Tate Environmental
Specialist Services

Kareekloof PV-SEF

Water Resource Study

Northern Cape, South Africa

January 2024

TATE ENVIRONMENTAL SPECIALIST SERVICES

Hydrology Biodiversity Ecology

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Declaration

I, Russell Tate, declare that:

- I act as the independent specialist in this study;
- I will perform the work relating to the study 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 science relevant to this study, including knowledge of the Act, regulations and any guidelines that have relevance to the study;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the study;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.
- Please refer to appendix A for the specialist CV.

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TESS

January 2024

Executive Summary

Tate Environmental Specialist Services (TESS) was appointed by Enviro-Insight to complete a water resource specialist study for areas associated with the proposed Kareekloof Photovoltaic Solar Energy Facility (PVSEF). The project covers an area of ~3720 ha, has a proposed generation capacity of up to 900 MW, and is located ~14 km southeast of Potfontein in the Northern Cape Province.

The aim of this study was to derive the extent and condition of the watercourses associated with the project and investigate the nature of the anticipated impacts of the activities.

The hydrological setting of the project was within the D62F and D33B quaternary catchment of the Orange River system. The nearest Sub Quaternary Reach associated with the project includes the D62F-04509. Within the context of the climate and hydrological setting, this project area is drained by unnamed non-perennial watercourses.

The outcome of this assessment delineated 3 watercourse HGM units within the Area of Interest (AoI). Where the summarised information is presented in Table 8-1. These watercourses were derived to range from largely natural (class B) and largely modified (class D) Present Ecological Status. The watercourses were classified as having Very High and High Ecological Importance and Sensitivity ratings. A scientific buffer was calculated for the watercourses, where a 40m buffer for depressions and 30m for rivers was utilised to protect these sensitive environments.

Table 0-1: PES and EIS Summaries

Watercourse Unit	PES	EIS	Buffer
HGM1	**Class C**	High	30m
HGM2	**Class D**	High	30m
HGM3	**Class B**	Very High	40m

The outcomes of the risk assessment indicate minor impacts from the proposed activities. The minor impacts can be attributed to the avoidance of the sensitive habitats and implementation of buffer zones.. Should avoidance and basic mitigation actions be implemented, limited impacts to aquatic biodiversity can be expected.

In the view of the proposed new activities, should the proposed mitigation actions be implemented, no fatal flaw was identified. In line with the recommendations, avoidance must be implemented.

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1 Introduction

Tate Environmental Specialist Services (TESS) was appointed by Enviro-Insight to complete a water resource specialist study for areas associated with the proposed Kareekloof Photovoltaic Solar Energy Facility (PVSEF). The project covers an area of ~3720 ha, has a proposed generation capacity of up to 900 MW, and is located ~14 km southeast of Potfontein in the Northern Cape Province (Figure 2-2).

This document presents the information relating to the wetland and freshwater biodiversity components (water resource) of the Environmental Impact Assessment (EIA) required as part of the process to obtain environmental authorisation (EA) for the proposed development.

The aim of this study was to derive the extent and condition of the watercourses associated with the project and investigate the nature of the anticipated impacts of the activities. In line with the aims of the study, the following Scope of Work (SoW) was established:

1. Comply with the specialist assessment protocols established in Government Gazette 43110 – GN320 and other relevant legislation.
2. Assess the nature and extent of the watercourses associated with the development;
3. Establish the Present Ecological Status (PES) of the associated watercourses;
4. Provide shapefiles and maps which visualise sensitive habitats;
5. Provide a risk assessment for the completed activities; and
6. Provide recommendations for mitigation and avoidance actions.

1.1 Definitions

According to the National Water Act (NWA) Act Number 36 of 1998 the definition of wetland and riparian areas are provided as:

- **Wetland**: Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.
- **Riparian:** The physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

Further definitions provided in the NWA defines a watercourse as:

- A river or spring

- A natural channel in which water flows regularly or intermittently
- A wetland, lake or dam into which, or from which water flows
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse.
- The watercourse includes, where relevant its bed and banks.

The definition of the extent of a watercourse is defined in the amendment of the General Authorisation for section 21 (c) and (i) water uses (RSA Government, 2016). The extent of the watercourse 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; and
- Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.

The definition of wetland areas is further defined by the Department of Water and Forestry (DWAF) 2005 guidelines (DWAF, 2005) where the following is considered pertinent to their classification:

- The presence, either permanently, seasonally or temporarily, of water at or near the surface
- Distinctive redoximorphic features in the soils, and
- Vegetation which is adapted to or tolerant of saturated soils.

2 Description of the Study Area

The study area was located approximately 14 km southeast of Potfontein in the Northern Cape Province, South Africa. The Mean Annual Precipitation (MAP) for the derived Area of Interest (AoI) over the periods 2009-2022 was 331 mm, peaking in 2022 at 623 mm, with the lowest value recorded in 2015 at 231 mm. The temporal distribution of rainfall in the AoI consisted of a unimodal flood regime where peak flows are observed in the summer between November and March. As is observed in the analysis the 2022/2023 hydroperiod received significantly more rainfall in November and December in comparison to previous periods.

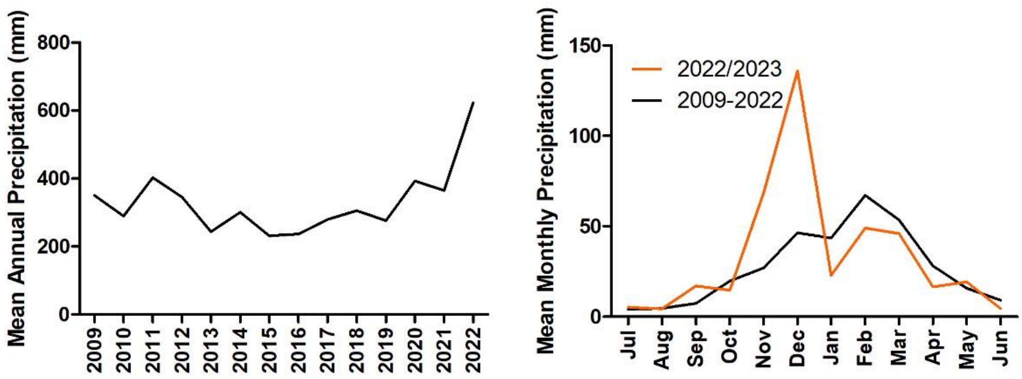


Figure 2-1: Annual (left) and mean monthly (right) precipitation in the Area of Interest between 2009 and 2022 (WaPOR, 2023)

The hydrological setting of the project was within the D62F and D33B quaternary catchment of the Orange River system. The nearest Sub Quaternary Reach associated with the project includes the D62F-04509. Within the context of the climate and hydrological setting, this project area is drained by unnamed non-perennial watercourses.

The National Freshwater Ecosystem Priority Area (NFEPA) and National Biodiversity Assessment (2018) maps indicated that there are riverine and impoundment related watercourses within the AoI (Figure 2-4).

