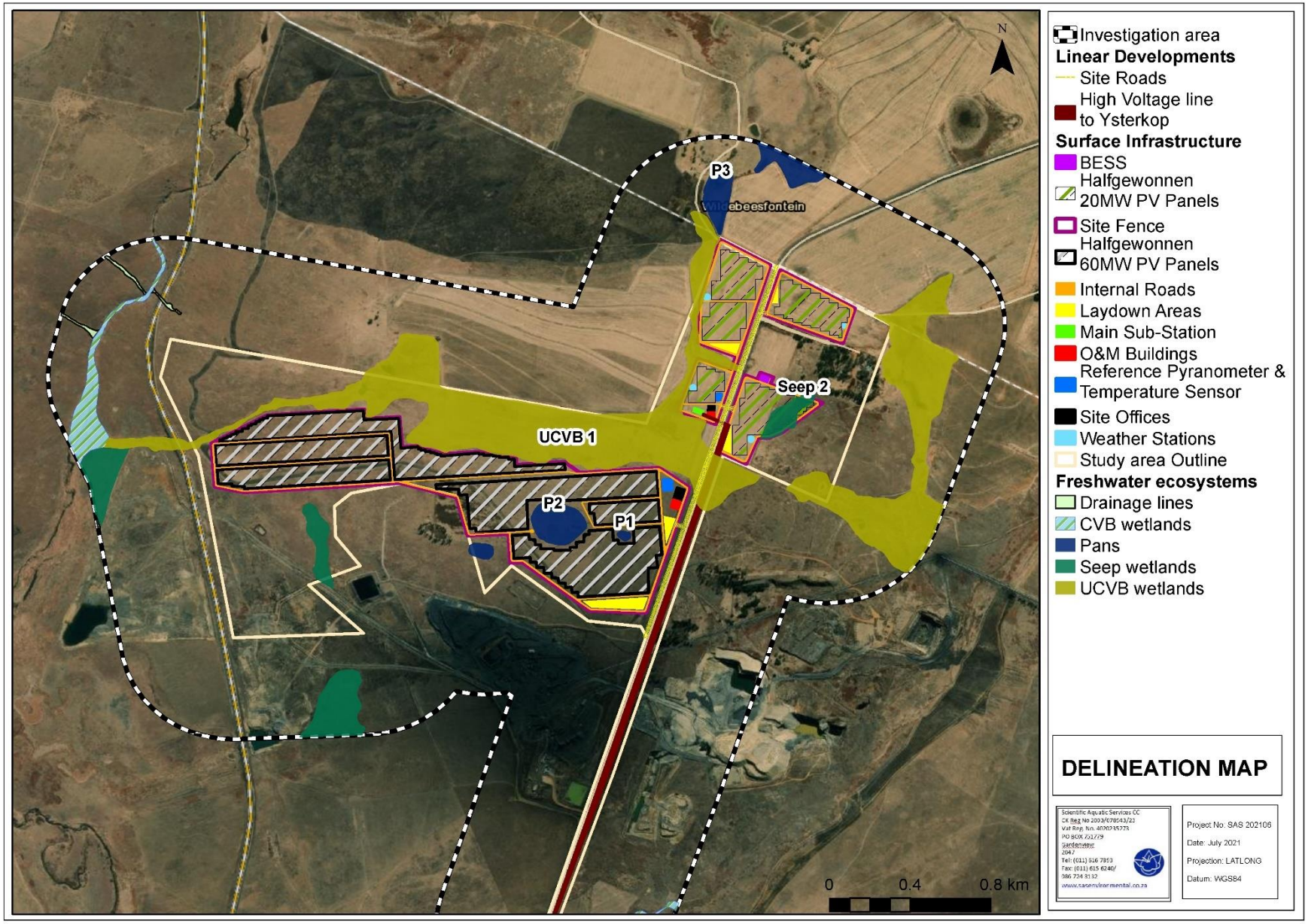


Figure 11: Zoomed location of the wetlands associated with the northern portion of the proposed development and associated investigation area.

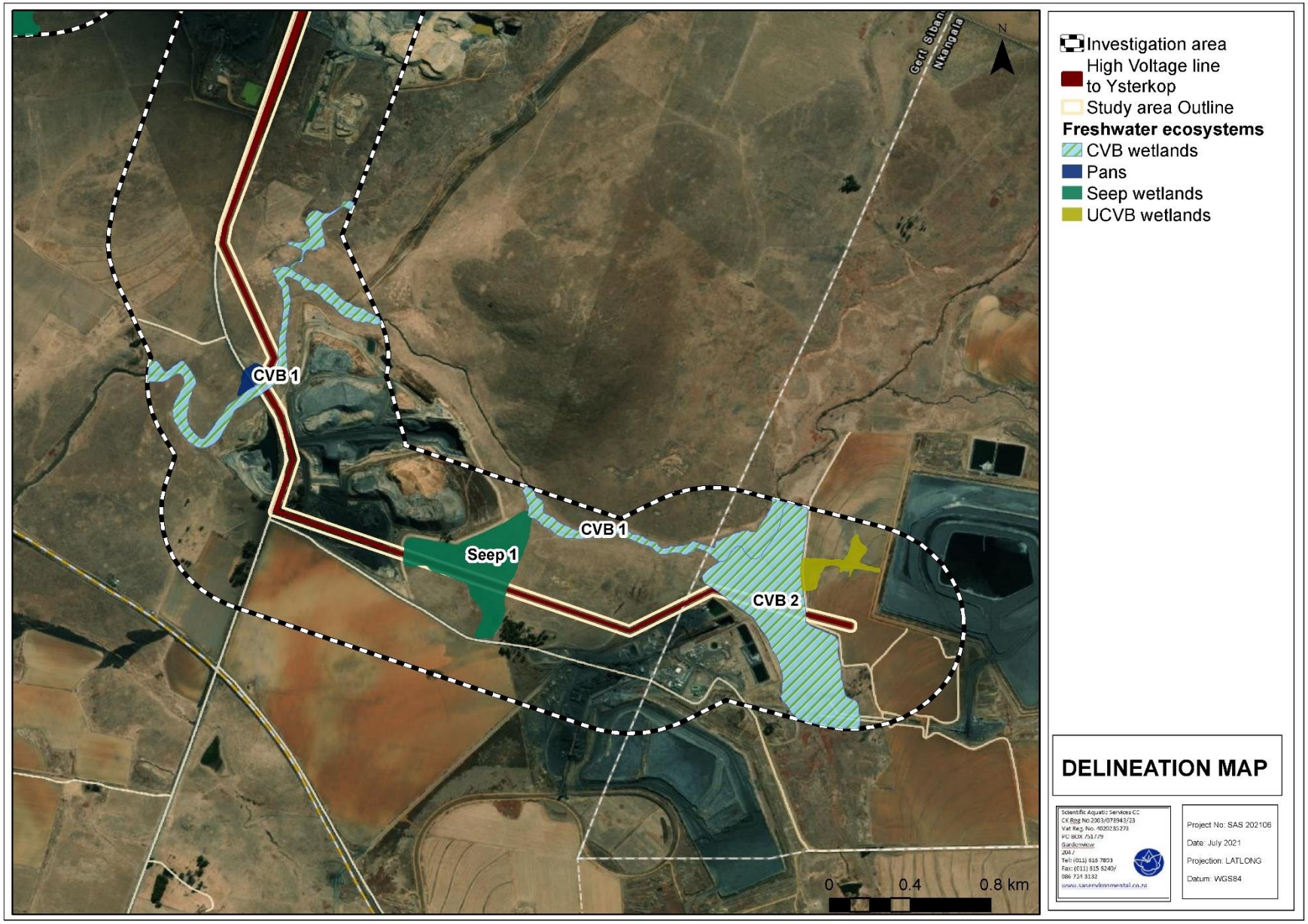
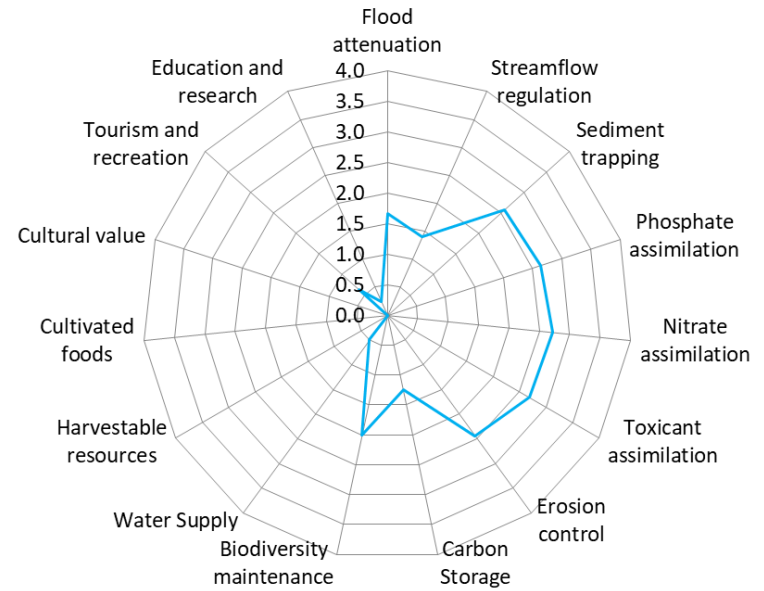


Figure 12: Zoomed location of the wetlands associated with the southern portion of the proposed development and associated investigation area.

4.3 *Site Verification Results*

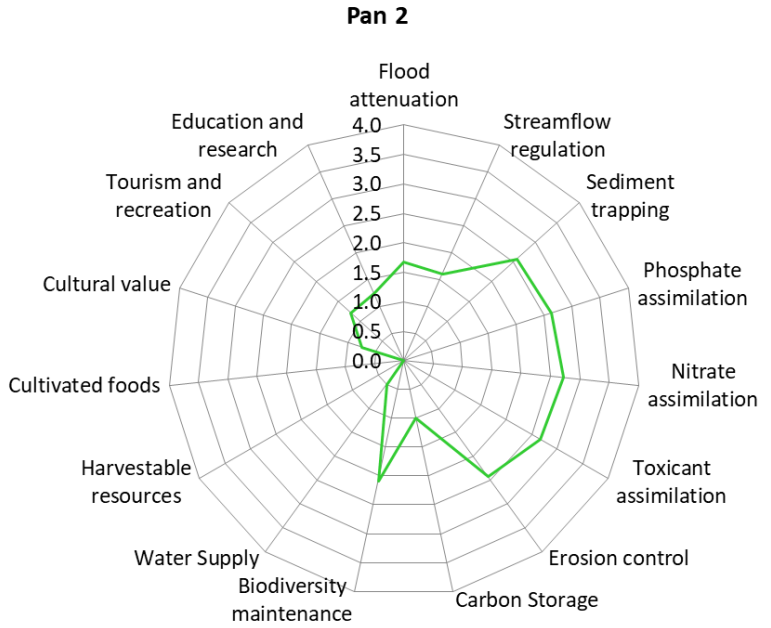
Following the site assessment, the assessments outlined in Section 1.2 were applied. The results of the assessments are discussed in the dashboard style reports which follow and the details thereof are presented in Appendix E.

Table 6: Summary of the assessment of Pan 1 associated with the surface infrastructure component of the proposed development.

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:
Pan 1
 
</td><td colspan="2"> 
Figure 13: (Top left) representative photograph of the vegetation cover within pan 1, (top right) surface water within pan 1; (bottom left) alien invasive vegetation along the disturbed portions of the pan and (bottom right), owl pellets present within the wetland.</td></tr>
<tr><td>PES Discussion (WET-Health)</td><td>PES Category: B
Pan 1 is situated towards the eastern extent of the surface infrastructure (PV 2 panels) and is classified as largely natural. The impacts to the wetland hydrology were considered minor, with increased runoff considered the major contributor. The primary impacts to geomorphology stem from a minor degree of infill and deposition within and along the wetland, altering the natural infiltration rates and supplying increased sediment within disturbed portions of the wetland. Increased runoff from surrounding agriculture was also considered likely to contribute additional sediment to the pan. The vegetation within pan 1 was primarily dominated by Cyperus sp., whilst disturbed portions hosted alien invasive plants (AIP's) including Conyza bonariensis and Bidens pilosa which may likely proliferate further within the wetland if not managed appropriately.</td><td>Ecoservice provision</td><td>Ecoservices category: Intermediate (Score 1.3)
Pan 1 provides an intermediate degree of ecological service provisioning with services such as sediment trapping, phosphate, nitrate and toxicant assimilation, erosion control, the potential for flood attenuation and biodiversity maintenance considered the primary services supplied. As typical of many pans, pan 1 is considered an isolated pan which is not linked to the stream network. Pan 1 was shown to supply a very limited degree of socio-cultural service provisioning with tourism and recreation, education and research, cultural value, cultivated food, harvestable resources and water supply for human use has the potential to be supplied, to a limited degree. This was due to a low use and reliance on pan 1 by the local community.</td></tr>
<tr><td>EIS discussion</td><td>EIS Category: Moderate
The EIS of pan 1 was defined as moderate. This was attributed to the sensitivity of the wetland type and provisioning of hydro-functional support services. Due to the small, isolated nature of the pan within the surrounding landscape, the pan was not considered especially important for biodiversity maintenance. Whilst this is noted, due to the surrounding natural areas (including pan 2 and UCVB wetland), some degree of biodiversity support was still considered likely for less-sensitive species.</td><td>REC, RMO & BAS Category</td><td>REC: B/ BAS: B/ RMO: Maintain
The Recommended Management Objective (RMO) for pan 1 based on the PES and EIS scores are to maintain the ecostatus of the wetland at a Recommended Ecological Category (REC) B. Any planned activities must be managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that at a minimum, the RMO is achieved.</td></tr>
</table>

Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
(a) Hydraulic regime The hydraulic regime of pan 1 has primarily been altered by increased runoff from adjacent agricultural activities whilst some degree of infill and deposited materials has altered natural infiltration rates within the wetland. **(b) Water quality** Water quality sampling was undertaken within pan 1 by means of i*n-situ* parameters were measured including pH, temperature and Electrical Conductivity (EC). The pH was 5.80 and fell below the Department of Water Affairs (DWA, 2011) Resource Water Quality Objectives (RWQO) albeit due to the isolated nature of pan 1, was considered potentially natural. Temperature was 16.2 °C and was considered largely natural for the season and time of day (before noon) at which sampling was undertaken. The EC within the pan was 2 mS/m and fell below than the ideal limits of the DWA (2011) RWQO, which may likely also be due to a degree of dilution as a result of excessive rainfall experienced during the assessment. Overall, the water quality taken during the assessment was considered natural at the time of sampling in February 2021. **(c) Geomorphology and sediment balance** Whilst it is acknowledged that geomorphology within pans do not undergo extensive changes, the increased runoff from agricultural activities and areas disturbed by infill and deposition have likely resulted in increased sediment within pan 1. **(d) Habitat and biota** Pan 1 was relatively well vegetated and primarily dominated by sedges including *Cyperus* and contained a large degree of surface water during the site assessment in February 2021. Given these characteristics and relative locality to surrounding natural areas (including pan 2 UCVB wetland), pan 1 is considered to provide some suitable habitat to biota including potential foraging habitat for *Asio capensis* (Marsh owl) which was observed within the surrounding landscape.	
Extent of modification anticipated.	The proposed development layout was optimised to avoid the delineated boundary of pan. However, it is recommended that the delineated boundary of the pan and associated 10 m construction and operational phase buffer zones be demarcated as “no-go” areas which will reduce the significant of impacts that may occur.
Risk Assessment Outcome & Business Case:	
Moderate	As the proposed development layout will avoid the boundary of the pan no direct impacts are anticipated, however, the potential for indirect impacts and edge effects are still considered likely. It must therefore be ensured that mitigation measures to prevent indirect impacts are in place during all phases of construction and operational phase activities including: Ensuring that all exposed soil is protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation pan 1 located downgradient of these stockpiles.