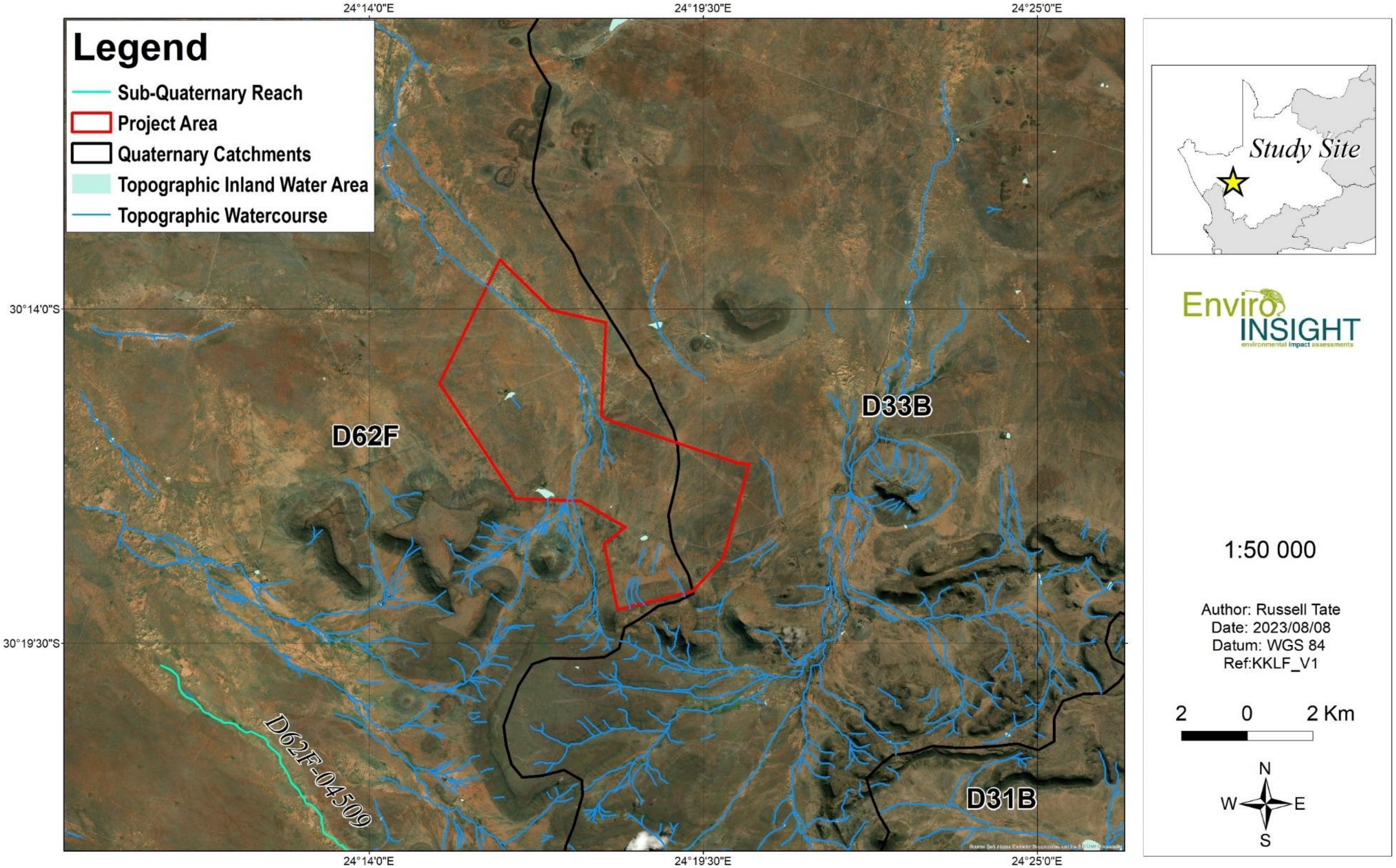


Figure 2-2: Hydrological and Local Setting of the Study Area

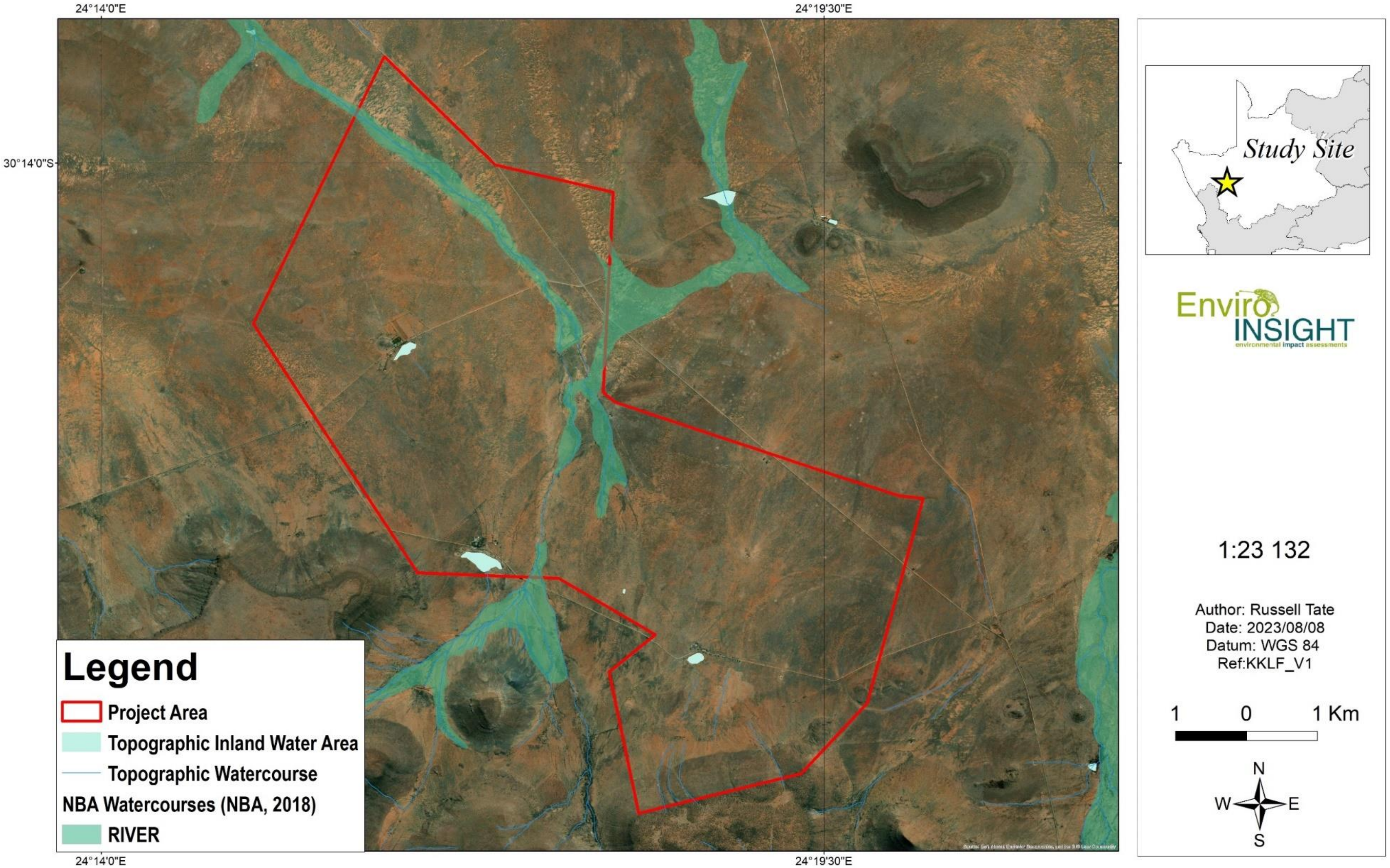


Figure 2-3: Desktop Wetlands (NBA, 2018)

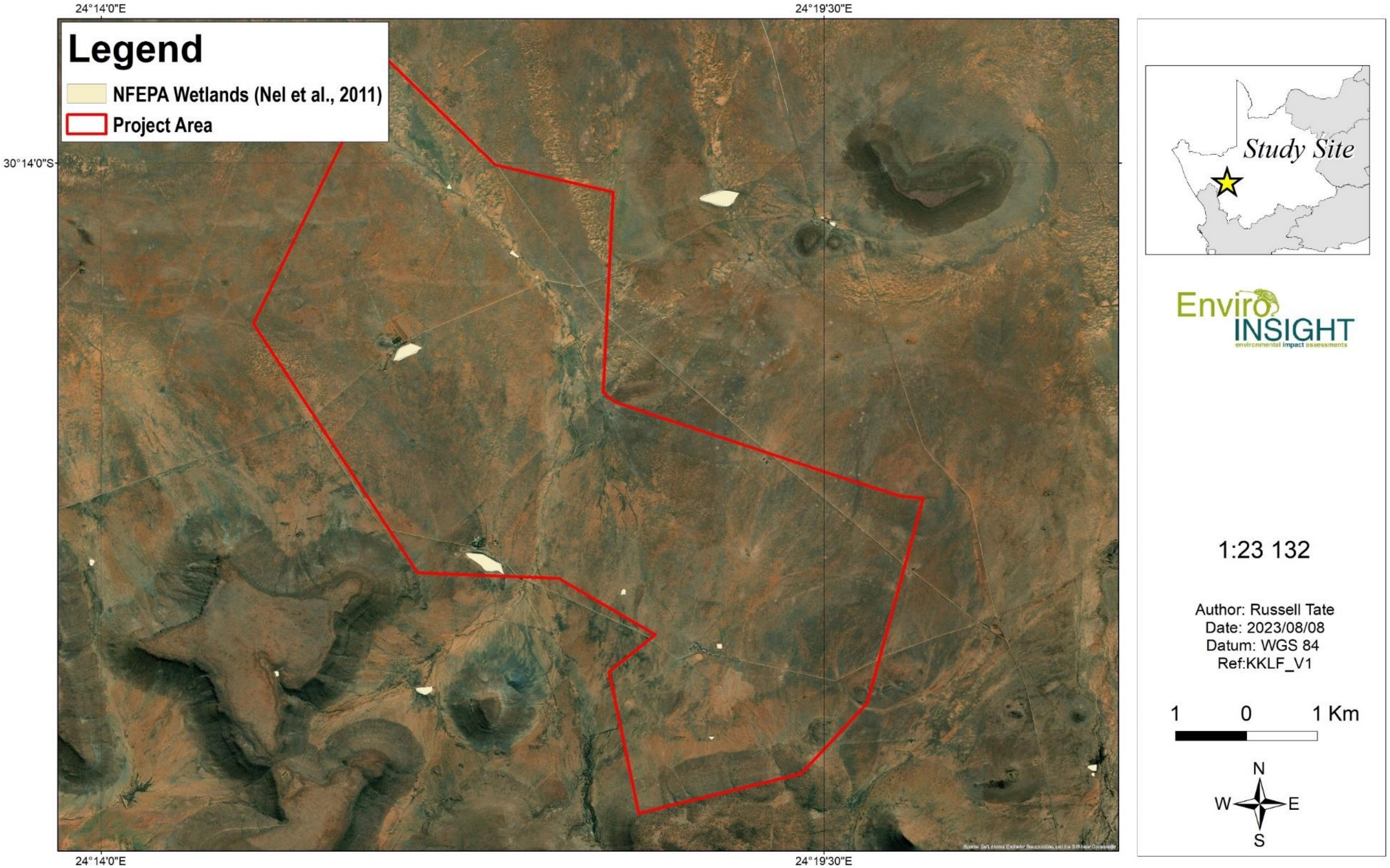


Figure 2-4: Desktop Wetlands (NFEPA)

3 Methods

3.1 Survey

A single survey was completed for this study and the survey was between the 31st of July and 5th of August 2023. The proposed development site was enlarged by 500m to delineate the screening area. This 500m screening area was considered for the watercourse assessment.

3.2 Wetland Ecology

Following the desktop assessment, the wetland areas were delineated in accordance with the procedures stipulated in DWS (2008) guidelines, where a cross section of a typical wetland profile is presented in Figure 3-2.

The identification of the wetland areas was completed by considering the following specific indicators:

- The terrain unit Indicator was used to identify areas in the landscape where wetlands are likely to occur;
- The soil form indicator, utilised the soil classifications where focus was drawn to soils that are associated with saturation;
    - Soils were assessed using a 75mm open bucket soil auger where notes on soil condition were made up to a depth of 50cm.
- The soil wetness indicator was utilised to study the morphological signatures of the soil profiles;
    - The following characteristics were used:
        - Permanent – Prominent Grey Matrix, Few to no high chroma mottles, sulphuric odour
        - Seasonal – grey matrix >10%, many low chroma mottles
        - Temporary – Minimal grey matrix <10%, few high chroma mottles
- The vegetation indicator was then used to confirm and identify hydrophilic vegetation associated with saturated soils according to the lists provided in DWAF (2005).

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) was used to classify the wetland hydrogeomorphic (HGM) types for this study (Ollis et al., 2013). This system uses a hierarchical classification where defining a wetland is based on the principles of the HGM approach which includes the assessment of the structural features of the wetland (Ollis et al., 2013).

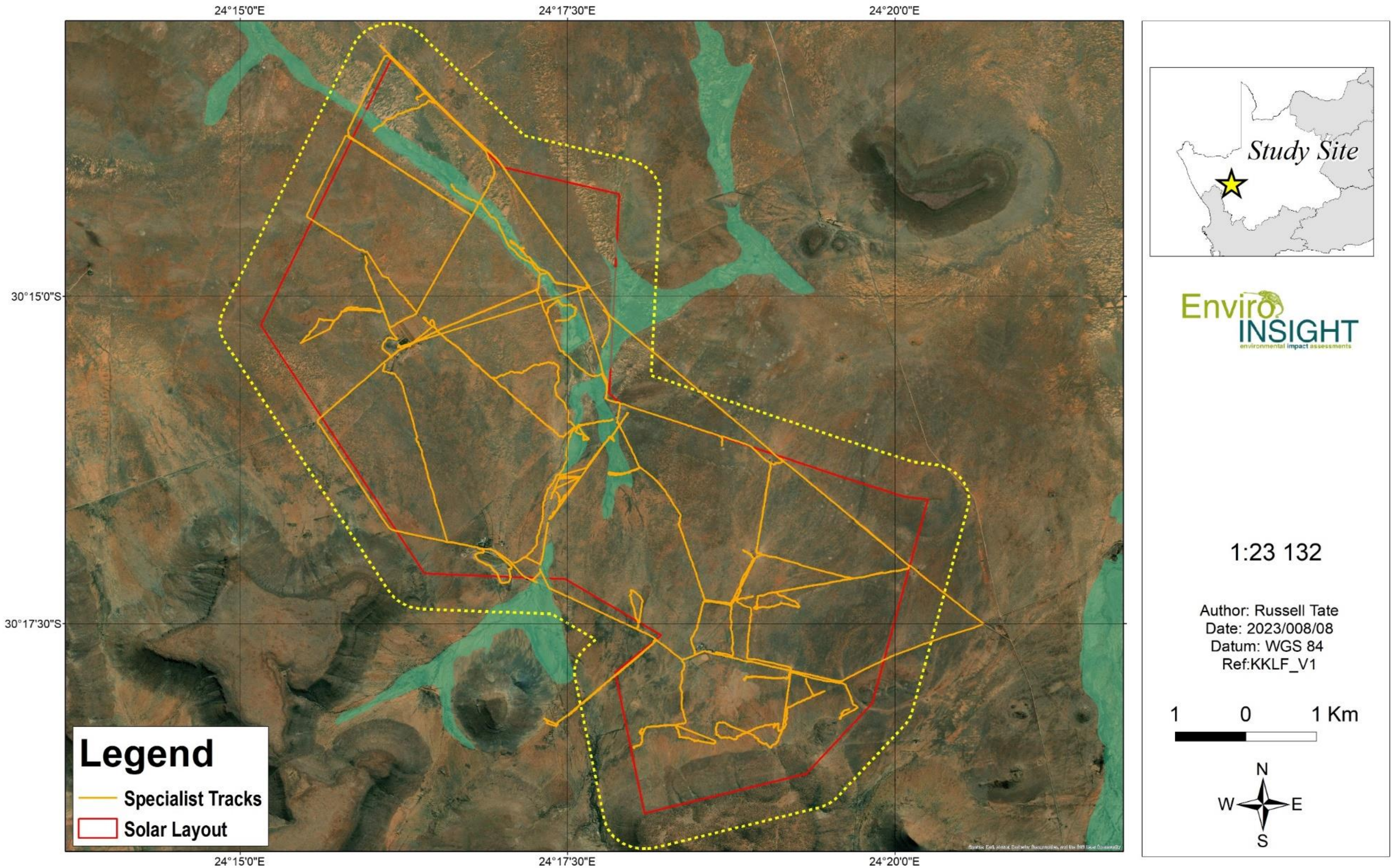


Figure 3-1: Watercourse specialist tracks (January 2024)

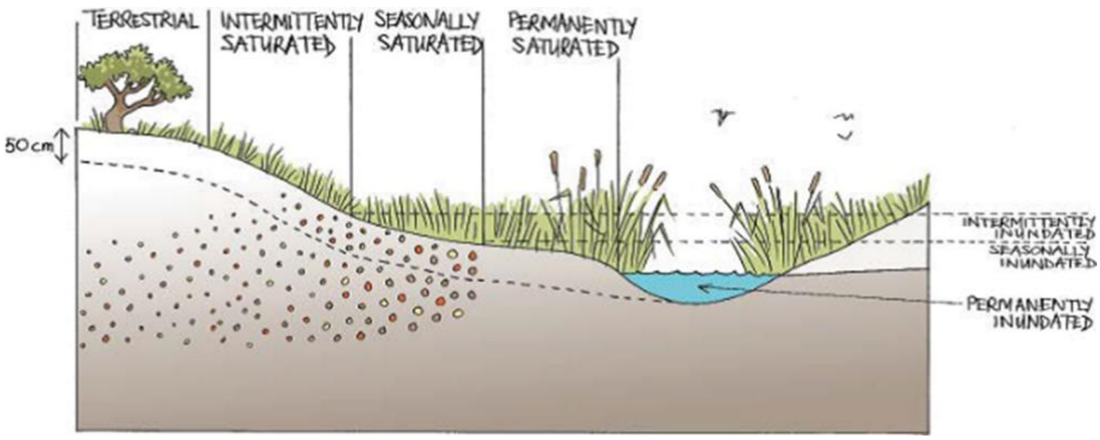


Figure 3-2: Cross section through a wetland (Ollis et al., 2013)

3.2.1 Literature Survey

The literature and spatial databases utilised to inform this study are presented below:

- Wetland Map 5 (NBA, 2018)
- National Freshwater Ecosystem Priority Areas (NFEPA, Nel et al., 2011)

3.2.2 Wetland Present Ecological Status

The overall approach used in the PES method followed the established guidelines presented in Macfarlane et al. 2020. A level 1 assessment was completed. The method relies on the assessment of land cover types within an established watershed, within incoming stream and wetland buffers, as well as within homogenous disturbance units established in the delineated wetland.

The PES method relies on the comparison of the subject wetland to an expected reference condition. The method makes use of 4 primary metrics including:

- Hydrology
- Geomorphology
- Water quality
- Vegetation

Through the assessment of land cover and the nature of impacts within disturbance units, the wetland can be classified into a PES category as provided. The PES field techniques included the assessment of the 4 metrics within the homogenous disturbance units.

Table 3-1: The Present Ecological Status categories, (Macfarlane et al., 2020)

Impact Category	Description	Impact Score Range	PES
None	Unmodified, natural	0 to 0.9	A

Impact Category	Description	Impact Score Range	PES
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.	1.0 to 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.	2.0 to 3.9	C
Large	**Largely Modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	**Seriously Modified.** The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	6.0 to 7.9	E
Critical	**Critical Modification.** The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F

3.2.3 Eco-Services and Functional Assessment

Wetland areas and watercourses are known to provide numerous and important ecosystem services to local communities. It is therefore of importance to study the ecological services of a wetland system in order to provide data which supports effective water resource management.

The assessment of the ecosystem services supplied by the identified wetland was conducted as per the guidelines as described in the WET-EcoServices manual (Kotze et al., 2020). A desktop assessment was completed prior to the survey where the following aspects related to domestic, agricultural, subsistence, commercial and recreational activities were noted:

- Downstream water users
- Within wetland water users
- Within wetland and downstream effected communities

The wetlands under consideration were then rated based on the findings from a field survey and further informed by aerial imagery. Following the rating of criteria the eco-services were classified into categories as provided in Table 3-2.

Table 3-2: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

3.2.1 Ecological Importance and Sensitivity

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWS (1999). The method takes into consideration PES scores obtained for WET-Health as well as function and service provision of the systems to enable determination of the representative EIS category for the wetland feature. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 3-3, (Rountree et al., 2013).

Table 3-3: Description of Ecological Importance and Sensitivity categories

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

3.3 Riverine Ecology

3.3.1 Riparian and Instream Habitat Condition

The Intermediate Habitat Integrity Assessment (IHIA) as described by Kleynhans (1996) was used to define the ecological condition of the riparian habitat of the considered river reach. The IHIA was informed by the results of the land cover assessments and direct observations of changes to the river system. The IHIA considers both the riparian and instream habitat condition. The method relies on the study of reference condition or natural watercourses within a similar setting. The integrity categories of the method are provided in Table 3-4. The spatial framework for the method was the AoI as derived above.

Table 3-4: Intermediate habitat integrity categories (Kleynhans, 1996)

Category	Description	Score
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A 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	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	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

3.3.2 Instream Condition

The watercourses under consideration are located within an arid environment where non-perennial systems are present. Standard riverine PES methods utilising fish as a means to derive instream condition were therefore excluded.

3.3.2.1 Water Quality

In situ water quality was obtained the single sampling site using a calibrated Extech DO-600 Multimeter. The following constituents included conductivity (µS/m), temperature (°C), pH and dissolved oxygen (mg/l).

3.3.2.2 Aquatic Macroinvertebrates

Macroinvertebrate assemblages are indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour et al., 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour et al., 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

Invertebrate sampling within the inundated impoundment at HGM2 (Figure 3-4) took place using standard kick and sweep methods whereby substrates were mobilised, and a 1mm mesh size net swept through the disturbed areas for up to 2 minutes per sample point. Invertebrates were then enumerated and identified to order and family levels using Gerber and Gabriel (2002).

Figure 3-3: Invertebrate sampling completed during the August 2023 survey

Figure 3-4: Example of conditions within the impoundment of HGM2 (-30.248284° , 24.288475° August 2023)

3.4 Limitations and Assumptions

The following limitations and assumptions form part of this study:

- The results of this study were derived from rapid ecological assessments.
- No floodline delineation was completed for this assessment.
- Areas directly affected by the project were surveyed, whilst within the 500m screening area, desktop information was utilised.
- Watercourses are defined by dynamic processes. Temporal variation of the extent and condition of the watercourses is a naturally occurring process. Therefore, the spatial extent of the watercourses provided in this study should be reconsidered within at least 5-10 years from the publishing of this study.
- No hydrological assessment was completed for this assessment.
- The delineations of the project were restricted within the accessible farm portions.
- The results of the PES assessment for the riverine ecosystems must be interpreted with caution given that these systems were non-perennial in character.
- Aside for discussions with local land owners and specialists working on the overall project, there was no additional consultation completed for this project.

4 Results

4.1 Screening Tool Results

The results of the Department of forestry, fisheries and the environment screening tool for aquatic biodiversity is provided in Figure 4-1. The screening tool identified

"Very High" sensitivities for the various identified riverine systems as indicated in the National Biodiversity Assessment spatial database (NBA, 2018).

Considering the sensitivity level of the proposed development area, this study was completed and serves as the site sensitivity verification report.

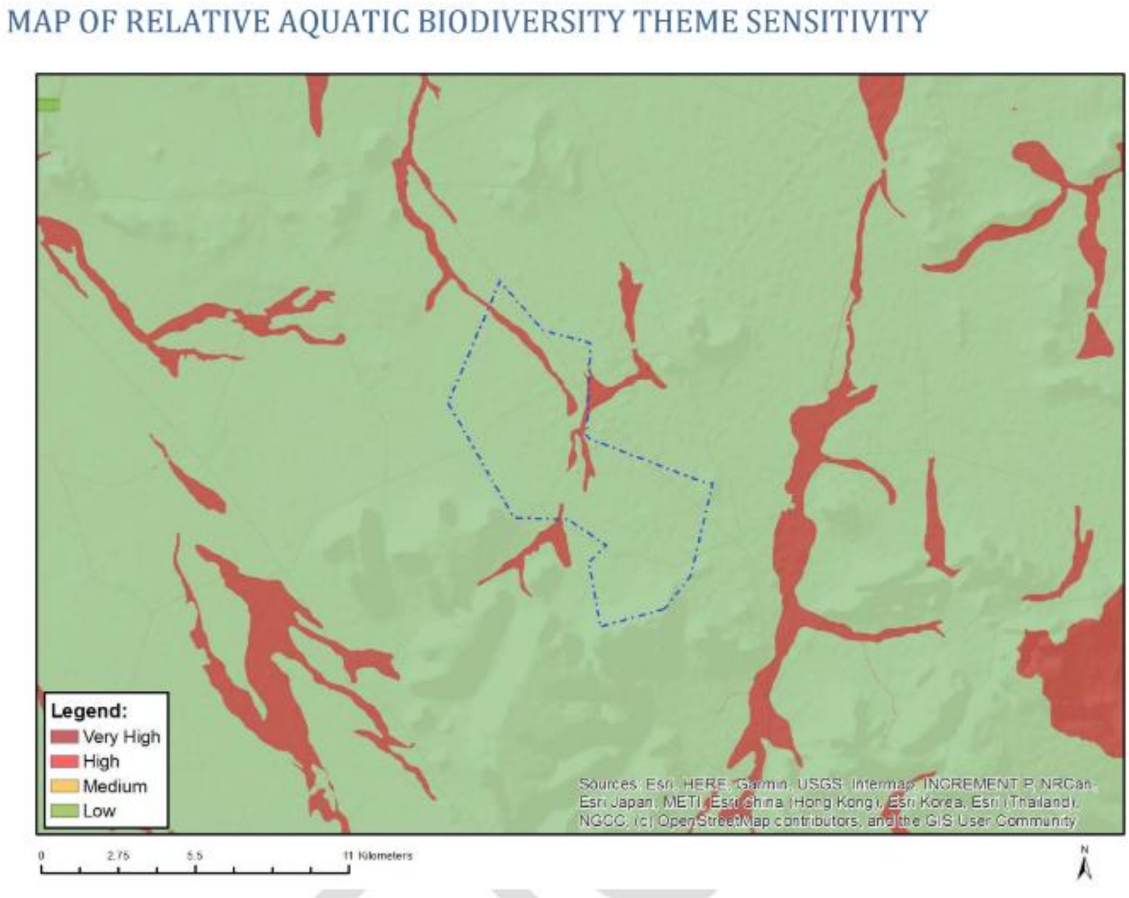


Figure 4-1: Results of the Screening Tool Assessment

4.2 Watercourse Type and Classification

Two HGM types were observed during the survey within the 500m screening area. These HGM types consisted of riverine and depression wetland types (Figure 4-2 and Figure 4-3). Several artificial wetlands were also identified during the survey and included historical borrow pits and impoundments created to capture surface runoff (Figure 4-5). Additional drainage features associated with the project include drainage lines (Figure 4-4). The wetland areas could be separated into 3 distinct HGM units as detailed in Table 4-1. The wetland delineations are provided in Figure 4-6.