Table 7: Summary of the assessment of Pan 2 associated with the surface infrastructure component of the proposed development.

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:
 
</td><td colspan="2"> 
Figure 14: (Top left) representative photograph of vegetation cover within the UCVB wetland, (top right) erosion along the UCVB; (bottom left) bridge culvert situated downgradient of the gravel access road and (bottom right) marsh owl that use the wetland as feeding and breeding habitat.</td></tr>
<tr><td>PES Discussion (WET-Health)</td><td>PES Category: C
Pan 2 is situated approximately 200 m west of pan 1 toward the eastern extent of the surface infrastructure and was classified as moderately modified. The primary impacts to hydrology include a minor degree of increased runoff and flood peaks, as well as dense amounts of AIP's. It was also considered likely that portions along and within pan 2 have been transformed, likely as a result of agricultural practices. The geomorphological processes of pan 2 were altered due to increased runoff from surrounding agricultural land and the presence of some infill material within the wetland. The vegetation community of pan 2 was dominated by sedges including Cyperus sp. and Pycreus sp. within the permanent and seasonal zones. AIP's including Verbena bonariensis, Conyza bonariensis and Gomphocarpus sp. have proliferated along the boundary of the temporary zones and disturbed portions of pan 2.</td><td>Ecoservice provision</td><td>Ecoservices category: Intermediate (Score 1.5)
Pan 2 provided an intermediate degree of ecological service provisioning, majority attributed to hydro-functional support services including sediment trapping, phosphate, nitrate and toxicant assimilation, erosion control and biodiversity maintenance. The potential for flood attenuation was also supplied, albeit to a lower degree due to the hydrogeomorphic type setting of these wetlands. The potential for socio-cultural services such as water supply for human use and tourism and recreation also have the potential to be supplied by the pan, however, these services were offered to a minor to a negligible degree.</td></tr>
<tr><td>EIS discussion</td><td>EIS Category: Moderate
Pan 2 was assessed to be of a moderate EIS. This was attributed to the hydro-functional importance of the wetland and sensitivity of the wetland type to changes in water quality and quantity. In addition, due to the size of the pan and vegetation cover, it was considered likely that the pan supports potential habitat for sensitive and less sensitive biota.</td><td>REC, RMO & BAS Category</td><td>REC: C /BAS: C/ RMO: Maintain
Based on the PES and EIS, the RMO is to maintain the ecostatus of Pan 2 at a BAS and REC C. As a result, should any activities be planned within the delineated boundary, the wetland must be managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that at a minimum the RMO is achieved.</td></tr>
</table>

Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
(a) Hydraulic regime The hydraulic regime of pan 2 has likely been affected by increased surface runoff and some infill and deposition which has altered natural infiltration rates within the wetland. AIP's were also considered likely to contribute towards desiccation of the wetland. **(b) Water quality** Water quality sampling was undertaken within pan 2 with measurements including pH, temperature and EC. The pH within pan 2 was 6.24 which was below the ideal range of the RWQO (2011) according to DWA (2011). Temperature was 16.3°C which complied with the TWQR and was considered largely natural for the season and time of day (midday) at which sampling was undertaken. The EC within pan 2 was 3 mS/m which fell below the RWQO according to the DWA (2011). Similar to pan 1, the EC concentrations potentially be affected by the degree of dilution as a result of excessive rainfall experienced during the assessment. Overall, the water quality taken during the assessment was considered largely natural at the time of sampling in February 2021 given the isolated nature of the pan. **(c) Geomorphology and sediment balance** Whilst pans are not considered to undergo large changes to geomorphology, an increased amount of sediment inputs were considered likely due to the potential for increased runoff from surrounding agriculture and deposited material within and along the pan boundary. **(d) Habitat and biota** Pan 2 was considered to provide suitable breeding and foraging habitat for potentially sensitive and less sensitive biota. During the site assessment, the pan was shown to provide roosting habitat for avifauna including *Asio capensis* (Marsh owl). It is also considered likely that the pan is used by other biota including small mammals, over avifauna, reptiles and amphibians.	
Extent of modification anticipated.	Similar to pan 1, pan 2 was also avoided as a result of the optimisation of the proposed development layout and recommendations for the delineated boundary of the pan and associated 10 m construction and operational phase buffer zones as "no-go" is thus advised.
Risk Assessment Outcome & Business Case:	
Moderate	The boundary of pan 2 will be avoided, thereby limiting the potential for direct impacts, however, indirect impacts are still likely to occur. Recommended mitigation measures to limit impacts such as sedimentation include protecting exposed soil for the duration of the construction phase with a suitable geotextile.

Table 8: Summary of the assessment of the Pan 3 situated approximately 60 m upgradient of the surface infrastructure component of the proposed development.

Ecological & socio-cultural service provision graph:

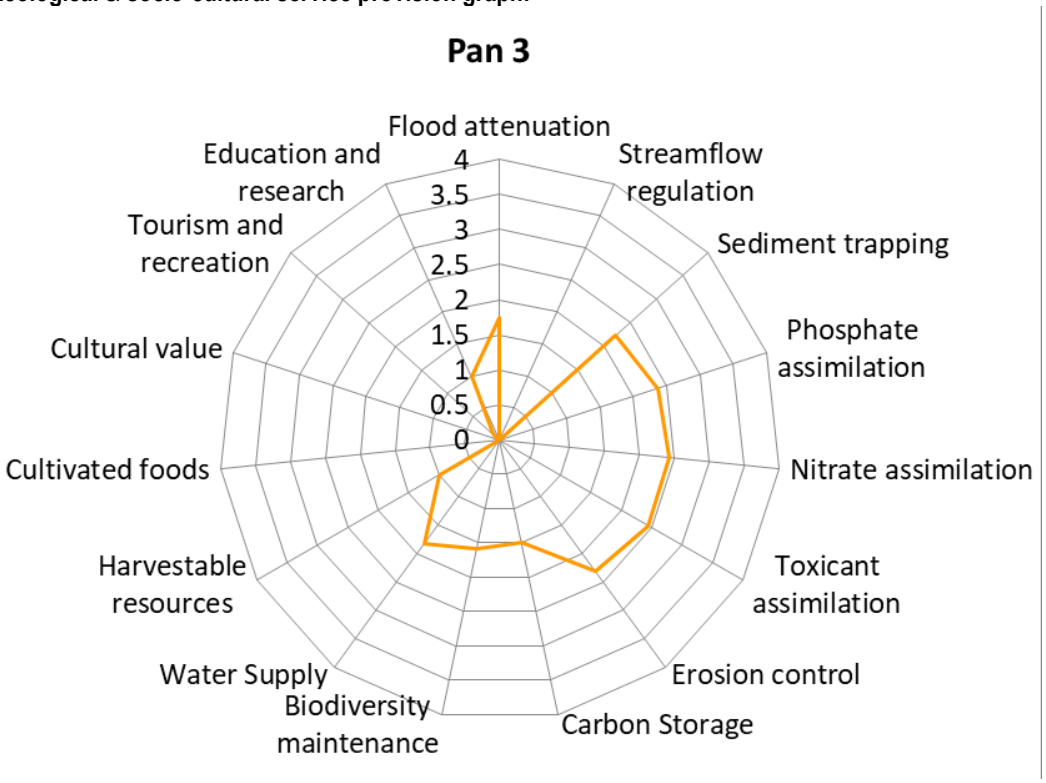


Figure 15: (Top left and right) representative views of Pan 3; (bottom left and right) "leaky portion" of Pan 3 and shallow canal draining into downgradient wetlands.

PES Discussion (WET-Health)	**PES Category: C** Pan 3 is situated approximately 60 m upgradient of UCVB wetland 1 and is considered moderately modified. Pan 3 is considered a "leaky pan" due to the various wetlands within the surrounding catchment (UCVB may receive partial surface water input from the pan during intense rainfall events). The primary impacts on the hydrology and geomorphology of Pan 3 stem from the surrounding agriculture, gravel access road which traverses the boundary of the pan and shallow canal that diverts surface water in the downgradient wetland. The vegetation community of the pan was dominated by grasses such as *Sporobolis africanus* and *Urochloa* sp. along with a mixture of *Cyperus* sp and *Juncus* sp whilst disturbed portions along the agricultural fields contain some AIPs such as *Cirsium vulgare* and *Conyza bonariensis* present within the wetland.	**Ecoservice provision**	**Ecoservices category: Moderately low (Score 1.2)** Pan 3 supplied a moderately low degree of ecological service provisioning. The primary services that the pan supplies were hydro-functional support services including sediment trapping, phosphate, nitrate and toxicant assimilation, and erosion control. Biodiversity maintenance and the potential for flood attenuation were also offered by the pan, although this was to a lower degree. The potential for socio-cultural services such as water supply for human use in particular was provided to a high degree due to the use of water from occupants and animals belonging to the nearby farmstead. The potential for the remaining socio-cultural services however such as harvestable resources, cultivated foods, cultural value, tourism and recreation, and education and research were offered to a very limited degree or absent.

<table>
<tr><td>EIS discussion</td><td>EIS Category: Moderate
The pan was assessed to have a moderate EIS due to the sensitivity of the wetland type and hydro-functional services supplied by the wetland. Due to the frequent anthropogenic disturbance alongside the wetland (agriculture), the potential for breeding and foraging habitat for biota was noted to be supplied albeit to a lesser degree.</td><td>REC, RMO & BAS Category</td><td>REC: C /BAS: C/ RMO: Maintain
The RMO for the wetland based on the PES and EIS scores is to maintain the ecostatus of Pan 3 at a REC C. Any planned activities must be managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that at a minimum the RMO is achieved.</td></tr>
<tr><td colspan="4">Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):</td></tr>
<tr><td colspan="4">(a) Hydraulic regime
Pan 3 has been encroached by a gravel access roadway whilst a shallow canal diverts water into the wetland system downgradient, thereby affecting the hydrology to some degree. The surrounding land-use practices such as agriculture were also considered likely to contribute increased floodpeaks and runoff into the wetland.

(b) Water quality
Water quality sampling was conducted in Pan 3 and included measurements of pH, temperature and EC. The pH of the pan was 6.96 which was below the ideal range of the RWQO (2011) according to DWA (2011). Temperature was 27.6 which complied with the TWQR and was considered largely natural for the season and time of day (midday) at which sampling was undertaken. The EC was 8 mS/m which fell below the RWQO according to the DWA (2011). Overall, the water quality taken within Pan 3 was considered largely natural at the time of sampling in February 2021.

(c) Geomorphology and sediment balance
The geomorphology of Pan 3 was primarily altered by the gravel access road and increased runoff from agricultural activities which have likely altered the natural movement of sediment within the wetland.

(d) Habitat and biota
Pan 3 was considered to provide some degree of habitat support to biota. During the site assessment it was worth noting that Pan 3 was used as a source of drinking water for horses from a nearby farmstead and likely also contributes habitat for avifauna, small mammals and reptiles.</td></tr>
<tr><td>Extent of modification anticipated.</td><td colspan="3">Pan 3 is located upgradient of the proposed development and hence will, at most be affected indirectly by construction and operational phase activities. The delineated boundaries of pan 3 and associated 10 m construction and operational phase buffers will however be avoided from the proposed development activities.</td></tr>
<tr><td colspan="4">Risk Assessment Outcome & Business Case:</td></tr>
<tr><td>Moderate</td><td colspan="3">The primary mitigation measures for consideration for pan 3 include the implementation of dust suppression measures (such as spray watering on gravel access roads) throughout the proposed development activities to prevent excessive dust and which is considered best practice.</td></tr>
</table>

Table 9: Summary of the assessment of the UCVB wetland 1 traversed by the surface infrastructure component of the proposed development.

Ecological & socio-cultural service provision graph:

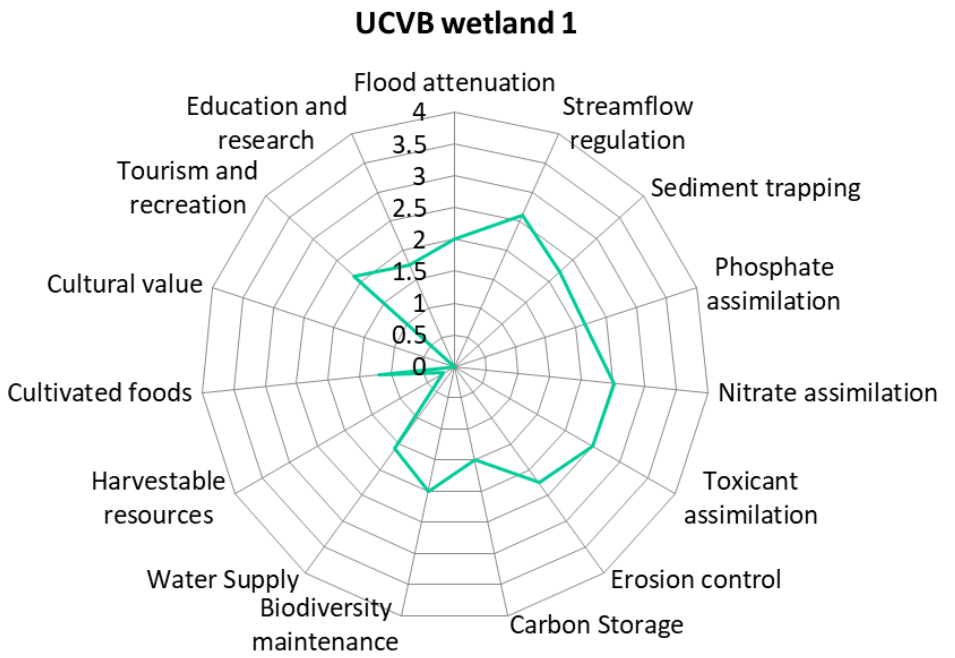


Figure 16: (Top left) Upper portions of the UCVB wetland 1; (top right) lower portion of the UCVB wetland 1, below the railway; (bottom left and right) portion of UCVB wetland 1 situated within the footprint of the surface infrastructure component of the proposed development 2.