Table 4-1: Wetland classification within 500m screening zone

HGM Name	Hectares	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	HGM Type

HGM Name	Hectares	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	HGM Type
HGM1	29.08	Inland	Nama Karoo	Upper Nama Karoo	Valley Bottom	River
HGM2	25.08	Inland	Nama Karoo	Upper Nama Karoo	Valley Bottom	River
HGM3	0.133	Inland	Nama Karoo	Upper Nama Karoo	Flat	Depression

Figure 4-2: The depression unit at HGM3 (August 2023)

Figure 4-3: The riverine geomorphic unit at HGM1 (August 2023)

Figure 4-4: An example of a drainage line in the project area (August 2023)

Figure 4-5: An artificial system including an impoundment in the project area (August 2023)

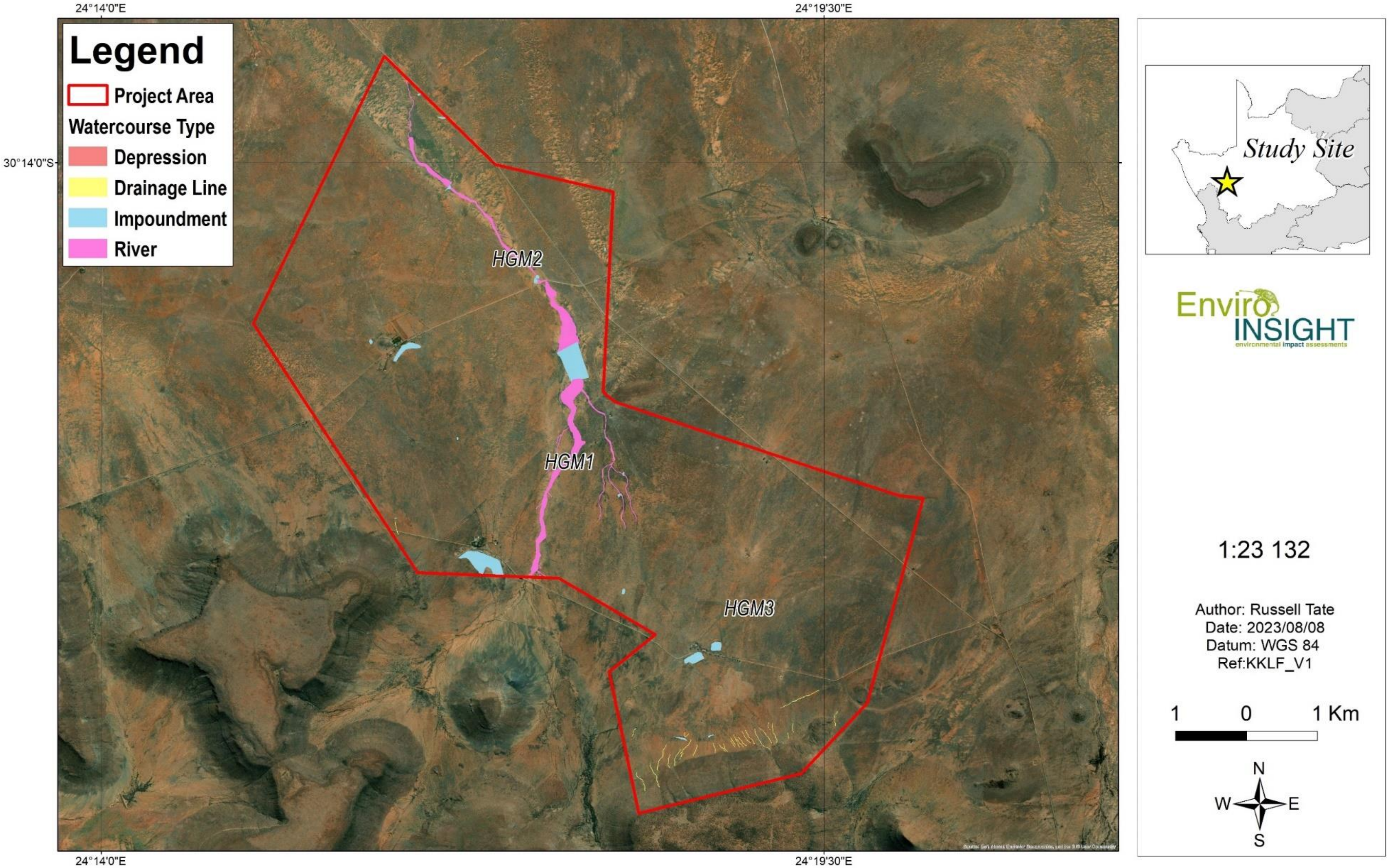


Figure 4-6: Delineation of the watercourses in the project area

4.3 Watercourse Present Ecological Status

4.3.1 Riparian and Instream Habitat Condition

The results of the IHIA are presented in Table 4-2 and Table 4-3. It is noted that HGM1 is located immediately upslope of HGM2 and therefore share similar impacts.

Table 4-2: IHIA for Instream Habitat

Criterion	Water loss	Flow mod	Bed mod	Channel mod	Water quality	Inundation	Exotic veg	Exotic fauna	Solid waste disposal	Condition
HGM1	10	10	12	10	5	9	5	0	10	68.96
HGM2	15	18	18	20	5	8	5	0	10	54.08

Table 4-3: IHIA for Riparian Habitat

Criterion	Indigenous vegetation removal	Exotic vegetation encroachment	Bank erosio n	Channel mod	Water loss	Inundation	Flow mod	Water quality	Condition
HGM1	5	7.5	0	11	10	9	10	5	73.16
HGM2	5	7.5	0	21	15	8	18	5	62.36

Th results of the IHIA assessment indicate that the instream and riparian habitat conditions of HGM1 were within a moderately modified condition (class C). The IHIA assessment for the HGM2 indicated more significant impacts within the watercourse, where largely modified (class D) instream conditions and moderately modified (class C) riparian habitats were derived to be the present condition.

The primary impacts observed within the watersheds could be summarised as follows:

- Watercourse diversion and impoundment is frequent in the watercourses, with larger and more frequent impoundments present in HGM2. These impoundments have had a significant impact on the substrates and bed structure of the watercourses, whilst negatively impacting natural flow conditions and channel structure.
- General landcover alteration has occurred in the watershed, it is accepted that the arid region of the Karoo in South Africa has been historically overgrazed which has subsequently impacted the land cover. Considering the ongoing livestock agricultural activities it is expected that land cover alteration has occurred.
- Exotic riparian vegetation such as *Prosopis glandulosa* were noted within the riparian zone of the watercourses.

Figure 4-7: An impoundment located in the upper reaches of HGM1 (August 2023)

Figure 4-8: A watercourse diversion discharging water to a local impoundment (August 2023)

4.3.2 Instream Riverine Condition

4.3.2.1 Water Quality

The results of the water quality analysis are presented in Table 4-4

Table 4-4: *In situ* water quality analysis results (August 2023)

Site	pH	Conductivity (mS/m)	DO (mg/l)	Temperature (°C)
RQO/TWQR	**6.5-9.5****	**-**	**>5.00****	**5-30**
KK1	8.2	162	5.4	18
**Target Water Quality Guidelines (DWAF, 1996) Red shading indicates values exceeding thresholds				

The results of the water quality analysis indicate the presence basic pH values, high levels of dissolved solids, adequate oxygen concentrations and temperatures within the expected range. The results of the water quality analysis conform to the expected results for a non-perennial system where dissolved solids have been concentrated due to low dilution capacities of the environment.

4.3.2.2 Aquatic Macroinvertebrates

The results of the biotope assessment are provided in Table 4-5. The watercourse under consideration is a non-perennial system, invertebrate assessments were completed to provide further evidence to support the established ecological importance and sensitivity.

Table 4-5: Invertebrate Biotope Assessment Results (August 2023)

Site	KK1
Hydraulic Biotope	**Impoundment**
Stones in current	0
Stones out of current	0
Bedrock	0
Aquatic Vegetation	0
Marginal Vegetation In Current	0
Marginal Vegetation Out Of Current	0
Gravel	0
Sand	1
Mud	3
Biotope Score	4
Weighted Biotope Score (%)	2
Biotope Category (Tate and Husted, 2015)	F

The results of the biotope analysis indicate only sand and mud substrates were present within the sampled survey point. This is typical of the environment considered and the impoundment nature of the watercourse. The results of the SASS5 assessment are presented in Table 4-6. It is important to note that no interpretation using Dallas (2007) was necessary owing to the non-perennial nature of the watercourses as well as the location of the sampling point within an impoundment.

Table 4-6: South African Scoring System Results (August 2023)

Site	SASS Score	No. of Taxa	ASPT*
KK1	43	11	3.9

The results of the invertebrate assessment indicated the presence of 11 families of aquatic macroinvertebrate. The overall sensitivity of the invertebrate assemblage was primarily low due to the restricted habitat availability which was likely compounded by the high salinities observed. Notably high abundances of invertebrates were observed during the August 2023 survey, possibly indicating the presence of a nutrient enriched environment. The rich abundance of the invertebrates are likely to support additional fauna present and therefore form an integral part of the local ecosystems.

4.3.3 Wetland Condition

A single wetland specific assessment was completed for this study on the depression system HGM3. The results of the PES study for HGM3 are presented in Table 4-7.

Table 4-7: Wetland Present Ecological Status for HGM3 (August 2023)

Final Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	1.5	1.6	1.6	3.3
PES Score (%)	85%	84%	84%	67%
Ecological Category	**B**	**B**	**B**	**C**
Trajectory of change	→	→	→	→
Confidence (revised results)	Low	Low	Low	Low
Combined Impact Score	1.9			
Combined PES Score (%)	81%			
Combined Ecological Category	**B**			
Hectare Equivalents	0.1 Ha			

The results of the wetland PES assessment indicates that HGM3 was classified as largely natural (class B). The modified nature of the wetland system was attributed to the combined effect of minor changes to landcover within the depression system watershed (Figure 4-9).

Figure 4-9: The wetland depression system at HGM3 showing limited signs of negative impacts (August 2023)

4.4 Ecosystem Services, Sensitivity and Importance

The results of the ecoservices assessment are presented in Table 4-8. The results of the ecoservices assessment show that the following ecosystem services are important (moderate and above) within the HGM units:

- Carbon storage
- Biodiversity Maintenance
- Harvestable resources

The watercourses were found to provide moderately high ecosystem services for downstream and in project area users. During the assessment this was effectively illustrated through camera trapping where examples of mammal diversity are provided in Figure 4-10. It is noted that there is no listed obligate aquatic fauna that is associated with the project.

Based on the layout and shapefiles provided in the Northern Cape conservation plan, the watercourses under consideration fall within an Ecological Support Area (ESA). When considering the NFEPA watershed data the project is associated with an upstream management area (Nel et al., 2011). The watercourses are not associated with any strategic water use areas.

The Ecological Importance and Sensitivity of the watercourses were derived to be very high and moderate as presented in Table 4-9. The riverine watercourses were found to contain alluvial substrates over clay's and are therefore susceptible to erosion. Flow modification within the project was high with a significant impact to local watercourses effectively demonstrating the sensitivity.

Table 4-8: Ecological Function Assessment Results (August 2023)

ECOSYSTEM SERVICE		Depressions	Non-Perennial Rivers
REGULATING AND SUPPORTING SERVICES	Flood attenuation	Very Low	Very Low
	Stream flow regulation	Very Low	Very Low
	Sediment trapping	Very Low	Very Low
	Erosion control	Very Low	Very Low
	Phosphate assimilation	Very Low	Very Low
	Nitrate assimilation	Very Low	Very Low
	Toxicant assimilation	Very Low	Very Low
	Carbon storage	Moderately High	Moderately High
	Biodiversity maintenance	Moderate	Moderate
PROVISIONING SERVICES	Water for human use	Very Low	Very Low
	Harvestable resources	Moderately Low	Moderately Low
	Food for livestock	Very Low	Very Low

ECOSYSTEM SERVICE		Depressions	Non-Perennial Rivers
	Cultivated foods	Very Low	Very Low
CULTURAL SERVICES	Tourism and Recreation	Very Low	Very Low
	Education and Research	Very Low	Moderately Low
	Cultural and Spiritual	Very Low	Very Low

Figure 4-10: Examples of mammals observed in the watercourses in the project area over the three night period (Top left: *Raphicerus campestris*, Top right: *Sylvicapra grimmia*, Bottom left: *Galerella sanguinea*, bottom right *Vulpes chama*)

Table 4-9: Ecological Importance and Sensitivity

Wetland Importance and Sensitivity	Depressions	Non-Perennial Rivers
Ecological Importance and Sensitivity	3.3	2.4
Hydrological/functional importance	2.4	1.2
Direct human benefits	1.1	1.0
Highest Value	**3.3**	**1.7**
EIS Category	**Very High**	**Moderate**

4.5 Buffers and Regulated Areas

It is important to note that the proposed project falls within the legislated 500m regulated area as per the following definition:

Regulated area of a watercourse for Section 21 (c) or (i) of the Act water uses in terms of the Notice means:

- (c) A 500m radius from the delineated boundary (extent) of any wetland or pan.

According to the National Environmental Management Act (Act no. 107 of 1998), Amendment of the Environmental Impact Assessment Regulations listing notice 1 of 2014, should no existing setback be defined, an area of 32 metres from the edge of the watercourse must not be developed (buffered).

Wetland buffer zones were defined according to Macfarlane et al. (2009). It is noted that the proposed project is to take place within the regulated areas within 500m from the delineated wetland areas. The proposed project will be a development of a PV facility and associated infrastructure.

The buffer tool does not currently cater for PV projects and therefore the mixed-use business land use impact sub sector was therefore utilised. The threat assessment for the proposed project is indicated in Table 4-10. The results of the buffer analysis are presented in Table 4-11 and Table 4-12 whilst this is mapped in Figure 4-11. The buffer analysis indicated a 15m buffer requirement for delineated rivers, whilst 20m were provided for depression systems. This analysis however does not effectively demonstrate the high levels of sensitivity and variability of the watercourses. Thus, to cater for this larger, more appropriate buffer zones have been recommended. Buffer zones for artificial impoundments and drainage lines have also been recommended at 5m and 10m respectively.

Table 4-10: The pre-and post- mitigation threat analysis defined for the project

Phase	Threat	Before Mitigation	After mitigation
Construction Phase	1. Alteration to flow volumes	VL	VL
	2. Alteration of patterns of flows (increased flood peaks)	L	L
	3. Increase in sediment inputs & turbidity	H	H
	4. Increased nutrient inputs	VL	VL
	5. Inputs of toxic organic contaminants	VL	VL
	6. Inputs of toxic heavy metal contaminants	L	VL
	7. Alteration of acidity (pH)	N/A	N/A
	8. Increased inputs of salts (salinization)	N/A	N/A
	9. Change (elevation) of water temperature	VL	VL
	10. Pathogen inputs (i.e. disease-causing organisms)	VL	VL
Operational Phase	1. Alteration to flow volumes	M	L

Phase	Threat	Before Mitigation	After mitigation
	2. Alteration of patterns of flows (increased flood peaks)	M	L
	3. Increase in sediment inputs & turbidity	L	L
	4. Increased nutrient inputs	VL	VL
	5. Inputs of toxic organic contaminants	VL	VL
	6. Inputs of toxic heavy metal contaminants	L	L
	7. Alteration of acidity (pH)	VL	VL
	8. Increased inputs of salts (salinization)	VL	VL
	9. Change (elevation) of water temperature	VL	VL
	10. Pathogen inputs (i.e. disease-causing organisms)	L	L

Table 4-11: Buffer requirements before and after mitigation Rivers

Phase	Before mitigation	After mitigation	Recommended Buffer
Construction	15	15	30
Operation	15	15	30

Table 4-12: Buffer requirements before and after mitigation Depressions

Phase	Before mitigation	After mitigation	Recommended Buffer
Construction	20	20	40
Operation	20	20	40

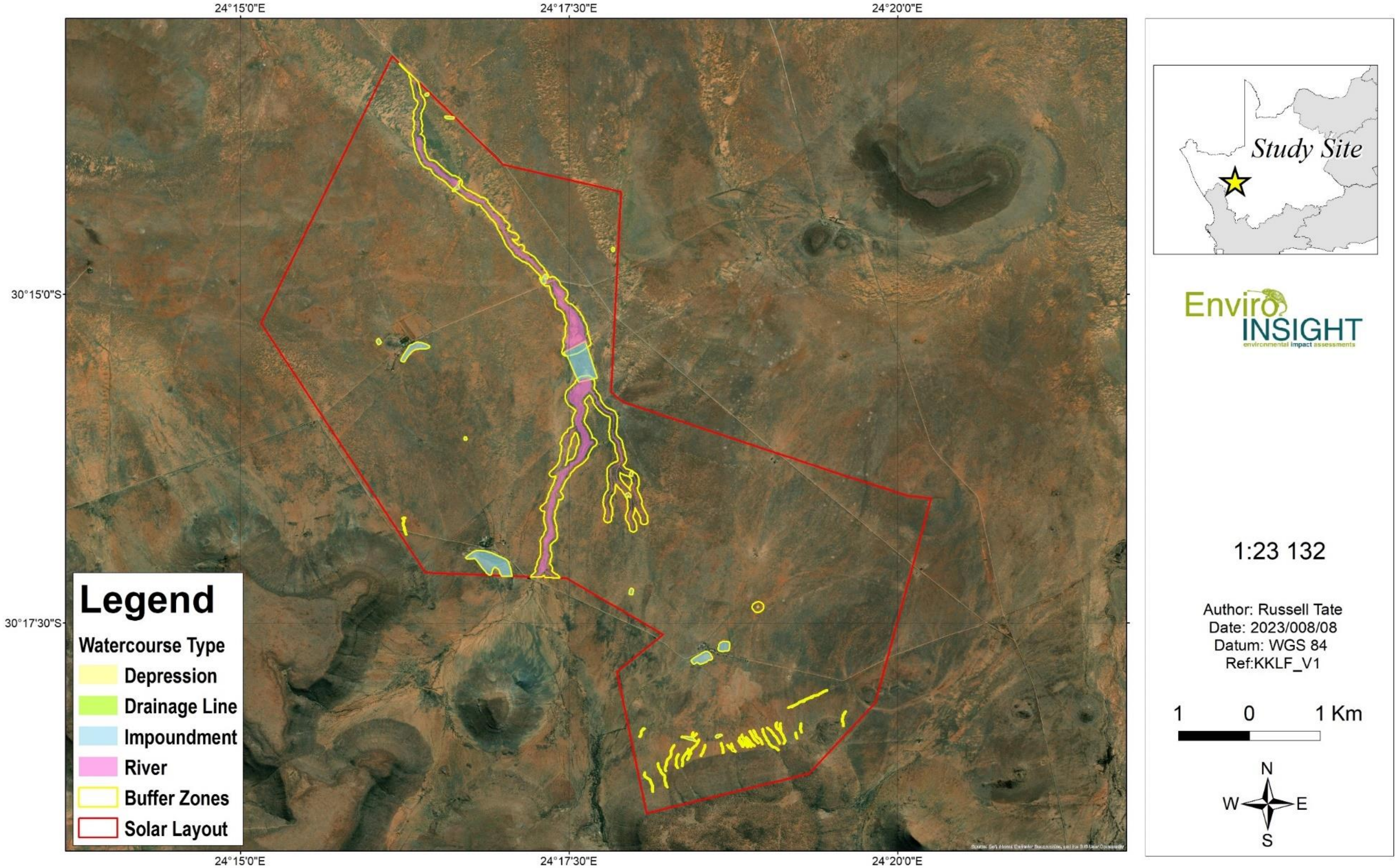


Figure 4-11: Buffer zones recommended for the watercourses in the project area

5 Anticipated Impacts

5.1 Risk Assessment Methodology

Two risk assessment approaches were utilised in this assessment, the first was to address the minimum requirements of the DWS, whilst the second risk assessment was applicable to the National Environmental Management Act (NEMA) standards. And aligns with standard approaches to determine impact in a similar manner to other ecological standards. The DWS risk assessment was conducted in accordance with the requirements of the DWS General Authorisation (GA) legislation in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 49833 of 2023).

Table 5-1: Risk Assessment Matrix Interpretation

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	**(L) Low Risk** **OR** **(+) Positive** **(+ +) Highly positive**	Acceptable as is or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.
30 – 60	**(M) Moderate Risk**	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
61 – 100	**(H) High Risk**	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Once a potential impact has been determined it is necessary to identify which project activity will cause the impact, the probability of occurrence of the impact, and its magnitude and extent (spatial and temporal). This information is important for evaluating the significance of the impact, and for defining mitigation and monitoring strategies. Direct and indirect impacts of the impacts identified during the specialist investigations were assessed in terms of five standard rating scales to determine their significance.