PES Discussion (WET-Health)	**PES Category: C** UCVB wetland 1 was classified as moderately modified. The primary impacts affecting the wetland hydrology stem from the surrounding agricultural practices and increased catchment wide runoff and floodpeaks. The wetland has been infringed on by cultivated fields along both the northern and southern extents which have reduced the overall extent of the wetland in some areas. It is also noted that historically, the wetland was impounded along numerous portions which have altered the natural pattern, flow and timing of water within the system. The impoundments were used as cattle watering points and sources of water for irrigation as evident during the site assessment. Impacts to the UCVB wetland 1 hydrology have contributed to subsequent impacts on the geomorphological processes. Whilst the UCVB wetland is predominantly unchannelled, a central channel is present within the lower reaches of the wetland and is attributed to headcut erosion that has migrated upgradient within the wetland. Increased runoff from surrounding agriculture has likely also contributed to increased sediment deposition within the wetland. In addition, the impoundments are considered likely to have altered the natural sediment fluxes within the wetland whilst infill and deposition was present along disturbed areas of the UCVB wetland, downgradient of the railway line (western extent of the wetland). This has resulted in compaction along these portions and reduced the natural infiltration rates into UCVB wetland 1. The natural vegetation community of UCVB wetland 1 was inhabited by	**Ecoservice provision**	**Ecoservices category: Intermediate (Score 1.8)** UCVB wetland 1 provided an intermediate degree of ecological service provisioning with ecological services such as flood attenuation, sediment trapping, erosion control and the assimilation of phosphates, nitrates and toxicants. Socio-cultural services such as tourism and recreation, education and research and water supply for human use were also supplied in addition to biodiversity maintenance due to the size and diversity of habitat within the wetland along with the presence of surface water.

	a variety of species owing to the diversity of habitat types within the wetland. These include *Calamagrostis epigejos*, *Schoenoplectus sp*., *Scirpoides* sp., *Juncus effusus*, *Leersia hexandra*, *Paspalum dilitatum, Typha capensis* and *Helichrysum aureonitens* within the permanent and seasonal zones of the wetland. Disturbed portions along UCVB wetland 1 were dominated by *Verbena bonariensis*, *Campuloclinium macrocephalum, Gomphocarpus fruticosus*, *Cirsium vulgare* and *Datura strarmonium* which may likely worsen and affect the health of the wetland if left unattended.		
EIS discussion	**EIS Category: High** The UCVB wetland 1 was assessed to have a high EIS due to the sensitivity of the wetland type and supply of hydro-functional support services that the wetland provides. The UCVB wetland 1 is noted to supply breeding and feeding habitat especially given the diversity of habitat types it contains. The wetland is also noted to be situated upgradient and drain into the Leeufonteinspruit and is situated adjacent to pans 1 and 2 which increase the likelihood of the wetland being used for migration and foraging habitat for biota.	**REC, RMO & BAS Category**	**REC: C /BAS: C/ RMO: Maintain** The RMO for UCVB wetland 1 based on the PES and EIS scores is to maintain the ecostatus of the wetland at a REC C. Any planned activities must be managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that at a minimum the RMO is achieved.

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

(a) Hydraulic regime

The hydraulic regime of the UCVB wetland has been affected by increased floodpeaks from surrounding land-use activities such as agriculture and hardened surfaces within the catchment. As such the UCVB wetland 1 is subject to increased runoff and surface water inputs. Impoundments within the system have also altered the natural pattern, timing and flow within the UCVB wetland.

(b) Water quality

Water quality sampling was conducted in the UCVB wetland and included measurements of pH, temperature and EC. The pH of UCVB wetland 1 was 6.23 which was below the ideal range of the RWQO (2011) according to DWA (2011). Temperature was 23.3°C which complied with the TWQR and was considered largely natural for the season and time of day (midday) at which sampling was undertaken. The EC was 17 mS/m which fell below the RWQO (30 mS/m) according to the DWA (2011). Overall, the water quality taken within the UCVB wetland was considered largely natural at the time of sampling in February 2021, however, changes need to be monitored to ensure no significant deviations from the natural range occur within the future.

(c) Geomorphology and sediment balance

The geomorphology of the UCVB wetland was primarily impacted by increased sediment from increased runoff and floodpeaks. The UCVB wetland 1 has also been affected by headcut erosion which has migrated up the channel. Infill and deposition that was likely attributed to construction of the railway has resulted in compaction, and encroachment along the wetland boundaries which have ultimately also resulted in the runoff of infill material within the wetland.

(d) Habitat and biota

The UCVB wetland 1 was shown to have a diversity of habitat types which would increase the potential for the wetland to support biota. The wetland is also located adjacent to pans 1 and 2 and is considered likely to contribute some degree of habitat for migration as well as breeding and foraging habitat to biota. During the site assessment, the UCVB wetland was utilised by avifauna such as *Asio capensis* (Marsh Owl) and *Euplectes orix* (Southern red bishop).

Extent of modification anticipated	UCVB wetland 1 extends throughout the majority of the footprint of the surface infrastructure component of the proposed development and is considered likely to be affected indirectly after the optimisation of the surface infrastructure to avoid the wetland.

Risk Assessment Outcome & Business Case:

Moderate	It is strongly recommended that the delineated boundary of UCVB wetland 1 and 10 m construction and operational phase buffers are cordoned off using a suitable barrier or material which is also able to control sedimentation as “no-go” areas as part of the proposed development. In addition, it is recommended that the majority of site clearing (where feasible) should ideally take place during the dry season to limit potential impacts to the wetland as a result of construction activities.

Table 10: Summary of the assessment of the CVB wetland associated with the Olifants River traversed by the high voltage line to Ysterkop.

Ecological & socio-cultural service provision graph:

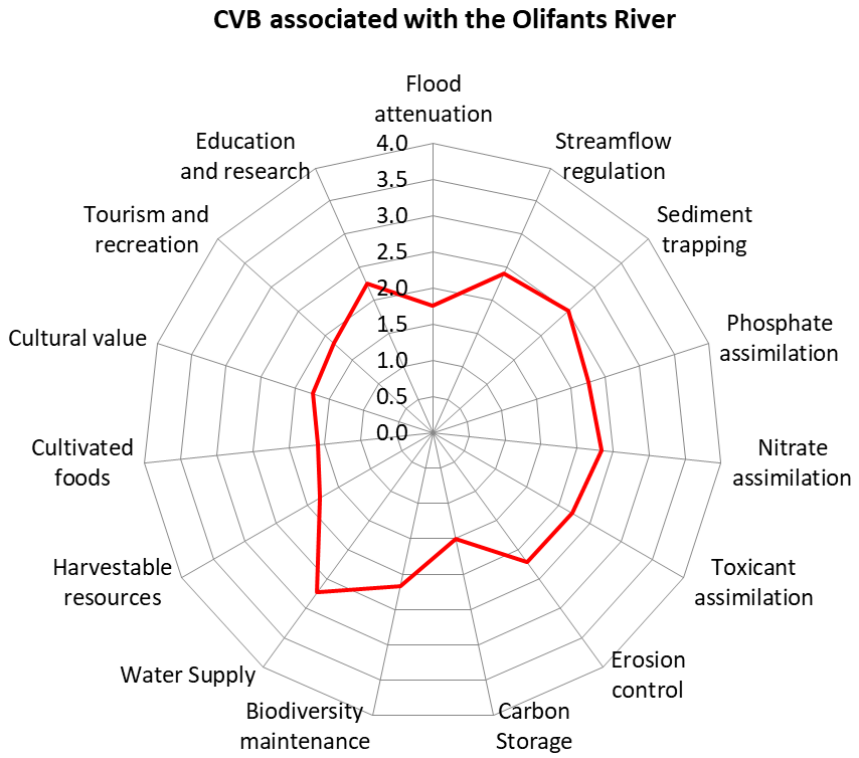


Figure 17: (Top left and right) representative photographs of the channelised portions of the CVB wetland; (bottom left) erosion occurring along the wetland; (bottom right) AIP's associated with the Olifants River.

PES Discussion (WET-Health)	**PES Category: D** CVB wetland 1 associated with the Olifants River is to be traversed by the linear development component of the proposed development. The CVB wetland is subject to numerous impacts along its course and was classified as largely modified. Primary impacts to hydrology include increased flood peaks and surface water input from catchment wide runoff and surrounding mining areas, respectively. The CVB wetland associated with the Olifants River is also subject to increased agricultural runoff and industrial discharge from catchment land-uses. The wetland is also bisected by numerous roadways along the reach of the wetland however, large box culverts underneath roadways have maintained hydraulic connectivity to a large degree. The geomorphology of the CVB wetland has been altered by the increased surface water and by extension, increased sediment inputs. The site assessment indicated that bankside collapse, erosion and subsequent deposition is occurring along the active channel of the wetland. These erosion events along with development of various industries have necessitated the construction of gabion structures and canalisation within portions of the wetland. The vegetation community of the wetland was dominated by grasses such as *Sporobolis africanus, Setaria sp.,* sedges and some woody	**Ecoservice provision**	**Ecoservices category: Moderately high (Score 2.1)** CVB wetland 1 provided a moderately high degree of ecological service provisioning attributed to hydro-functional support services such as flood attenuation, streamflow regulation, sediment trapping, erosion control, and the assimilation of phosphates, nitrates and toxicants owing to the size of the wetland in relation to the catchment. The CVB wetland also provided biodiversity maintenance and socio-cultural support services such as the potential for water supply, harvestable resources, cultivated foods, cultural value, tourism and recreation and education and research.

	vegetation such as *Salix* sp. AIP's including *Tagetes minuta* and *Conyza bonariensis* have also proliferated along disturbed portions of the CVB wetland.		
EIS discussion	**EIS Category: High** The CVB wetland was assessed to have a high EIS attributed to the hydro-functional importance, and sensitivity and landscape size of the wetland relative to the catchment. Due to the scale of the Olifants River associated with the CVB wetland, the wetland is considered to provide habitat to terrestrial, riverine and aquatic species.	**REC, RMO & BAS Category**	**REC: D /BAS: D/ RMO: Maintain** The RMO for the CVB wetland 1 based on the PES and EIS scores is to maintain the ecostatus at a REC D. Should any planned activities occur within the CVB wetland, these must be managed to mitigate (in-line with the mitigation hierarchy) impacts and ensure that at minimum, the RMO is achieved.

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

(a) Hydraulic regime

The CVB hydrological regime has been altered by increased surface water inputs from mining, agriculture and industry within the catchment.

(b) Water quality

The water quality of CVB wetland 1 was sampled for measurements including pH, temperature and EC. The pH of CVB wetland 1 was 7.24 which was within the ideal range of the RWQO (2011) according to DWA (2011). Temperature was 21.3°C which complied with the TWQR and was considered largely natural for the season and time of day (midday) at which sampling was undertaken. Electrical Conductivity was 27 mS/m which fell below the RWQO according to the DWA (2011). Overall, the water quality taken during the assessment was considered largely natural.

(c) Geomorphology and sediment balance

The geomorphology of the wetland was altered with increased sediment and deposition as well as subsequent erosion owing to increased surface water that the wetland receives from surrounding land uses in the catchment such as industry.

(d) Habitat and biota

CVB wetland 1 provides habitat for biota including owing to the instream channel and presence of surface water as well as the adjacent wetland habitat. This increases the potential for the migration sites and habitat for breeding and foraging. As such, CVB wetland 1 is considered likely to inhabit aquatic and terrestrial species such as avifauna, small mammals, invertebrates, amphibians, reptiles and icythofauna.

Extent of modification anticipated	CVB wetland 1 extends is traversed by the linear development component of the proposed development and as these are overhead lines, it is likely to be only affected indirectly. However, the placement of support structures to facilitate the high voltage line may result in indirect impacts to the wetland.

Risk Assessment Outcome & Business Case:

Moderate	The delineated boundary of CVB wetland 1 and 10 m construction and operational phase buffers are to be cordoned off as "no go" areas and it is recommended that mitigation measures are to be implemented to limit impacts such as sedimentation by protecting exposed soil for the duration of the construction phase with a suitable geotextile.

Table 11: Summary of the assessment of the CVB wetland 2 traversed by the high voltage line to Ysterkop.

Ecological & socio-cultural service provision graph:

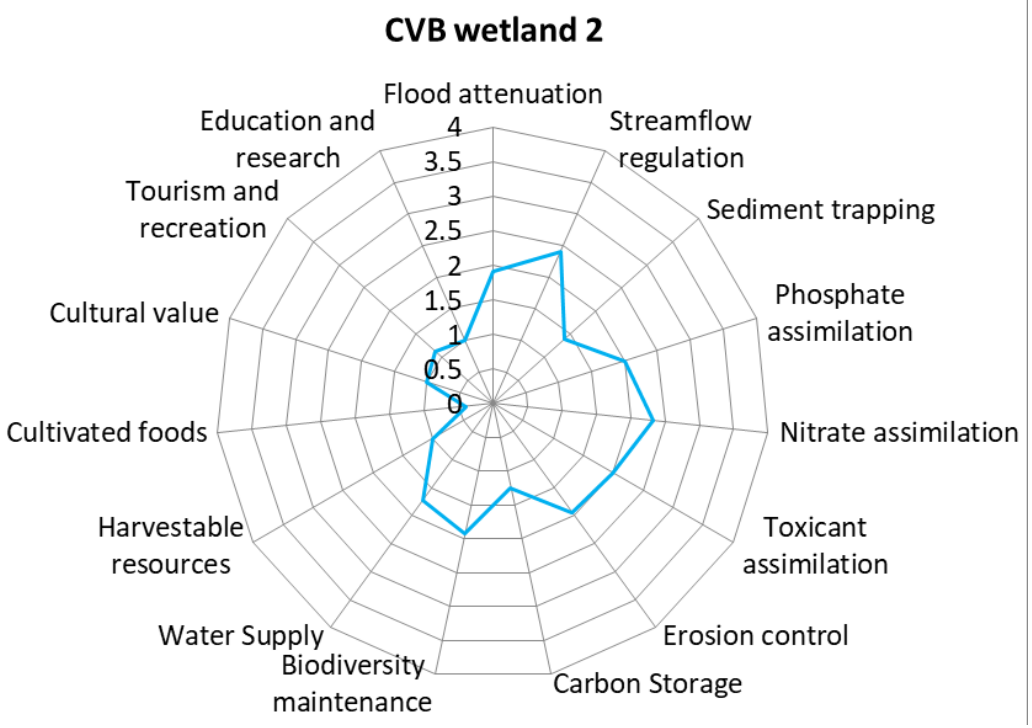


Figure 18: (Top left) Representative view of CVB wetland 2 showing vegetation cover (top right and bottom left) central channel within the CVB wetland 2 undergoing erosion (bottom left) portion of the CVB wetland showing infrastructure of the Halfgewonnen Colliery in the background.

PES Discussion (WET-Health)	**PES Category: C** CVB wetland 2 is situated towards the southernmost extent of the linear component of the proposed development and is classified as moderately modified. Impacts to hydrology include increased floodpeaks from adjacent agricultural activities. The CVB wetland is also noted to receive increased runoff from activities of the Halfgewonnen Colliery, specifically overflow from the mining related water retention dams. Geomorphology of the CVB wetland 2 was primarily affected by the increased surface runoff from the water retention dams of the mine and surrounding agricultural activities which have likely contributed increased runoff and sediment into the wetland. The active channel of the CVB wetland has also undergone incision and erosion, negatively affected the wetland geomorphology. The vegetation community of the wetland was dominated by *Typha capensis* and *Imperata cylinderica*, *Learsia hexandra*, *Juncus effusus, Calamagrostis epigejos* and *Themeda triandra* with disturbed portions infested with *Conyza bonariensis.*	**Ecoservice provision**	**Ecoservices category: Intermediate (Score 1.7)** The CVB wetland 2 provided an intermediate degree of ecological service provisioning with ecological services such as streamflow regulation, flood attenuation, sediment trapping, erosion control and the assimilation of phosphates, nitrates and toxicants. The wetland also supplied biodiversity maintenance and the potential for socio-cultural service provisioning such as education and research and water supply for human use whilst cultural value and use of the wetland for cultivated foods was low to absent.

EIS discussion	**EIS Category: High** The CVB wetland 2 was assessed to have a high EIS due to the sensitivity of the wetland type and hydro-functional importance of the wetland. The wetland is identified as a CBA wetland according to the MBSP (2019). Potential breeding and foraging habitat for biota was noted to be supplied especially given the proximity to other wetlands within the landscape and connectivity to the Olifants River situated downstream.	**REC, RMO & BAS Category**	**REC: C /BAS: C/ RMO: Maintain** The RMO for the wetland based on the PES and EIS scores is to maintain the ecostatus of the CVB wetland 2 at a REC C. Any planned activities must be managed to mitigate (in-line with the mitigation hierarchy) impacts to ensure that at a minimum the RMO is achieved.
Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):			
(a) Hydraulic regime The CVB wetland 2 hydraulic regime was primarily affected by increased floodpeaks and surface inputs from the Halfgewonnen Colliery and agricultural runoff. This has resulted in an increased degree of hydrological recharge from normal conditions which has likely resulted in alteration of the wetland zonation. **(b) Water quality** *In-situ* water quality monitoring for CVB wetland 2 was not undertaken during the assessment in February 2021, however potential impacts on the water quality may be considered likely. **(c) Geomorphology and sediment balance** The geomorphology of the CVB wetland 2 was altered by increased surface water input as well as agricultural runoff which have likely increased deposited sediment and altered the natural sediment fluxes of the wetland. It was also noted that the increased runoff and floodpeaks that the wetland receives have exacerbated incision and erosion of the active channel which has also affected the wetland geomorphology. **(d) Habitat and biota** CVB wetland 2 was shown to provide habitat to support biota attributed to the well vegetated nature of the wetland. Whilst it was acknowledged that some anthropogenic disturbance to biota was anticipated due to the proximity of the wetland to the surrounding Halfgewonnen Colliery and agricultural practices, due to the size and proximity of the wetland to other natural areas, the wetland was still considered important as breeding and feeding habitat to biota. CVB wetland 2 is also indicated as a CBA wetland (MBSP, 2019) and drains into the Olifants river which increases the potential of the wetland to provide natural habitat for biota.		
Extent of modification anticipated	Similar to CVB wetlad 1, CVB wetland 2 will be traversed by the linear development component of the proposed development and as these are overhead lines, it is likely to be only affected indirectly. The placement of support structures to facilitate the high voltage line may however result in indirect impacts to the wetland.		
Risk Assessment Outcome & Business Case:			
Moderate	CVB wetland 2 is classified as a CBA wetland according to the MBSP (2014) database, as such CVB wetland 2 is subject to a 100 m MBSP Setback buffer which should be cordoned off as a “no go” area.		

Table 12: Summary of the assessment of the Seep wetland 1 traversed by the linear component of the proposed development.

Ecological & socio-cultural service provision graph:

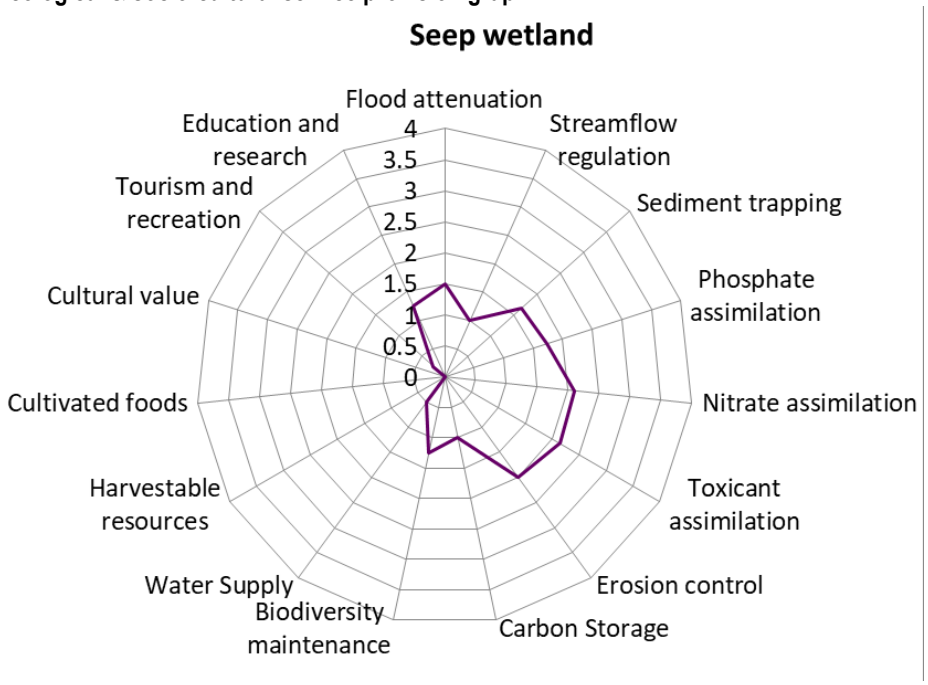


Figure 19: (Top left and right) representative photographs of the seep vegetation cover by *Juncus effusus;* (bottom left) erosion and formation of a channel within the seep*; (*bottom right) culvert which facilitates additional runoff into the seep.

PES Discussion (WET-Health)	**PES Category: C** The seep wetland is situated along the linear component of the proposed development and is classified as moderately modified. The primary impacts to the seep hydrology stem from increased surface water inputs from agricultural activities upgradient and channelised surface water from the Halfgewonnen Colliery. The increased hydrological recharge has likely contributed to alteration of the wetland hydroperiod. Geomorphology of the seep has primarily been impacted by the formation of erosion channels that drain into the Olifants River situated downgradient. An increased amount of sediment deposition was also considered likely due to the increased flood peaks that the wetland receives. The wetland was primarily vegetated by *Juncus sp*., *Calamagrostis epigejos* and *Sporobolis sp*. Some AIP's such as *Cirsium vulgare*, *Conyza bonariensis* and *Gomphocarpus fruticosus* was also prevalent within the seep and have contributed to negatively affecting the wetland health.	**Ecoservice provision**	**Ecoservices category: Moderately low (Score 1.1)** The seep provided a moderately low degree of ecological service provisioning with ecological services such as flood attenuation, sediment trapping, erosion control and the assimilation of phosphates, nitrates and toxicants the primary services supplied. Due to the limited size of the seep, biodiversity maintenance was also supplied by the wetland, albeit considered limited. The seep wetland was also considered limited in terms of socio-cultural services with education and research from previous studies considered one of the primary services provided in this regard.
EIS discussion	**EIS Category: Low/marginal** The seep was assessed to have a low EIS attributed to some degree of hydro-functional importance, besides its small size and isolated nature. Whilst the wetland may provide some degree of foraging habitat, due to the low vegetation cover and ongoing disturbance, this was noted to be limited.	**REC, RMO & BAS Category**	**REC: C /BAS: C/ RMO: Maintain** The RMO for the seep based on the PES and EIS scores is to maintain the ecostatus at a REC C. Should any planned activities occur within the seep, these must be managed to mitigate (in-line with the mitigation hierarchy) impacts and ensure that at minimum, the RMO is achieved.

Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
(a) Hydraulic regime The seep wetland hydrological regime has been altered due to increased floodpeaks, agricultural runoff and surface water input from the Halfgewonnen Colliery. It was considered likely that the increased surface water inputs have contributed alterations to the wetland hydroperiod. **(b) Water quality** The seep lacked sufficient surface water and as a result, i*n-situ* water quality monitoring was not undertaken during the assessment in February 2021. **(c) Geomorphology and sediment balance** Geomorphology within the seep has been altered due to the additional surface water input from the Halfgewonnen Colliery and agricultural runoff which have likely resulted in increased sediment deposition into the wetland. Some erosion has also occurred within the seep which has created a "channel" linked to the Olifants River situated downgradient. **(d) Habitat and biota** The seep wetland was considered to contribute a limited degree of supporting habitat to biota due to the small size, limited vegetation cover and frequent anthropogenic disturbances surrounding the wetland. Whilst this is noted, due to the relative proximity to other natural areas within the landscape, some degree of biodiversity maintenance for less sensitive species may still be considered likely.	
Extent of modification anticipated	The seep wetland is to be traversed by the linear development component of the proposed development with only indirect impacts anticipated.
Risk Assessment Outcome & Business Case:	
Moderate	As with the other wetlands that are to be indirectly affected by the proposed development, seep wetland 1 and 10 m construction and operational phase buffers are to be cordoned off as "no go" areas and mitigation measures to control sedimentation such as the use of a suitable geotextile are recommended, should the need arise.

Table 13: Summary of the assessment of Seep wetland 2 traversed by the surface infrastructure component of the proposed development.

Ecological & socio-cultural service provision graph:

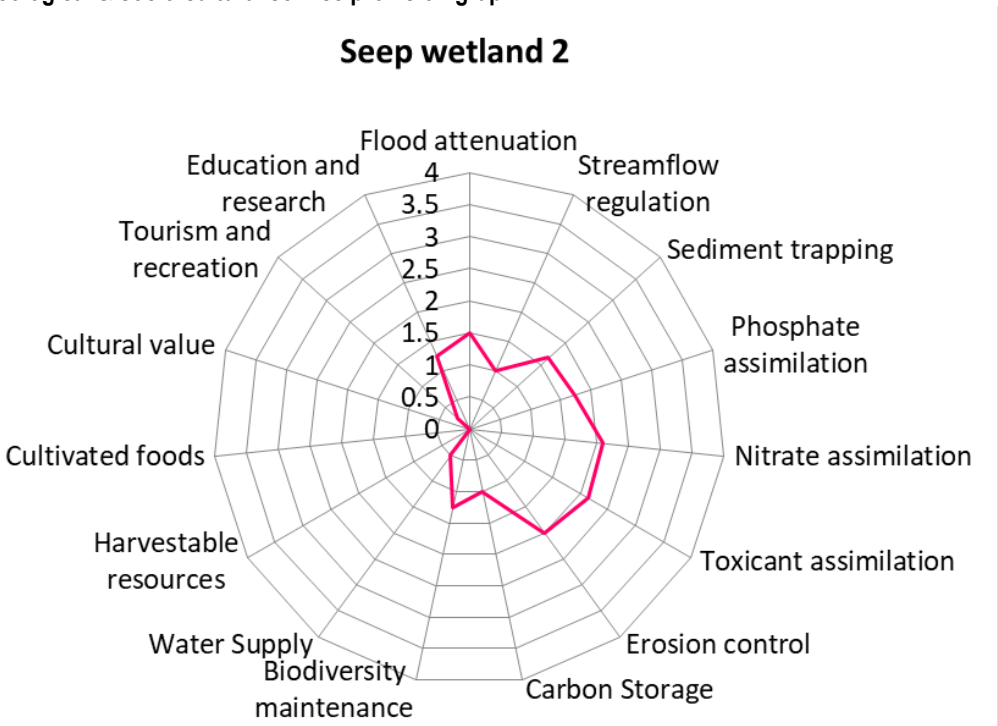


Figure 20: Representative photographs of the seep wetland 2 vegetation cover by *Imperata cylindrica* with the presence of footpaths and historical disturbance along the wetland.

PES Discussion (WET-Health)	**PES Category: D** Seep wetland 2 is situated within the footprint of the surface infrastructure component of the proposed development (specifically 20 MW PV Panels) and is classified as largely modified. The hydrology of the seep has been affected by activities in the catchment such as historical excavation in the catchment which has altered runoff patterns and increased compaction in the wetland and adjacent landscape. An artificial trench is also situated upgradient of seep wetland 2 which is likely to have reduced recharge that the seep may have received, under unimpacted conditions and therefore promote desiccation of the wetland. The seep geomorphological processes have been impacted by the historical excavation which likely contributes increased sedimentation of the wetland. Vegetation within the seep was primarily dominated by *Imperata cylindrica* with AIP encroachment by *Flaveria bidentis* along the seasonal and temporary zones of the wetland.	**Ecoservice provision**	**Ecoservices category: Moderately low (Score 1.1)** Seep wetland 2 provided a moderately low degree of ecosystem services including sediment trapping, assimilation of phosphates, nitrates and toxicants and flood attenuation and erosion control to a lesser extent. The seep supplies services such as biodiversity maintenance to a limited extent given the degraded nature and relatively short vegetation cover. Socio-cultural services of seep wetland 2 were also limited due to the degraded nature and isolated locality in the landscape.

EIS discussion	**EIS Category: Low/marginal** The EIS of seep wetland 2 was assessed as low and primarily attributed to hydro-functional support of the wetland. The wetland was also dominated by short vegetation cover and therefore, breeding and feeding habitat for biota was still offered, albeit to a limited degree.	**REC, RMO & BAS Category**	**REC: C /BAS: C/ RMO: Maintain** The RMO for seep wetland 2 is to maintain the ecostatus at a REC D. The planned activities such as the placement of the surface infrastructure component within the seep must be managed to mitigate (in-line with the mitigation hierarchy) impacts and ensure that at minimum, the RMO is achieved.
Watercourse drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):			
(a) Hydraulic regime The hydrological regime of seep wetland 2 has been affected by compaction and alterations in runoff patterns within the landscape. A trench upgradient is also considered likely to reduce recharge of the seep and alter natural hydrology. **(b) Water quality** The seep lacked sufficient surface water and as a result, i*n-situ* water quality assessment was not undertaken. **(c) Geomorphology and sediment balance** Geomorphology of seep wetland 2 has primarily been altered by increased sediment that is likely received from the surrounding excavated landscape. In addition, additional runoff from adjacent agricultural activities are also considered likely to contribute sediment into the seep. **(d) Habitat and biota** The availability of habitat to biota provided by seep wetland 2 was considered limited owing to the short vegetation cover and uniformity of habitat as well as the wetlands degraded nature, albeit the wetland may still provide biodiversity maintenance for less sensitive species.			
Extent of modification anticipated	The boundary of seep wetland 2 falls within the footprint of the infrastructure component of the proposed development and as such is likely to receive direct impacts during construction and operational phase activities. This include the laydown of the solar PV panels within the wetland which will result in decline fo the health and functionality of the wetland.		
Risk Assessment Outcome & Business Case:			
Moderate	As seep wetland 2 is likely to be directly impacted by the proposed development, it is recommended that impacts on hydraulic processes and geomorphological stability must be minimised as far as possible, including the use of suitable sediment control devices such as geotextiles and undertaking the laydown of the PV panels and support infrastructure during the dry season.		