The rating system used for assessing impacts (or when specific impacts cannot be identified, the broader term issue should apply) is based on six criteria, namely:

- Status of impacts (Table 5-2) – determines whether the potential impact is positive (positive gain to the environment), negative (negative impact on the environment), or neutral (i.e. no perceived cost or benefit to the environment). Take note that a positive impact will have a low score value as the impact is considered favourable to the environment;
- Spatial extent of impacts (Table 5-3) – determines the spatial scale of the impact on a scale of localised to global effect. Many impacts are significant only within the immediate vicinity of the site or within the surrounding

community, whilst others may be significant at a local or regional level. Potential impact is expressed numerically on a scale of 1 (site-specific) to 5 (global);

- Duration of impacts (Table 5-4) – refers to the length of time that the aspect may cause a change either positively or negatively on the environment. Potential impact is expressed numerically on a scale of 1 (project duration) to 5 (permanent);
- Frequency of the activity (Table 5-5)– The frequency of the activity refers to how regularly the activity takes place. The more frequent an activity, the more potential there is for a related impact to occur.
- Severity of impacts (Table 5-6) – quantifies the impact in terms of the magnitude of the effect on the baseline environment, and includes consideration of the following factors:
    - The reversibility of the impact;
    - The sensitivity of the receptor to the stressor;
    - The impact duration, its permanency and whether it increases or decreases with time;
    - Whether the aspect is controversial or would set a precedent;
    - The threat to environmental and health standards and objectives;
- Probability of impacts (Table 5-7) –quantifies the impact in terms of the likelihood of the impact occurring on a percentage scale of <5% (improbable) to >95% (definite).
- Confidence – The degree of confidence in predictions based on available information and specialist knowledge:
    - Low;
    - Medium; or
    - High.

In addition, each impact needs to be assessed in terms of reversibility and irreplaceability as indicated below:

- Reversibility of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):
    - High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);
    - Moderate reversibility of impacts;
    - Low reversibility of impacts; or
    - Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment).
- Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks – the degree to which the impact causes irreplaceable loss of

resources assuming that the project has reached the end of its life cycle (decommissioning phase):

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

Table 5-2: Status of Impacts

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment (positive impact)	+
Neutral	No determined cost or benefit to the receiving environment	N
Negative	At cost to the receiving environment (negative impact)	-

Table 5-3: Extent of Impacts

Rating	Description	Quantitative Rating
Very Low	**Site Specific** – impacts confined within the project site boundary	1
Low	**Proximal** – impacts extend to within 1 km of the project site boundary	2
Medium	**Local** – impacts extend beyond to within 5 km of the project site boundary	3
High	**Regional** – impacts extend beyond the site boundary and have a widespread effect - i.e. > 5 km from project site boundary	4
Very High	**Global** – impacts extend beyond the site boundary and have a national or global effect	5

Table 5-4: Duration of Impacts

Rating	Description	Quantitative Rating
Very Low	**Project duration** – impacts expected for the duration of the project or not greater than 1 year	1
Low	**Short term** – impacts expected on a duration timescale of 1 to 2 years	2
Medium	**Medium term** – impacts expected on a duration timescale of 2-5 years	3
High	**Long term** – impacts expected on a duration timescale of 5-15 years	4
Very High	**Permanent** – impacts expected on a duration timescale exceeding 15 years	5

Table 5-5: Frequency of impacts

Rating	Frequency	uantitative Rating
Very Low	Annually or less	
Low	6 monthly	
Medium	Monthly	
High	Weekly	
Very High	Daily / Permanent	

Table 5-6: Severity of Impacts

Rating	Description	Quantitative Rating
Very Low	Negligible – zero or very low impact	1
Low	Small / potentially harmful	2
Medium	Significant / slightly harmful	3
High	Great / harmful	4
Very High	Disastrous / extremely harmful	5

Table 5-7: Probability of Impacts

Rating	Description	Quantitative Rating
Highly Improbable	Likelihood of the impact arising is estimated to be negligible; <5%.	1
Improbable	Likelihood of the impact arising is estimated to be 5-35%.	2
Possible	Likelihood of the impact arising is estimated to be 35-65%	3
Probable	Likelihood of the impact arising is estimated to be 65-95%.	4
Highly Probable	Likelihood of the impact arising is estimated to be > 95%.	5

5.2 Determination of Impact Significance

The information presented above in terms of identifying and describing the aspects and impacts is summarised in below in Table 5-8 and significance is assigned with supporting rational.

Table 5-8: Consolidated Table of Aspects and Impacts Scoring

Spatial Scale	Rating	Duration	Rating	Severity	Rating
Activity specific	1	One day to one month	1	Insignificant/non-harmful	1
Area specific	2	One month to one year	2	Small/potentially harmful	2
Whole site/plant/mine	3	One year to ten years	3	Significant/slightly harmful	3
Regional/neighbouring areas	4	Life of operation	4	Great/harmful	4
National	5	Post closure	5	Disastrous/extremely harmful	5
Frequency of Activity		Rating	Probability of Impact		Rating
Annually / Once-off		1	Almost never/almost impossible (<5%)		1
6 monthly		2	Very seldom/highly unlikely (5-35%)		2
Monthly		3	Infrequent/unlikely/seldom (35-65%)		3
Weekly		4	Often/regularly/likely/possible (65-95%)		4
Daily / Regularly		5	Daily/highly likely/definitely (> 95%)		5
Significance Rating of Impacts			Timing		
Very Low (1-25) Low (26-50) Low – Medium (51-75) Medium – High (76-100) High (101-125) Very High (126-150)			Pre-construction Construction Operation Decommissioning		

The environmental significance rating is an attempt to evaluate the importance of a particular impact, the consequence and likelihood of which is assessed by the relevant specialist. The description and assessment of the aspects and impacts is presented in a consolidated table with the significance of the impact assigned using the process and matrix detailed below.

The sum of the first three criteria (spatial scope, duration and severity) provides a collective score for the consequence of each impact. The sum of the last two criteria (frequency of activity and frequency of impact) determines the likelihood of the impact occurring. The product of consequence and likelihood leads to the assessment of the significance of the impact (Significance = Consequence X Likelihood), shown in the significance matrix below in Table 5-9.

Table 5-9: Significance Assessment Matrix

	Consequence (Severity + Spatial Scope + Duration)														
Likelihood (Frequency of Activity + Probability of Impact)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	08	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 5-10: Positive and Negative Impact Mitigation Ratings

Colour Code	Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
	Very High	126-150	Avoidance – consider alternatives	Optimal contribution from Project
	High	101-125	Avoidance as far as possible; implement strict mitigation measures to account for residual impacts	Positive contribution from Project with scope to improve
	Medium-High	76-100	Where avoidance is not possible, consider strict mitigation measures	Moderate contribution from Project with scope to improve
	Low-Medium	51-75	Mitigation measures to lower impacts and manage the project impacts appropriately	Improve on mitigation measures
	Low	26-50	Appropriate mitigation measures to manage the project impacts	Improve on mitigation measures; consider alternatives to improve on
	Very Low	1-25	Ensure impacts remain very low	Consider alternatives to improve on

The model outcome is then assessed in terms of impact certainty and consideration of available information. Where a particular variable rationally requires weighting or an additional variable requires consideration the model outcome is adjusted accordingly.

5.3 Risk Assessment Results

5.3.1 Existing Activities – No Go Situation

Existing activities within the project area include livestock agriculture, road and electricity transmission infrastructure.

These activities have had a moderate to minor impact on the status of the watercourses. The no-go situation indicates the long-term maintenance of the assessed watercourses.

5.3.2 Proposed Activities

No specific project activities were provided for this assessment. The expected activities that will be completed for the proposed projects are summarised below:

- Site access and clearing of vegetation in working areas;

- Establishment of laydown yard/construction camps;
- Excavations and earthworks for infrastructure setting;
- Excavations and earthworks for infrastructure foundations;
- Stockpiling and movement of soils and construction materials;
- Storage and use of chemicals, fuels and oils;
- Storm-water management.

5.3.3 Linear Infrastructure

The existing road infrastructure on the site will be utilised for all ongoing and proposed activities. Additional roads are however going to be required, these will be used to access and service the PV and Battery Energy Storage System (BESS) structures. In addition, some roadways will require upgrading of existing informal watercourse crossings.

5.3.3.1 Avoidance

It is noted that the watercourses delineated in this study have been effectively avoided, along with a suitable buffer for PV, substation and BESS infrastructure. Roads however will cross the riverine associated habitats where the following avoidance recommendations are provided.

5.3.3.1.1 <u>Roads</u>

Based on the reviewed layouts, only a single crossing point is anticipated to be upgraded with the bulk of the roadways avoiding sensitive water associated habitats.

5.3.3.1.2 <u>Culverts/Drifts - Crossings</u>

Should culverts be utilised, rivers are recommended to be crossed by multiple culverts spread across the watercourse as opposed a single culvert, this is recommended to ensure the spread flows across the systems and the maintenance of alluvial deposition in riparian habitats.

Should culverts not be utilised due to the design requirements of the project, it is recommended that reinforced drift structures are utilised.

5.3.3.2 Construction Phase

The construction phase of linear infrastructure will involve the active clearing of vegetation, altering of slope as well as general catchment drainage modification. Direct unavoidable impacts are anticipated at the river crossing point where these are required.

The clearing of vegetation and exposure and movement of top and sub-soils present risk to altering chemical and physical conditions in local watercourses. The presence of roadways will further decrease surface roughness in the watersheds. The expected impacts are sedimentation and erosion of downstream reaches as a resultant impact of increased surface flow velocity and substrate erodibility. The crossing points will directly modify instream and bank conditions and may result in direct instream habitat loss.

5.3.3.2.1 Mitigation Actions

- Where culverts are required it is recommended that these are spread across the wetland units and not directed through single culverts.
- Where drifts are utilised, it is recommended that these structures are reinforced with erosion control measures that protect downstream riverine substrates and riparian habitats.
- All contractors and staff are to be familiarised with the method statement and have undergone an induction / training on the location of sensitive No-Go areas and basic environmental awareness using the mitigation provided in this report.
- Areas where construction is to take place must be clearly demarcated. Any areas not demarcated must be avoided;
- Storm-water generated from roadways must be captured and buffered, where flow velocities are to be significantly reduced before discharge into the environment.
- Storm-water verges as well as other denuded areas must be grassed (re-vegetated) with local indigenous grasses to protect against erosion;
- Any materials excavated must not be deposited in the wetlands or areas where it is prone to being washed downstream or impeding natural flow;
- Stockpiling or storage of materials and/or waste must be placed beyond the defined buffers in this report for each respective activity;
- No vehicles shall enter watercourse buffer zones outside of construction footprints;
- No vehicles shall be serviced on site; a suitable workshop with appropriate pollution control facilities should be utilised offsite;
- Hydrocarbons for refuelling purposes must be stored in a suitable storage device on an impermeable surface outside of the delineated wetland buffer zone;
- Disturbed areas must be re-vegetated after completion of the phase;
  - A three-month timeframe for the initiation of this action;
  - Ripping of the soils should occur in two directions; and
  - Removed vegetation and topsoil can be harvested and applied here.
- Drainage channels constructed for the access roads must be constructed so as not to result in erosion;
- An alien vegetation removal and management plan must be implemented along the verges of the roads and crossing points;
- General storm-water management practices should be included in the design phase and implemented during the construction phase of this project; and

- Following the completion of the phase, all construction materials and debris should be removed and disposed of in a suitable area. An inspection should be completed within a 4 weeks after the phase is completed.