5 LEGISLATIVE REQUIREMENTS PROVINCIAL GUIDELINES AND BUFFER ZONE REQUIREMENTS

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 to be 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 assessed wetlands can be summarised as follows:

Table 14: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application for water uses as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998).	**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)** 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 21 (c) and 21 (i) 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 **500 m radius from the delineated boundary (extent) of any wetland** or pan in terms of this regulation.
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended must be taken into consideration. The activities which might trigger the required authorisations must be determined by the EAP in consultation with the relevant authorities.	**Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 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;* *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.* excluding— (dd) where such development occurs within an urban area; or (ee) where such development occurs within existing roads or road reserves or railway line reserves; **Activity 19** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA regulations, 2014 (as amended) states "The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse.
Specific guidelines for meeting minimum requirements for CBA and ESA wetlands (MBSP, 2014).	• All wetlands are protected under the National Water Act, 1998 (Act No. 36 of 1998). • In terms of the National Water Act, 1998 (Act No. 36 of 1998)., freshwater ecosystems (all wetlands included) should not be allowed to degrade to an unacceptably modified condition (E or F ecological category); • Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status. • Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetlands.

These zones of regulation must be taken into consideration during any future planning processes, in line with the mitigation hierarchy as advocated by the Department of Environmental Affairs (DEA) *et. al*, 2013, and should they be encroached upon then the relevant authorisations will need to be obtained prior to the commencement of any activities. The delineated wetlands and their applicable zones of regulation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (GN 509), NEMA (2014) and MBSP (2019) as well as the calculated 10 m construction and operational phase buffers are conceptually depicted in Figure 21 to 24, below.

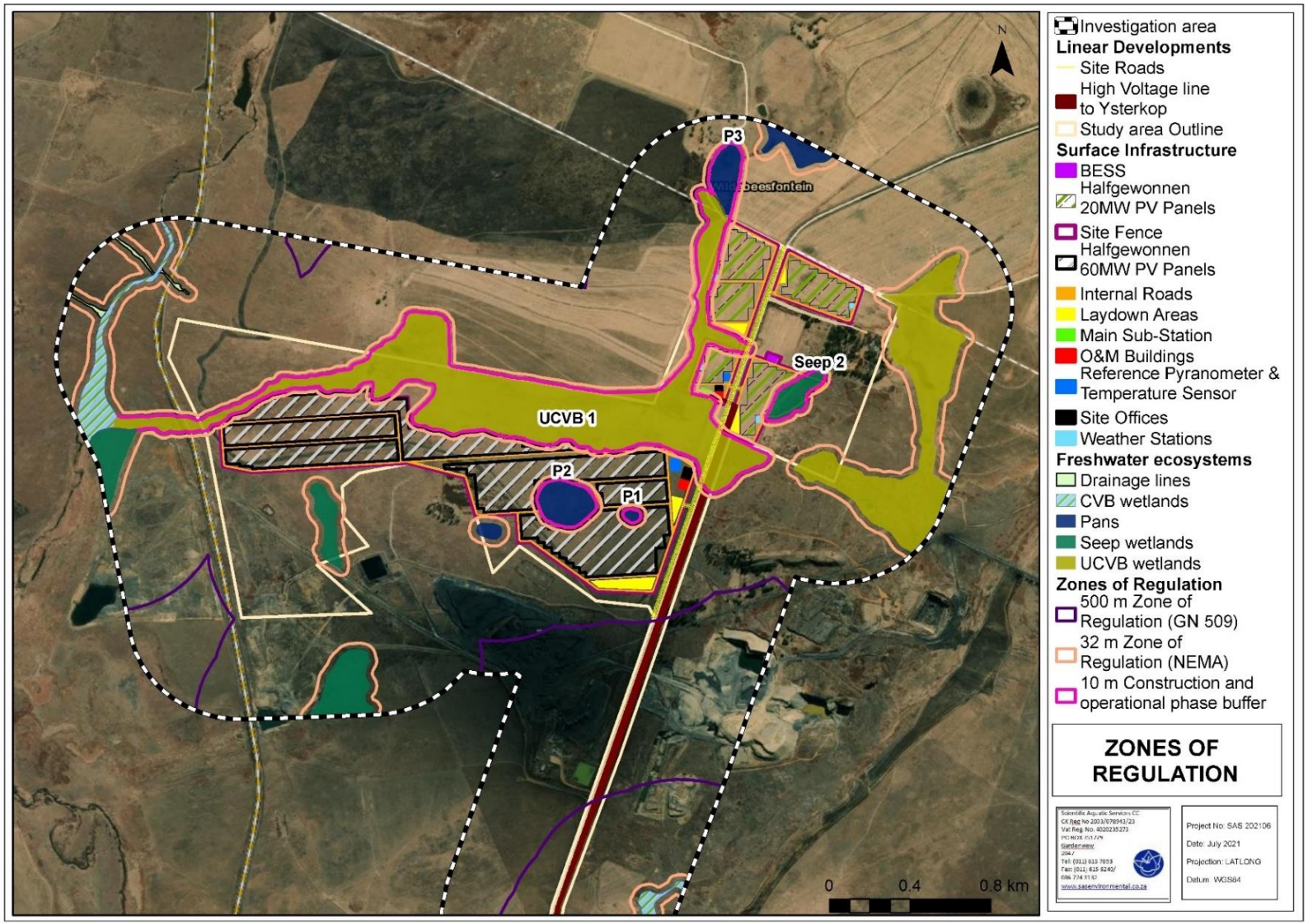


Figure 21: Zoomed in conceptual representation of the zones of regulation in terms of NEMA and GN 509 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) and buffer zones associated with the proposed development and investigation area.

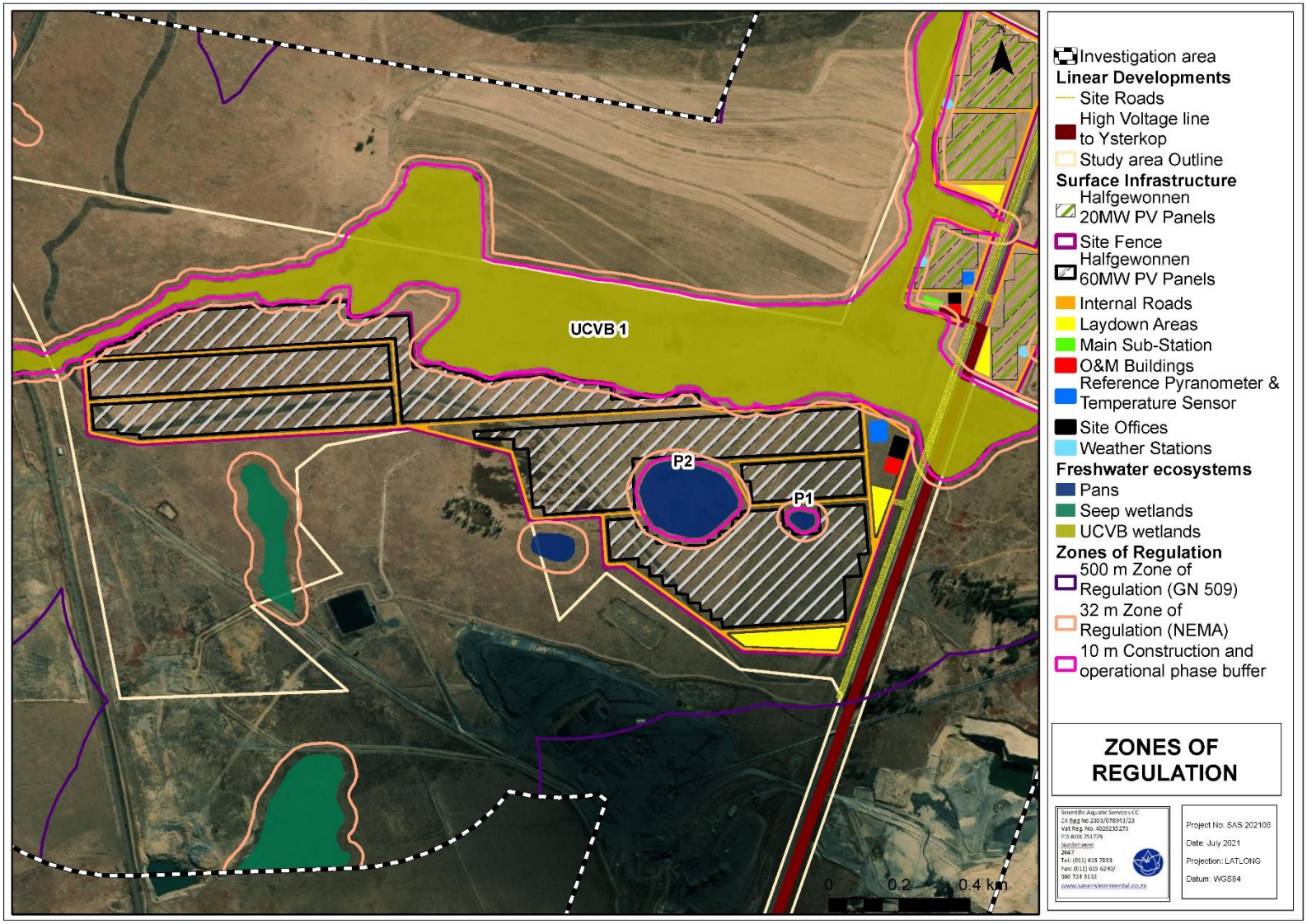


Figure 22: Zoomed in conceptual representation of the solar PV panels and zones of regulation in terms of NEMA and GN 509 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) and buffer zones associated with the proposed development and investigation area.

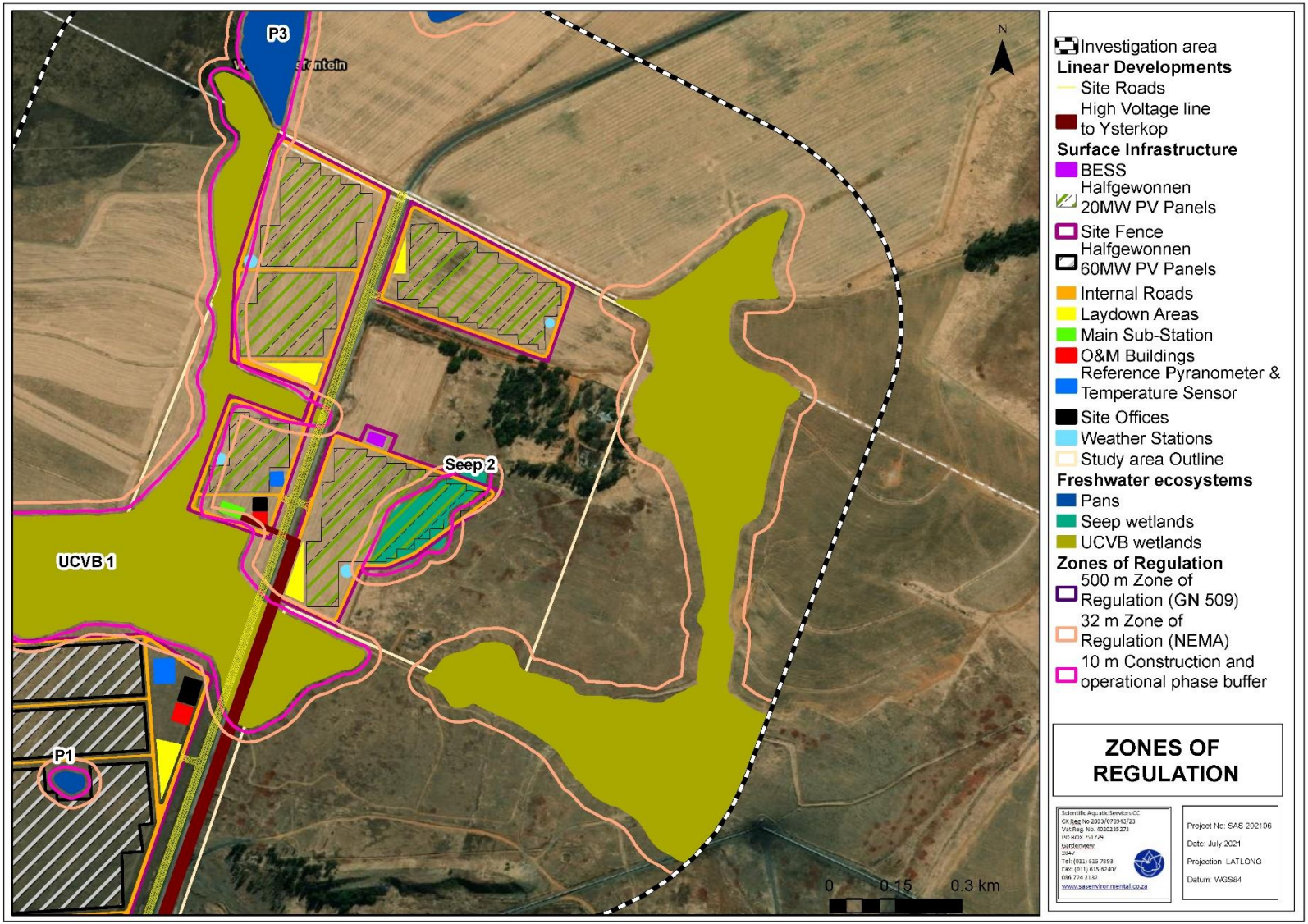


Figure 23: Zoomed in conceptual representation of the solar PV panels and zones of regulation in terms of NEMA and GN 509 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) and buffer zones associated with the proposed development and investigation area.