5.3.3.3 Operation Phase

Drainage off the hardened surfaces created by the roadways, PV, BESS, and substation structures are anticipated to be silt laden and of a higher runoff velocity during rainfall events. This can result in the erosion and sedimentation of downslope watercourses. Similarly, to the construction phase, the operation phase of the crossing point are likely to inundate upstream areas and concentrate flows downstream. The above two processes are likely to result in erosion and sedimentation. The subsequent effect of this would be water and habitat quality deterioration leading to a decreased ecological status of associated watercourses.

5.3.3.3.1 <u>Mitigation Actions</u>

The following mitigation is recommended for the operational phase

- The implementation of a suitable storm-water management plan for the disturbance footprint must be in place and implemented by this phase;
- An annual audit of the road and PV areas for signs of environmental disturbance outside and within the footprint area must be conducted; and
- Alien invasive management programmes should continue throughout the duration of the activity.
- Watercourse monitoring should take place at least every three years as part of the environmental management plan.

5.3.4 Solar Activities

5.3.4.1 Avoidance

It is recommended that the buffer zones established in this study are utilised to inform the placement of the solar infrastructure. It is noted that this was already in place based on the layout provided in this study (Figure 5-1).

5.3.4.2 Construction Phase

The construction phase of the solar facility will clear vegetation whereafter minor earthworks will be completed. It is noted that the linear infrastructure impacts provided above are relevant for the proposed road networks within the solar farm portion.

The clearing of vegetation and placement of hardened surfaces increases rainfall runoff velocities which can result in the increase in flood-peaks, sedimentation and erosion of downstream watercourses. Furthermore, the reduced infiltration because of the hardened surfaces will negatively affect the catchment water balance.

Workshops and laydown yards are often sources for contaminants such as hydrocarbons. Thus, runoff or seepage from these areas can negatively affect local watercourses. Offices, including domestic waste facilities are sources for contaminants to local watercourses and therefore mitigation must ensure these aspects are contained.

5.3.4.2.1 Mitigation Actions

- The implementation of the buffer zone stipulated in this report;
- Clean and dirty surface water separation and a storm-water management plan must be put into place via standard best practice methods;
- A clear storm-water management plan for hardened surfaces must be implemented;
- The revegetation of disturbed non-active cleared areas must take place within the first growing season between following completion of the activity;
- The above must be audited within 3 months of completing the phase;
- No discharge of domestic water must occur if possible. Domestic water must be reused for dust suppression.
- All stockpiles and hazardous waste storage areas must be bunded by either a cut-off trench or berm directed to a Pollution Control Dam or alternative storage facility inline with best practice surface water management guidelines.

5.3.4.3 Operational Phase

The operation of the structures will impact the surrounding watercourses via direct runoff from hardened surfaces and materials from stockpiles and workshops. This runoff will likely contain contaminants and occur at elevated velocities. Impacts to be expected in this phase can largely be related to water quality and quantity impacts.

5.3.4.3.1 Mitigation Actions

- The implementation of the buffer zones provided in this report;
- Clean and dirty surface water separation and storm-water management plan must be put into place via standard best practice methods;
- An effective storm-water management plan for the solar farm must be implemented;
- The revegetation of disturbed non active cleared areas must take place within 1 month of completing the construction phase;
- The above must be audited within 3 months of completing the phase;
- No discharge of domestic water must occur if possible. Domestic water must be reused for dust suppression. Should domestic water be required to be discharge, the management of nitrogen concentrations is imperative.

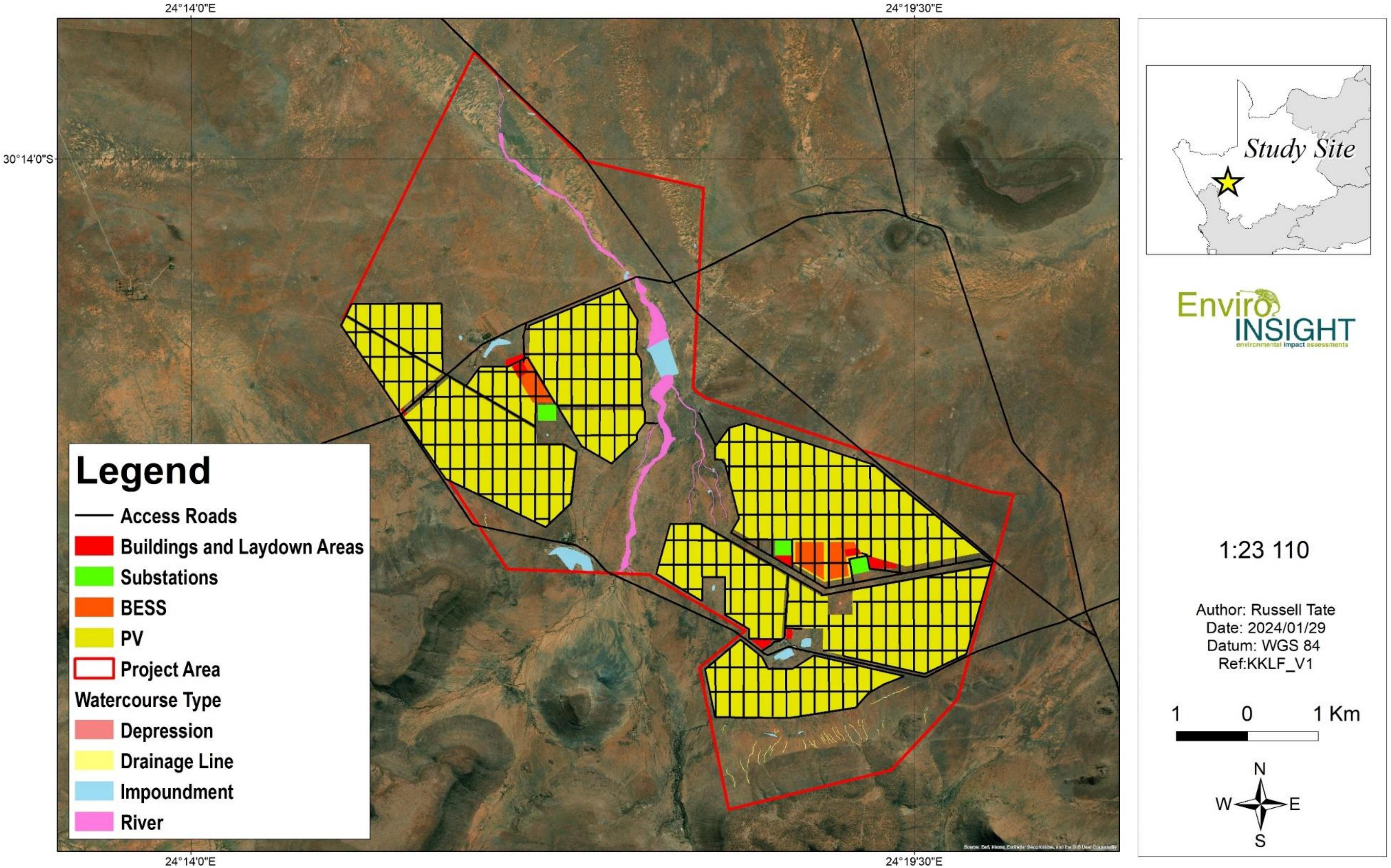
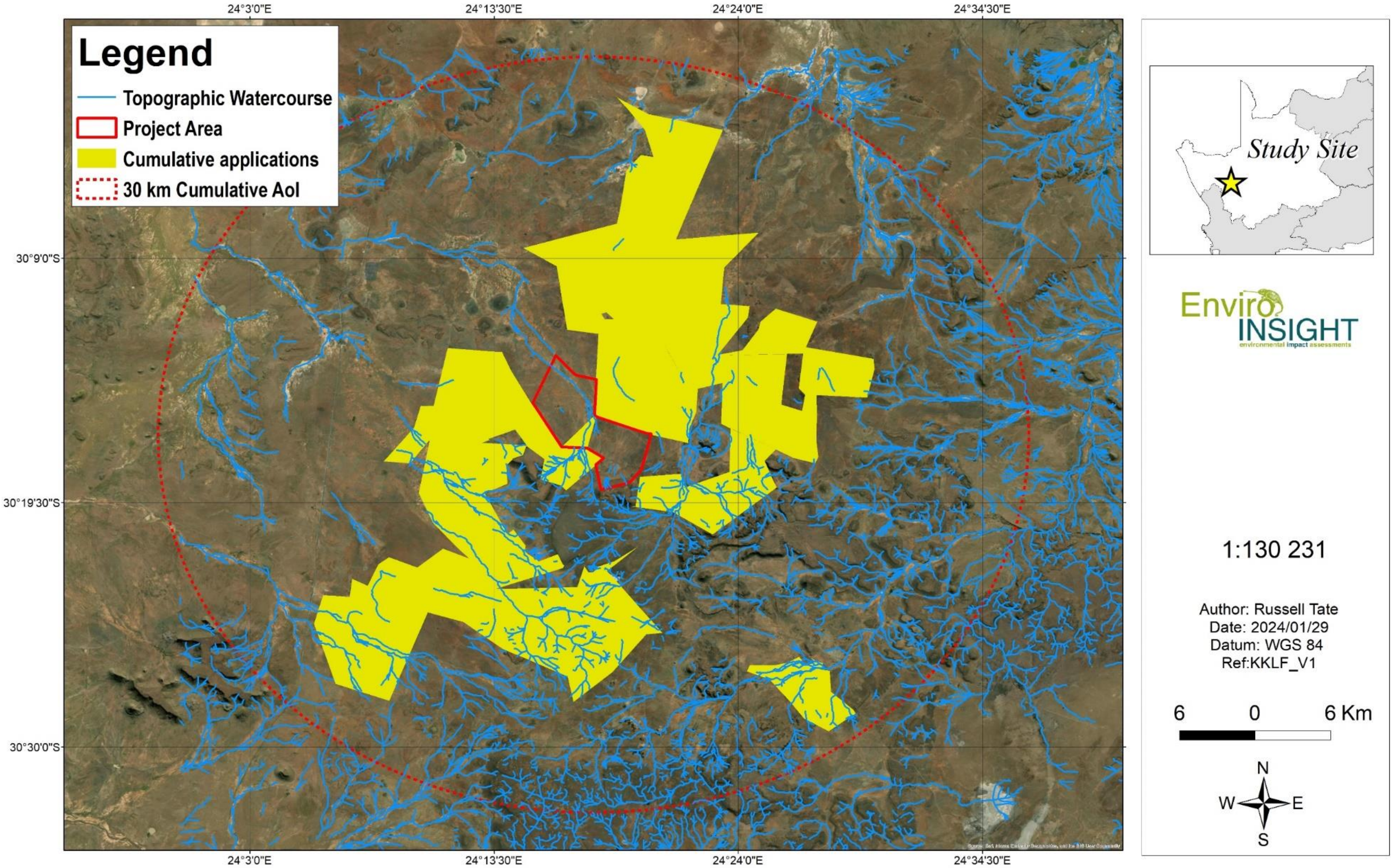