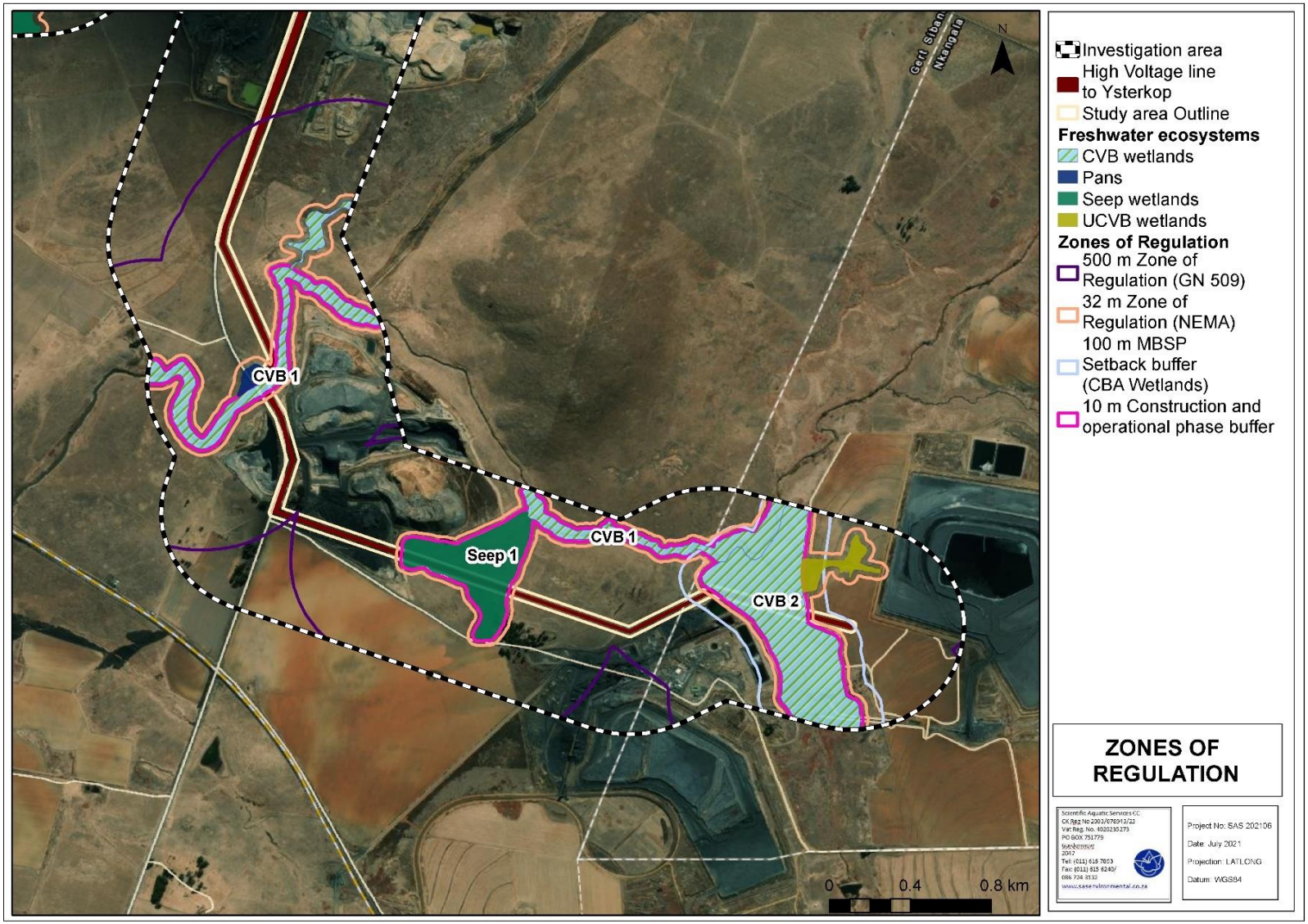


Figure 24: Zoomed in conceptual representation of the zones of regulation in terms of NEMA and GN 509 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) and buffer zones associated with the proposed development and investigation area.

6 RISK ASSESSMENT

6.1.1 Consideration of impacts and application of mitigation measures

Following the assessment of the wetlands associated with the proposed development, the DWS prescribed Risk Assessment Matrix (2016) was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of these wetlands. These results are summarised in Table 15, presented at the end of Section 6.1.2 of this report.

The points below summarise the considerations undertaken when applying the DWS Risk Assessment Matrix (2016):

- The DWS Risk Assessment Matrix (2016) was applied assuming that a high level of mitigation will be implemented, thus the results, provided in this report presents the perceived impact significance ***post-mitigation***;
- In applying the risk assessment, it was assumed that the mitigation hierarchy as advocated by the DEA *et al* (2013) would be followed, i.e. the impacts would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;
- Should the proposed development layout change from the layout provided and assessed in this report or details pertaining to the construction and use of materials become available, the Risk Assessment Matrix will need to be revised and potentially amended based on the new design layout and specifics;
- The proposed development will be located within the applicable 500 m ZoR in terms of the National Water Act, 1998 (Act No. 36 of 1998) of all wetlands. As such, all legal issues pertaining to aspects and activities relating to the wetlands were scored as “5”;
- While the operation of the proposed development will be a permanent activity, the construction thereof is envisioned to take no more than a few months to a year. However, the frequency of the construction impacts may be daily during this time; and
- Most impacts are considered to be easily detectable, with the exception of potential contamination of surface and groundwater which will require some effort. Assessing these potential impacts falls outside of the scope of this freshwater ecosystem study.

6.1.2 Impact discussion and essential mitigation measures

There are four key ecological impacts on the wetlands that are anticipated to occur namely,

- Loss of wetland habitat and ecological structure;

- Changes to the sociocultural and service provision;
- Impacts on the hydrology and sediment balance of the wetlands; and
- Impacts on water quality.

This section presents the significance of potential impacts on the freshwater ecology of the wetlands associated with the proposed development. In addition, it indicates the required mitigatory measures needed to minimise the perceived impacts of each of the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented. At the time of the assessment (February 2021) and compilation of this report, no construction method statement or proposed construction works besides the footprint of the study area and surface and linear component infrastructure overlays was provided. As a result, the risk assessment was based purely on the three proposed development footprint and infrastructure overlays, and information as provided by the proponent, taking into account basic good practice principles for construction and assumptions based on the site conditions. The proposed development will entail the laydown of Photovoltaic (PV) panels and infrastructure such as buildings including a main substation and battery storage. As a result, potential risks pertaining to clearing and excavation activities within (specifically, seep wetland 2) and adjacent to wetland habitat is anticipated during construction and operational phases of the proposed development. The potential risks are briefly presented below:

- Whilst the surface infrastructure component of the proposed development was moved outside of the delineated wetlands (with the exception of seep wetland 2) to avoid impacts to the freshwater ecosystem, some indirect impacts relating to construction and operational phase activities was still considered likely and assessed within the contents of this Risk Assessment Matrix;
- Wetlands assessed for direct impacts are confined to seep wetland 2 whilst wetlands assed for indirect impacts include CVB wetlands 1 and 2, seep wetland 1, UCVB wetland 1 and pans 1, 2 and 3;
- The clearing, excavation and laydown of concrete and construction of infrastructure that forms part of the surface infrastructure component of the proposed development which may result in encroachment of the delineated wetlands (specifically seep wetland 2) and associated 10 m construction and operational phase buffer zones. In addition, these activities may result in decreased ecological service provisioning, potential for degradation in wetland health and ingress of hydrocarbons, toxicants and sediment runoff into the wetlands. This may have a cumulative impact on the health, functionality and water quality of the freshwater ecosystems;

- Pollutants from construction and excavation activities (sediment, contaminated runoff and hydrocarbons) and spills during the construction and operational phase may contaminate nearby freshwater ecosystems and/or groundwater reserves;
- Potential changes to the pattern, flow and timing of water in the landscape due to the introduction of infrastructure within the wetlands;
- The potential for the exposure of soil and increased sediment laden runoff (potentially transporting toxicants and nutrients)) and thus increased sedimentation of the wetlands;
- Possible alterations to vegetation community composition as a result of increased alien vegetation proliferation arising from disturbance to soil profiles and clearing of vegetation in the construction footprint;
- Soil and water contamination from oils and hydrocarbons resulting from vehicular transport;
- Loss of wetland and freshwater ecosystem drivers;
- Potential for deterioration in water quality, including increased likelihood of dust generation, turbidity and sedimentation within the wetlands; and
- Noise disturbance and barriers to avifauna and aquatic biota associated with the placement of surface infrastructure within the wetlands.

Various activities and development aspects may lead to these impacts, however, provided that the mitigation hierarchy is followed, some impacts can be avoided or adequately minimised where avoidance is not feasible. The typical arrangement of components in a conceptual PV development is indicated in Figure 25, below followed by a summary of the risk assessment in Table 15. A comprehensive outcome of the risk assessment is presented in Appendix B. Additional “good practice” mitigation measures applicable to a project of this nature are provided in Appendix F of this report.

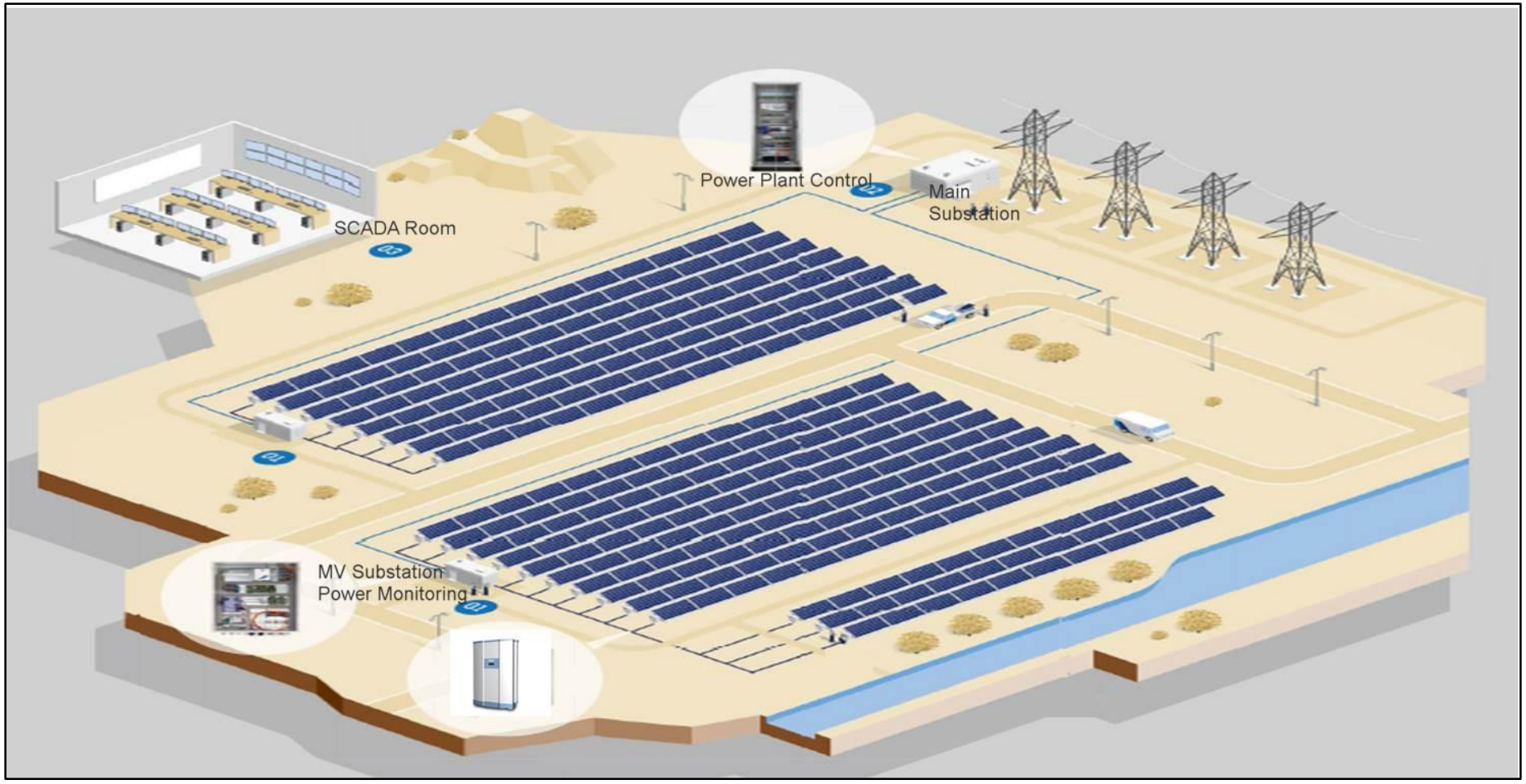


Figure 25: Representative typical arrangement of components in a conceptual PV development (as received from Cabanga Environmental, 2021).

Table 15: Summary of the results of the DWS risk assessment matrix applied to the wetlands associated with the proposed development.

No.	Phases	Activity	Aspect	Impact	Significance	Risk Rating	Control Measures
1	Construction	Site clearing and set-up of contractor camps prior to commencement of construction activities.	Wetlands directly affected by the Halfgewonnen Solar PV Facility (specifically seep wetland 2): *Removal of vegetation leading to exposure and associated disturbances to soil; *Exposure of soil and increased likelihood of dust generation into seep wetland 2; *Potential creation of access roads to facilitate contractor laydown areas and subsequent construction activities; *Laydown of construction offices and ablution facilities adjacent to the wetlands; *Movement of construction vehicles within the seep wetland.	*Compaction of soil due to the movement of heavy machinery within seep wetland 2; *Reduced vegetation cover within seep wetland 2; *Alteration of runoff patterns into seep wetland 2; *Smothering of the vegetation within seep wetland 2 as a result of increased sediment leading to altered habitat; *Disturbance of soil leading to increased AIP proliferation into seep wetland 2; *Potential decrease in ecoservice of seep wetland 2; *Potential soil and stormwater contamination from oils as well as hydrocarbons into the seep wetland 2 from construction machinery; *Loss of breeding and feeding habitat for faunal and aquatic biota; *Anthropogenic and noise-	84	M	*Due to the location of the wetlands within and adjacent to the proposed, it is considered imperative that the delineated boundaries of the wetlands and their associated 10 m construction and operational phase buffers and 100 m MBSP setback buffer (where applicable) be demarcated as "no-go areas" in which no construction personnel, equipment and vehicle movement should be allowed, unless approval for specific construction of infrastructure and services is granted. The freshwater ecosystems must be cordoned off using a suitable barrier or material which is also able to control sedimentation; *In order to gain access to the study area, existing access and informal gravel within the footprint of the study area must be utilised. This will ensure no encroachment and indiscriminate vehicle movement within the wetlands, thereby limiting disturbance and impacts to the associated wetlands. In the event that the creation of any access roads are required to facilitate construction, they must ensure that they take into account the delineated boundaries of the wetlands and associated buffer zones (as mentioned above), ensuring that access roads do not infringe on the boundaries of these freshwater ecosystems and construction, operational phase and 100 m MBSP setback buffer zones (where applicable); *Areas which are to be cleared of vegetation including contractor laydown areas must remain as small as possible and it must be ensured as far as possible that vegetation clearing is focused to the proposed development footprint; *Protect exposed soil/ soil stockpiles by means of a geotextile fabric such as hessian sheeting; *Contractor laydown areas should remain outside of the delineated boundaries of the wetlands and associated buffer zones. A designated contractor laydown area should be approved by the Environmental Control Officer (ECO) prior to use; *An Environmental Control Officer (ECO) must be appointed in order to ensure all water related aspects are adequately mitigated for the life of the proposed development.

				pollution to surrounding biota.			
			Wetlands indirectly affected by the Halfgewonnen Solar PV Facility: *Removal of vegetation leading to exposure and associated disturbances to soil; *Exposure of soil and increased likelihood of dust generation into seep wetland 2; *Removal of topsoil and creation of topsoil stockpiles adjacent to seep wetland 2; *Potential creation of access roads to facilitate contractor laydown areas and subsequent construction activities; *Laydown of construction offices and ablution facilities adjacent to the wetlands; *Movement of construction vehicles within proximity of the wetlands.	*Increased runoff and erosion, and thus increased sedimentation of the CVB, UCVB, Pans and seep wetlands; *Potential smothering of the vegetation within the CVB, UCVB, Pan and seep wetlands as a result of increased sediment from cleared areas, leading to altered wetland habitat; *Disturbance of soil leading to potential for increased alien invasive plant (AIP) proliferation along the wetlands; *Anthropogenic and noise-pollution to wetland biota.	72	**M**	

2		Installation of the surface infrastructure such a solar panels, collector cables, substation, battery storage and administrative buildings of the Halfgewonnen Solar PV facility.	<u>Wetlands directly affected by the Halfgewonnen PV Solar facility</u> *Excavation of soil to facilitate foundations for mounting of the Solar panels and associated buildings; *Mixing and casting of concrete for foundations and buildings within seep wetland 2; *Installation of solar panels including mounting of rods into foundations; *Installation of collector cables to collect generated electricity to report to the BESS; *Vehicles, construction machinery and personnel to facilitate mounting of Solar panels and associated buildings.	*Infringement of seep wetland 2, resulting in impacts on hydrology and sediment balance; *Disturbance to suitable habitat for biota including breeding and foraging grounds; *Removal of hydrophytic vegetation within seep wetland 2; *Disturbances to soil within the wetlands, leading to altered freshwater ecosystem habitat; *Altered runoff patterns as a result of excavation and concrete within the wetland, leading to increased erosion and sedimentation of seep wetland 2; *Disturbance within the wetland leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity; *Physical obstruction of habitat to biota from the surface infrastructure component of the proposed development.	81	**M**	*As highlighted above, the delineated boundaries of the wetlands and associated construction, operational phase and 100 m MBSP setback buffers (where applicable) are to be demarcated as "no go" areas unless approval for specific construction of infrastructure and services is granted. As such the following measures are recommended to mitigate against indirect impacts: With regards to excavation and soil compaction activities within vicinity or within the wetlands: *During excavation activities, it must be ensured that stockpiles are not higher than 2 m in height and all exposed soil must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) to prevent erosion and sedimentation of the wetlands. Furthermore, measures should be undertaken to limit the time in which soil is exposed; *Dust suppression measures must be implemented (such as spray watering on gravel access roads) throughout the proposed development activities to prevent excessive dust and suppress the potential for runoff of sediment which may smother hydrophytic vegetation of the wetlands; With regards to concrete mixing on site: *Concrete and cement-related mortars can be toxic to aquatic life and other biota. Proper handling and disposal is considered imperative to minimize or eliminate discharge into the wetlands. High alkalinity associated with cement can dramatically affect and contaminate both soil and ground water. The following recommendations must be adhered to: -Fresh concrete and cement mortar should not be mixed near the proximity of the wetlands and associated buffer zones, as applicable; -Mixing of cement should only be undertaken within the construction camp and may not be mixed on bare soil; -Mixing of concrete is also to be strictly undertaken within a lined, bound or bunded portable mixer. Consideration must be taken to use ready mix concrete; -A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited whilst it awaits placing; -A washout area should be designated outside of the confines of the wetlands and associated buffer zones and wash water should be treated on-site or discharged to a suitable sanitation system; -Any cement bags must be disposed of in the demarcated hazardous waste receptacles; -Concrete spillage outside of the areas of application must be promptly removed and taken to a suitably licenced waste disposal site.

			<u>Wetlands indirectly affected by the Halfgewonnen PV Solar facility</u> *Excavation of soil adjacent to the wetlands in order to facilitate foundations for mounting of the Solar panels; *Mixing and casting of concrete for foundations adjacent to the wetlands; *Installation of solar panels including mounting of rods into foundations alongside the wetlands; *Vehicles, construction machinery and personnel to facilitate mounting of Solar panels adjacent to the wetlands.	*Excavations and concreted surfaces adjacent to the wetlands, resulting in impacts on hydrology and sediment balance; *Disturbance to suitable habitat for biota including breeding and foraging grounds; *Removal of hydrophytic vegetation within the wetlands; *Disturbance to soil within the wetlands, leading to altered freshwater ecosystem habitat; *Altered runoff patterns as a result of excavation and concrete upgradient of the wetlands, leading to increased erosion and sedimentation to the wetlands; *Disturbance surrounding the wetlands, leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity; *Physical obstruction of habitat to biota from the surface infrastructure component of the proposed development.	78	**M**	*Excavation of pits for the foundation of Solar panels and support structures may result in loose sediments within the landscape, specifically if works are taken during a period of rainfall (if applicable). As such, sediment traps should also be installed downstream/downgradient of the construction area. Sediment traps can be created by pegging an appropriate geotextile across the entire width of the work area at the specified support structure, held down by cobbles/boulders or by geotextile wrapped hay bales spanning the width of the work area and staked into position; *During excavation of the foundations to facilitate support structures, soil must be stockpiled upgradient of the excavated pits. Mixture of the lower and upper layers of the excavated soil should be kept to a minimum. These soils must be used to close off the pits, immediately after installation of the support structures.

3		Installation of the High-voltage line (± 6.2 km) from substation to Ysterkop.	Wetlands indirectly affected by the Halfgewonnen PV Solar facility *Excavation of soil adjacent to the wetlands in order to facilitate mounting of support structures for the overhead line; *Potential mixing and casting of concrete for foundations of support structures adjacent to the wetlands; *Movement of construction vehicles and personnel adjacent to wetlands	*Disturbance surrounding the wetlands, leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity during mounting of support structures.	42	**L**	
4	**Operational phase**	Operation and maintenance of the Halfgewonnen Solar PV plant.	*Potential indiscriminate movement of maintenance vehicles along wetlands situated in close proximity to the Solar panels; *Potential maintenance activities such as cutting of grass and cleaning of surface area underneath the solar panels	*Disturbance to soil, vegetation, biota and potentially water quality as a result of periodic maintenance activities; *Potential spillage and ingress of hydrocarbons from maintenance vehicles; *Increased sedimentation, runoff and turbidity as a result of reduced vegetation cover adjacent to wetlands.	74.25	**M**	*Maintenance vehicles must make use of dedicated access roads and no indiscriminate movement in the wetlands and associated buffer zones, unless authorised for maintenance activities may be permitted; *During periodic maintenance activities of the surface infrastructure (such as solar panels, substations) and linear component, monitoring for erosion should be undertaken with specific mention of investigating the support structures and areas accessed to facilitate maintenance activities; *Should erosion be noted at the base of the support structures that may potentially impact on a wetland situated adjacent, the areas must be rehabilitated by infilling and erosion gullies, resurfacing disturbed areas and revegetating these areas with suitable indigenous vegetation; *Monitoring for the establishment for AIP's along wetlands must be undertaken along disturbed areas and access roads used to facilitate maintenance activities. Should AIP's be identified, they must be removed and disposed of as per an AIP control plan and the area must be revegetated with suitable indigenous vegetation.

7 CONCLUSION

A freshwater ecosystem assessment was as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Halfgewonnen Solar PV Facility project for Dreamworks Haven Investments (Pty) Ltd in Mpumalanga province, South Africa. The proposed Halfgewonnen Solar PV Facility project was referred to as the proposed development.

The proposed development will generate approximately 80 Mega Watts (MW) of power for distribution into the National Grid, specifically for the benefit of mining and farming communities located closer to the proposed development. The surface infrastructure component of the proposed development will thus, include the PV 1 (anticipated 34 Ha) and PV 2 panels (anticipated 88 Ha), the main substation (± 0.3 Ha), additional buildings (± 0.3 Ha), and the battery storage area (± 3.3 Ha). The linear component of the proposed development will include the high-voltage line (± 6.2 km) that is recommended to connect the main substation to the Ysterkop substation. Eight wetlands were identified during the freshwater ecosystem assessment which may be affected by the proposed development. The results of the assessment are summarised in the table below:

Table 16: Summary of results of the field assessment as discussed in Section 4.

Freshwater ecosystem	PES	Ecoservices	EIS	REC / RMO / BAS
UCVB wetland 1	C	Intermediate	High	C/Maintain/C
Pan 1	B	Intermediate	Moderate	B/Maintain/B
Pan 2	C	Intermediate	Moderate	C/Maintain/C
Pan 3	C	Intermediate	Moderate	C/Maintain/C
CVB wetland 1	D	Moderately high	High	D/Maintain/D
CVB wetland 2	C	Intermediate	High	D/Maintain/D
Seep wetlands 1	C	Moderately low	Low	C/Maintain/C
Seep wetlands 2	D	Moderately low	Low	D/Maintain/D

Following the freshwater ecosystem assessment, the DWS Risk assessment Matrix (2016) was applied to determine the significance of impacts of the proposed development on the receiving freshwater environment. Whilst the proposed development was mostly optimised and moved outside of the delineated wetlands (with the exception of seep wetland 2 which is low ecological importance and sensitivity and limited in extent and level of integrity) in order to avoid impacts to the freshwater ecosystems, some indirect impacts relating to construction and operational phase activities was still considered likely to affect these wetlands and therefore, these impacts were assessed further. The risk significance posed to the directly affected (seep wetland 2) and indirectly affected (UCVB wetland 1, CVB wetlands 1 and 2, pans 1, 2 and 3 and seep wetland 1) is considered of “moderate” significance respectively,

provided that the application of strict mitigation measures are adhered to, in line with the requirements of the mitigation hierarchy (DEA et al., 2013). Key mitigation measures include ensuring that the delineated boundaries of the wetlands (UCVB wetland 1, pans 1, 2 and 3, CVB wetland 1 and 2 and seep wetlands 1 and 2 and 10 m construction and operational phase buffer zones must be demarcated as “no-go areas” from the proposed development as this will greatly reduce the significance of impacts which may occur. The freshwater ecosystems must also be cordoned off using a suitable barrier or geotextile material in order to control sedimentation and erosion control.

It is also advised that should encroachment within the freshwater ecosystems occur as a result of the proposed development, a suitable wetland rehabilitation plan is recommended, in order to minimise impacts and ensure that no net loss of biodiversity occurs as a result of the proposed development. It must be ensured that sufficient budget and management/supervisory support are catered for this as part of the proposed development.

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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 CC and its staff reserve the right, at their sole discretion, 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 CONSIDERATIONS

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 (Act No. 107 of 1998) (NEMA)	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.
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).
The National Water Act 1998 (Act No. 36 of 1998) (NWA)	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).
Government 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 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.
Specific guidelines for meeting minimum requirements for CBA and ESA wetlands (MBSP, 2014).	➢ All wetlands are protected under the National Water Act, 1998 (Act No. 36 of 1998). ➢ In terms of the National Water Act, freshwater ecosystems (all wetlands included) should not be allowed to degrade to an unacceptably modified condition (E or F ecological category). ➢ Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status. ➢ Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetlands.

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 freshwater features present or in close proximity of the proposed 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 proposed study area.

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

The freshwater features encountered within the proposed 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 C3: 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. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C5 below.

Table C5: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.*2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39

F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

5. WET-Health

The Riparian Vegetation Response Assessment Index (VEGRAI)
VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans *et al.*, 2007a). Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Riparian vegetation is described in the National Water Act (Act No. 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soil, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Table C6: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

6. Watercourse Functional 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 freshwater features 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;

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

- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- 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 freshwater features.

Table C7: 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

7. 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 C8) of the wetland system being assessed.

Table C8: 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	>2 and <=3	B

EIS Category	Range of Mean	Recommended Ecological Management Class
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.		
Moderate 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.	>1 and <=2	C
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

8. 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 freshwater resource (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourse in order to ensure continued ecological functionality.

Table C9: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
PES	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 freshwater resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A freshwater resource may receive the same class for the REC as the PES if the freshwater resource 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 C10: Description of Recommended Ecological Category (REC) classes.

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

APPENDIX D – Risk Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[5]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as freshwater features, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[6].

[5] The definition has been aligned with that used in the ISO 14001 Standard.
[6] Some risks/impacts that have low significance will however still require mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (Act No. 107 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table D1: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table D2: Spatial Scale (How big is the area that the aspect is impacting on)

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

Table D3: Duration (How long does the aspect impact on the resource quality)

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

Table D4: Frequency of the activity (How often do you do the specific activity)

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

Table D5: The frequency of the incident or impact (How often does the activity impact on the resource quality)

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

Table D6: Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table D7: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

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

Table D8: Rating Classes

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

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

Table D9: Calculations

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

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for construction phase and operational phase; and
  - Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[7] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and

[7] Mitigation measures should address both positive and negative impacts.

- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources traversed by or in close proximity of the proposed project.

Table D10: Reversibility of impacts on the watercourses

Reversibility Rating:	**Irreversible** (the activity will lead to an impact that is permanent)
	Partially reversible (The impact is reversible to a degree e.g. acceptable revegetation measures can be implemented but the pre-impact species composition and/or diversity may never be attained. Impacts may be partially reversible within a short (during construction), medium (during operation) or long term (following decommissioning) timeframe
	Fully reversible (The impact is fully reversible, within a short, medium or long-term timeframe)

APPENDIX E – 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 PES assessment applied to the wetlands associated with the proposed development.

Wetlands	Hydrology		Geomorphology		Vegetation	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
UCVB wetland 1						
Pan 1	1		0.3	-1	2.3	-1
Pan 2	4		0.4		4.6	
Pan 3	3.5		0.6		4.5	
CVB wetland 1	4	-2	2.6	-1	5.4	-1
CVB wetland 2	2	0	1.3	0	4.1	-1
Seep wetland 1	2	0	1.3.		4.1	0
Seep wetland 2	3.5	-1	1.6	-1	7.7	-1

Table E2: Presentation of the results of the Ecoservices assessment applied to the wetlands associated with the proposed development.

Ecosystem service	UCVB	Pan 1	Pan 2	Pan 3
Flood attenuation	2.0	1.7	1.7	1.8
Streamflow regulation	2.6	1.4	1.6	0.0
Sediment trapping	2.2	2.6	2.6	2.2
Phosphate assimilation	2.2	2.6	2.6	2.4
Nitrate assimilation	2.5	2.7	2.7	2.4
Toxicant assimilation	2.5	2.7	2.7	2.4
Erosion control	2.3	2.4	2.4	2.3
Carbon Storage	1.5	1.3	1.0	1.5
Biodiversity maintenance	2.0	2.0	2.1	1.6
Water Supply	1.6	0.5	0.5	1.8
Harvestable resources	0.2	0.0	0.0	1.0
Cultivated foods	1.2	0.0	0.0	0.0
Cultural value	0.0	0.0	0.8	0.0
Tourism and recreation	2.1	0.6	1.2	0.1
Education and research	1.8	0.3	1.3	1.0
SUM	**26.6**	**20.7**	**23.1**	**20.6**
Average score	**1.8**	**1.4**	**1.5**	**1.4**

Table E3: Presentation of the results of the Ecoservices assessment applied to the wetlands associated with the proposed development.

Ecosystem service	CVB 1	CVB 2	Seep 1	Seep 2
Flood attenuation	1.8	1.9	1.5	1.5
Streamflow regulation	2.4	2.4	1.0	1.0
Sediment trapping	2.5	1.4	1.7	1.7
Phosphate assimilation	2.3	2.0	1.7	1.7
Nitrate assimilation	2.3	2.3	2.1	2.1
Toxicant assimilation	2.2	2.0	2.1	2.1
Erosion control	2.2	1.9	2.0	2.0
Carbon Storage	1.5	1.3	1.0	1.0
Biodiversity maintenance	2.2	1.9	1.3	1.3
Water Supply	2.7	1.7	0.5	0.5

Ecosystem service	CVB 1	CVB 2	Seep 1	Seep 2
Harvestable resources	1.8	1.0	0.0	0.0
Cultivated foods	1.6	0.4	0.0	0.0
Cultural value	1.8	1.0	0.0	0.0
Tourism and recreation	1.8	1.1	0.3	0.3
Education and research	2.3	1.0	1.3	1.3
SUM	**31.3**	**23.4**	**16.4**	**16.4**
Average score	**2.1**	**1.6**	**1.1**	**1.1**

Table E4: Presentation of the results of the EIS assessment applied to the UCVB wetland 1 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			1.33	3
Presence of Red Data species			1	3
Populations of unique species			1	3
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	(average)
			1.60	3
Protection status of the wetland			1	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			2	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	(average)
			2	3
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
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		2	4
	Water Quality Enhancement	***Sediment trapping***	1	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	***Water for human use***		2	3
	Harvestable resources		2	3
	Cultivated foods		1	3
Cultural benefits	***Cultural heritage***		1	3
	Tourism and recreation		1	3
	Education and research		1	3

Table E5: Presentation of the results of the EIS assessment applied to the pan 1 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			2	3
Presence of Red Data species			2	3
Populations of unique species			2	3
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	(average)
			1.80	3
Protection status of the wetland			1	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			2	3
Size and rarity of the wetland type/s present			3	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	(average)
			1.67	2.67
Sensitivity to changes in floods			1	3
Sensitivity to changes in low flows/dry season			2	3
Sensitivity to changes in water quality			2	2
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		1	4
	Water Quality Enhancement	***Sediment trapping***	1	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		2	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	***Water for human use***		1	3
	Harvestable resources		0	3
	Cultivated foods		0	3
Cultural benefits	***Cultural heritage***		0	3
	Tourism and recreation		2	4
	Education and research		1	3

Table E6: Presentation of the results of the EIS assessment applied to the pan 2 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			0.33	3.33
Presence of Red Data species			0	3
Populations of unique species			0	4
Migration/breeding/feeding sites			1	3
Landscape scale			B (average)	(average)
			0.80	3
Protection status of the wetland			0	3
Protection status of the vegetation type			1	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)	(average)
			1.67	3
Sensitivity to changes in floods			1	3
Sensitivity to changes in low flows/dry season			1	3
Sensitivity to changes in water quality			1	3
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		0	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
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		1	3
	Education and research		1	3

Table E7: Presentation of the results of the EIS assessment applied to the Pan 3 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			0.67	3.33
Presence of Red Data species			0	3
Populations of unique species			1	4
Migration/breeding/feeding sites			1	3
Landscape scale			B (average)	(average)
			0.60	3
Protection status of the wetland			0	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			1	3
Size and rarity of the wetland type/s present			0	3
Diversity of habitat types			1	3
Sensitivity of the wetland			C (average)	(average)
			0.67	3
Sensitivity to changes in floods			1	3
Sensitivity to changes in low flows/dry season			0	3
Sensitivity to changes in water quality			1	3
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	Flood attenuation		1	4
	Streamflow regulation		1	4
	Water Quality Enhancement	*Sediment trapping*	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	*Water for human use*		0	4
	Harvestable resources		0	4
	Cultivated foods		0	4
Cultural benefits	*Cultural heritage*		0	4
	Tourism and recreation		0	4
	Education and research		0	4

Table E8: Presentation of the results of the EIS assessment applied to the CVB wetland 1 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			1	3.33
Presence of Red Data species			1	3
Populations of unique species			0	4
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	(average)
			2	3
Protection status of the wetland			3	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			2	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	(average)
			2	3
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
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		2	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	***Water for human use***		1	4
	Harvestable resources		0	4
	Cultivated foods		0	4
Cultural benefits	***Cultural heritage***		0	4
	Tourism and recreation		1	4
	Education and research		1	4

Table E9: Presentation of the results of the EIS assessment applied to the CVB wetland 2 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			1	3.33
Presence of Red Data species			1	3
Populations of unique species			0	4
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	(average)
			2	3
Protection status of the wetland			3	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			2	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	(average)
			2	3
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
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		2	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	***Water for human use***		1	4
	Harvestable resources		0	4
	Cultivated foods		0	4
Cultural benefits	***Cultural heritage***		0	4
	Tourism and recreation		1	4
	Education and research		1	4

Table E10: Presentation of the results of the EIS assessment applied to the Seep wetlands 1 and 2 associated with the proposed development.

Ecological Importance and Sensitivity			Score (0-4)	Confidence (1-5)
Biodiversity support			A (average)	(average)
			1	3.33
Presence of Red Data species			1	3
Populations of unique species			0	4
Migration/breeding/feeding sites			2	3
Landscape scale			B (average)	(average)
			2	3
Protection status of the wetland			3	3
Protection status of the vegetation type			1	3
Regional context of the ecological integrity			2	3
Size and rarity of the wetland type/s present			2	3
Diversity of habitat types			2	3
Sensitivity of the wetland			C (average)	(average)
			2	3
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
Hydro-Functional Importance			Score (0-4)	
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		2	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		1	4
Direct Human Benefits			Score (0-4)	Confidence (1-5)
Subsistence benefits	***Water for human use***		1	4
	Harvestable resources		0	4
	Cultivated foods		0	4
Cultural benefits	***Cultural heritage***		0	4
	Tourism and recreation		1	4
	Education and research		1	4

APPENDIX F – Risk Assessment Outcome

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical	Habitat (Geomorph+V	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
1	**Construction**	Site clearing and set-up of contractor camps prior to commencement of construction activities.	<u>Wetlands directly affected by the the Halfgewonnen Solar PV Facility (specifically seep wetland 2):</u> *Removal of vegetation leading to exposure and associated disturbances to soil; *Exposure of soil and increased likelihood of dust generation into seep wetland 2; *Potential creation of access roads to facilitate contractor laydown areas and subsequent construction activities; *Laydown of construction offices and ablution facilities adjacent to the wetlands; *Movement of construction vehicles within the seep wetland.	*Compaction of soil due to the movement of heavy machinery within seep wetland 2; *Reduced vegetation cover within seep wetland 2; *Alteration of runoff patterns into seep wetland 2; *Smothering of the vegetation within seep wetland 2 as a result of increased sediment leading to altered habitat; *Disturbance of soil leading to increased AIP proliferation into seep wetland 2; *Potential decrease in ecoservice of seep wetland 2; *Potential soil and stormwater contamination from oils as well as hydrocarbons into the seep wetland 2 from construction machinery; *Loss of breeding and feeding habitat for faunal and aquatic biota; *Anthropogenic and noise-pollution to surrounding biota.	3	3	3	3	3	2	2	7	1	5	5	1	12	84	**M**

			Wetlands indirectly affected by the Halfgewonnen Solar PV Facility: *Removal of vegetation leading to exposure and associated disturbances to soil; *Exposure of soil and increased likelihood of dust generation into seep wetland 2; *Removal of topsoil and creation of topsoil stockpiles adjacent to seep wetland 2; *Potential creation of access roads to facilitate contractor laydown areas and subsequent construction activities; *Laydown of construction offices and ablution facilities adjacent to the wetlands; *Movement of construction vehicles within proximity of the wetlands.	*Increased runoff and erosion, and thus increased sedimentation of the CVB, UCVB, Pans and seep wetlands; *Potential smothering of the vegetation within the CVB, UCVB, Pan and seep wetlands as a result of increased sediment from cleared areas, leading to altered wetland habitat; *Disturbance of soil leading to potential for increased alien invasive plant (AIP) proliferation along the wetlands; *Anthropogenic and noise-pollution to wetland biota.	2	2	2	2	2	2	2	6	1	5	5	1	12	72	**L**

2		Installation of the solar panels, collector cables, substation, battery storage and administrative buildings of the Halfgewonnen Solar PV facility.	<u>Wetlands directly affected by the Halfgewonnen PV Solar facility</u> *Excavation of soil to facilitate foundations for mounting of the Solar panels and associated buildings; *Mixing and casting of concrete for foundations and buildings within seep wetland 2; *Installation of solar panels including mounting of rods into foundations; *Vehicles, construction machinery and personnel to facilitate mounting of Solar panels and associated buildings.	*Infringement of seep wetland 2, resulting in impacts on hydrology and sediment balance; *Disturbance to suitable habitat for biota including breeding and foraging grounds; *Removal of hydrophytic vegetation within seep wetland 2; *Disturbances to soil within the wetlands, leading to altered freshwater ecosystem habitat; *Altered runoff patterns as a result of excavation and concrete within the wetland, leading to increased erosion and sedimentation of seep wetland 2; *Disturbance within the wetland leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity.	3	3	3	2	2.75	2	2	6.75	1	5	5	1	12	81	**M**
			<u>Wetlands indirectly affected by the Halfgewonnen PV Solar facility</u> *Excavation of soil adjacent to the wetlands in order to facilitate foundations for mounting of the Solar panels; *Mixing and casting of concrete for foundations adjacent to the wetlands; *Installation of solar panels including mounting of rods into foundations alongside the wetlands; *Vehicles, construction machinery and personnel	*Excavations and concreted surfaces adjacent to the wetlands, resulting in impacts on hydrology and sediment balance; *Disturbance to suitable habitat for biota including breeding and foraging grounds; *Removal of hydrophytic vegetation within the wetlands; *Disturbance to soil within the wetlands, leading to altered freshwater ecosystem habitat; *Altered runoff patterns as a result of excavation and concrete upgradient of the wetlands, leading to increased erosion and sedimentation ofthe wetlands; *Disturbance surrounding the	2	2	2	2	2	2	2	6	1	5	5	2	13	78	**M**

			to facilitate mounting of Solar panels adjacent to the wetlands.	wetlands, leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity.															
3		Installation of the High-voltage line (± 6.2 km) from substation to Ysterkop.	Wetlands indirectly affected by the Halfgewonnen PV Solar facility *Excavation of soil adjacent to the wetlands in order to facilitate mounting of support structures for the overhead line; *Potential mixing and casting of concrete for foundations of support structures adjacent to the wetlands; *Movement of construction vehicles and personnel adjacent to wetlands	*Disturbance surrounding the wetlands, leading to increased AIP proliferation and freshwater ecosystem habitat; *Potential for deteriorated water quality, including increased likelihood of dust generation and turbidity during mounting of support structures.	1	2	2	1	1.5	1	1	3.5	1	4	5	2	12	42	**L**
4	**Operational phase**	Operation and maintenance of the Halfgewonnen Solar PV plant.	*Potential indiscriminate movement of maintenance vehicles along wetlands situated in close proximity to the Solar panels.	*Disturbance to soil, vegetation, biota and potentially water quality as a result of periodic maintenance activities; *Potential spillage and ingress of hydrocarbons from maintenance vehicles.	1	2	2	2	1.75	1	4	6.75	1	3	5	2	11	74.25	**M**

APPENDIX G – Generic Mitigation Measures

General construction management and good housekeeping practices

Latent and general impacts which may affect the freshwater ecology and biodiversity of the receiving freshwater environment, will include any activities which take place in close proximity to the proposed Witbank South project that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the wetland systems identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should not encroach into the freshwater areas. It must be ensured that the freshwater habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid freshwater areas and be restricted to existing roads;
- Appropriate sanitary facilities must be provided for the life of the construction phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. The vegetation component within the freshwater environment is transformed to a minor extent by alien plant invasion; therefore, these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered within the wetlands must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act (Act No. 107 of 1998). Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species; and
  - No vehicles should be allowed to drive through designated freshwater habitat during the eradication of alien and weed species.

Soil

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;

- As far as possible, all construction activities should occur in the low flow season, during the drier winter months;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soil;
- No stockpiling of topsoil is to take place within close proximity to the freshwater habitat, and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the freshwater habitat;
- All soil compacted as a result of ongoing operational activities falling outside of project footprint areas should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed Witbank South project should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

APPENDIX H – 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)

Sashin Pillay BSc Hons (Biological Sciences) (University of KwaZulu-Natal)

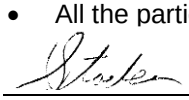
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	1401	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) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	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)		

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

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 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

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018
Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy)	2018

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

DEVELOPMENT SECTORS OF EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river sand, clay, fluorspar
2. Linear developments (energy transmission, telecommunication, pipelines, roads)
3. Minerals beneficiation
4. Renewable energy (Hydro, wind and solar)
5. Commercial development
6. Residential development

7. Agriculture
8. Industrial/chemical

KEY SPECIALIST DISCIPLINES

Legislative Requirements, Processes and Assessments

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

Freshwater Assessments

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

Biodiversity Assessments

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

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF SASHIN PILLAY

PERSONAL DETAILS

Position in Company	Junior Ecologist
Joined SAS Environmental Group of Companies	2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the Gauteng Wetlands Forum
Member of the South African Wetland Society (SAWS)

EDUCATION

Qualifications

BSc (Hons) Biological Sciences (Aquatic Ecology) (University of KwaZulu-Natal)	2017
BSc (Environmental and Life Sciences) (University of KwaZulu-Natal)	2016

SHORT COURSES

Additional Training

Back-2-Basics wetland workshop presented by Piet-Loius Grundling	(2020)
Environmental management training course by Enaq Environmental Consulting	(2018)
Young-Leaders academy, leadership development programme	(2012)

AREAS OF WORK EXPERIENCE

South Africa – KwaZulu-Natal, Gauteng, Mpumalanga, Free-State, Limpopo

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

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, IHIA)
- Toxicological Analysis
- Water quality Monitoring