Figure 5-1: Proposed Project Layout for the project


Legend
Topographic Watercourse
Project Area
Cumulative applications
30 km Cumulative AoI
24°3'0"E
24°13'30"E
24°24'0"E
24°34'30"E
30°9'0"S
30°19'30"S
30°30'0"S
Study Site
1:130 231
Author: Russell Tate
Date: 2024/01/29
Datum: WGS 84
Ref:KKLF_V1
6 0 6 Km
N
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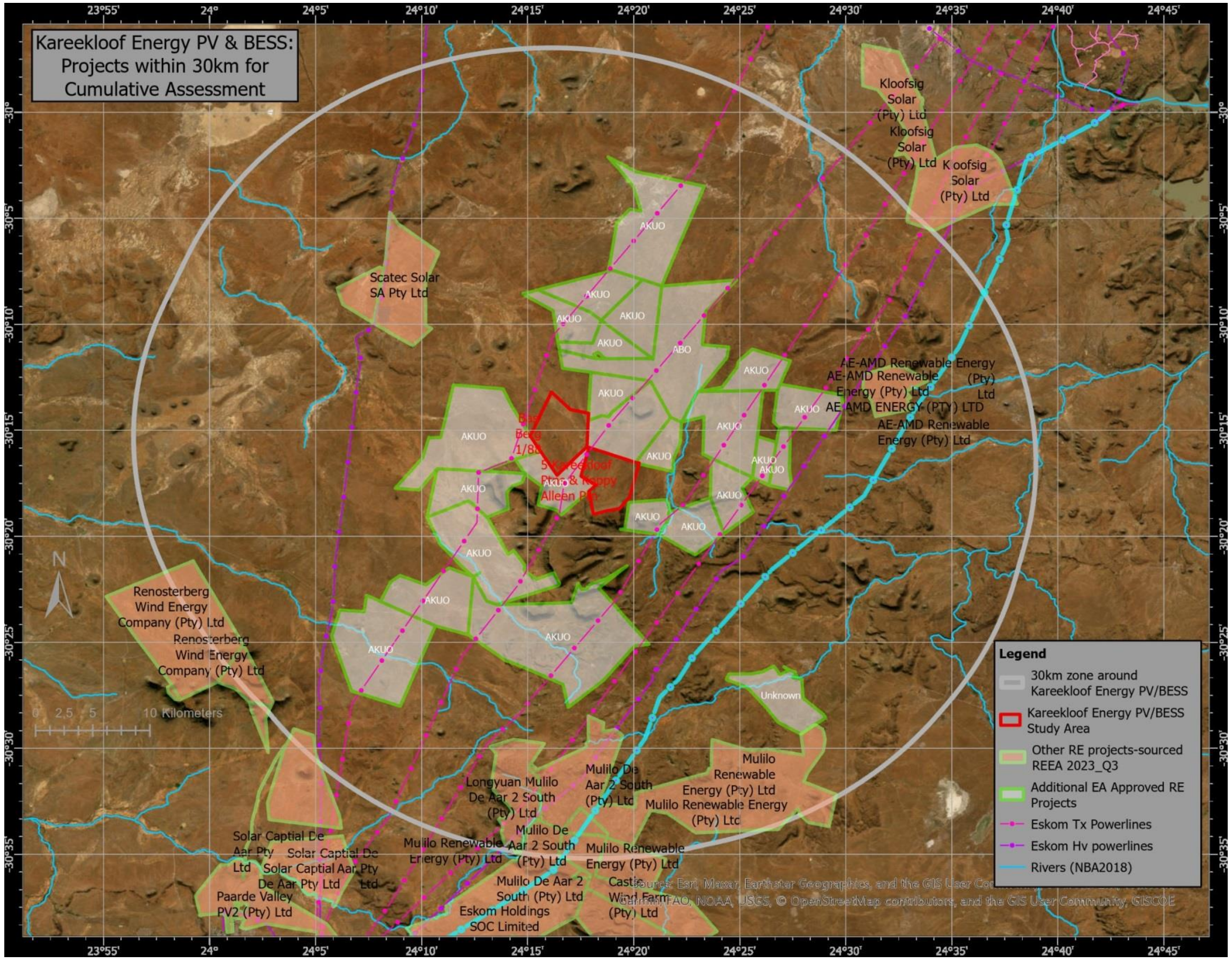

Figure 5-2: Cumulative Project Layout and Buffer

5.3.5 Risk Assessment Tables

Table 5-11: Summary Results of the standardised DWS Risk Assessment

Risk assessment completed by Russell Tate (Pr. Sci. Nat)			
Phase	**Activity**	**Impact**	**Risk Ratings**
CONSTRUCTION	Clearing of vegetation	Alteration of runoff velocity	Low
		Production of sediment	Low
		Increasing erosion downslope	Low
	Excavating/shaping landscape for infrastructure placement	Alteration of runoff velocity	Low
		Production of sediment	Low
		Increasing erosion downslope	Low
	Stockpiling and placement of construction materials and structures	Alteration of runoff velocity	Low
		Production of fines and contaminants	Low
		Increasing erosion downslope	Low
OPERATIONAL	Solar PV Structures	Direct alteration of drainage	Low
		Hydrological process alteration	Low
		Establishment of alien plants on disturbed areas	Low
	Linear Infrastructure (Roads)	Alteration of surface drainage	Low
		Alteration of instream habitats	Low
		Establishment of alien plants on disturbed areas	Low
DECOMMISSIONING	Clearing of vegetation	Alteration of runoff velocity	Low
		Production of sediment	Low
		Increasing erosion downslope	Low
	Excavating/shaping landscape for infrastructure placement	Alteration of runoff velocity	Low
		Production of sediment	Low
		Increasing erosion downslope	Low
	Stockpiling and placement of construction materials and structures	Alteration of runoff velocity	Low
		Production of fines and contaminants	Low
		Increasing erosion downslope	Low

Table 5-12: NEMA Impact Assessment – Linear, Infrastructure and Solar Activities – Water and Habitat impacts – Pre-Mitigation

Phase	Construction					Operation		
Activity	Operation of equipment and machinery	Clearing vegetation	Stockpiling of and placement construction materials	Excavating/shaping landscape	Final landscaping, backfilling and postconstruction rehabilitation	Alteration of drainage	Alteration of surface water flow dynamics	Establishment of alien plants on disturbed areas
Spatial Scale	1	1	1	1	1	1	1	1
Duration	3	3	3	3	3	4	4	4
Severity	2	3	2	3	2	3	3	3
Frequency	1	1	1	1	1	5	5	5
Probability	4	4	4	4	4	4	4	4
Significance Rating	30	35	30	35	30	72	72	72
Significance interpretation	Low	Low	Low	Low	Low	Low-medium	Low-medium	Low-medium

Table 5-13: NEMA Impact Assessment – Linear, Infrastructure and Solar Activities – Water and Habitat impacts – Post Mitigation

Phase	Construction				Operation			
Activity	Operation of equipment and machinery	Clearing vegetation	Stockpiling of and placement construction materials	Excavating/shaping landscape	Final landscaping, backfilling and postconstruction rehabilitation	Alteration of drainage	Alteration of surface water flow dynamics	Establishment of alien plants on disturbed areas
Spatial Scale	1	1	1	1	1	1	1	1
Duration	3	3	3	3	3	4	4	4
Severity	2	3	2	3	2	3	3	3
Frequency	1	1	1	1	1	5	5	5
Probability	1	1	1	1	1	1	1	1
Significance Rating	12	14	12	14	12	48	48	48
Significance interpretation	Low	Low	Low	Low	Low	Low	Low	Low

Table 5-14: NEMA Impact Assessment –Cumulative – Water and Habitat impacts Pre-Mitigation

Phase	Construction					Operation		
Activity	Operation of equipment and machinery	Clearing vegetation	Stockpiling of and placement construction materials	Excavating/shaping landscape	Final landscaping, backfilling and postconstruction rehabilitation	Alteration of drainage	Alteration of surface water flow dynamics	Establishment of alien plants on disturbed areas
Spatial Scale	1	1	1	1	1	1	1	1
Duration	3	3	3	3	3	4	4	4
Severity	2	3	2	3	2	3	3	3
Frequency	1	1	1	1	1	5	5	5
Probability	4	4	4	4	4	4	4	4
Significance Rating	30	35	30	35	30	72	72	72
Significance interpretation	Low	Low	Low	Low	Low	Low-medium	Low-medium	Low-medium

Table 5-15: NEMA Impact Assessment –Cumulative – Water and Habitat impacts Post Mitigation

Phase	Construction				Operation			
Activity	Operation of equipment and machinery	Clearing vegetation	Stockpiling of and placement construction materials	Excavating/shaping landscape	Final landscaping, backfilling and postconstruction rehabilitation	Alteration of drainage	Alteration of surface water flow dynamics	Establishment of alien plants on disturbed areas
Spatial Scale	1	1	1	1	1	1	1	1
Duration	3	3	3	3	3	4	4	4
Severity	2	3	2	3	2	3	3	3
Frequency	1	1	1	1	1	5	5	5
Probability	1	1	1	1	1	1	1	1
Significance Rating	12	14	12	14	12	48	48	48
Significance interpretation	Low	Low	Low	Low	Low	Low	Low	Low

5.4 Unplanned Events

The planned activities of the development will have known impacts which were discussed; however, there is potential for unanticipated impacts on a watercourse which result from accidents or equipment failure. As a result, these risks are undefined as the size, volume, toxicity etc. are unknown making assessing the risk unfeasible; however, their potential for modification of a system should still be noted. Due to the unanticipated nature of these risks, capturing them all is impossible. Hydrocarbon or battery acid spillages into riverine habitat has the potential to contaminate both sediments and water resources. As a result, spill kits must be always available on site with all incidents reported to the onsite Environmental Control Officer (ECO). During construction, unplanned erosion may occur from, for example bank collapse during construction which will result in the sedimentation of the watercourse downstream. Erosion control measures must therefore be considered.

Table 5-16 is a summary of the findings from a riverine ecology perspective. Please note not all potential unplanned events may be captured herein and this must therefore be managed throughout all phases.

Table 5-16: Unplanned Events and their Management Measures

Unplanned Event	Potential Impact	Mitigation
Hydrocarbon spill	Contamination of sediments and water resources associated with the spillage.	A spill response kit must be always available. The incident must be reported on and if necessary a wetland specialist must investigate the extent of the impact and provide rehabilitation recommendations.
Uncontrolled erosion	Sedimentation of downstream river reach.	Erosion control measures must be put in place. Monitoring and active engagement with local land users is recommended to monitor for erosion in the long term.

5.5 Cumulative Impact Assessment

The results of the cumulative impact assessment are provided above Table 5-14 and Table 5-15. The layout of similar projects within a 30km radius of the proposed project are presented in Figure 5-2.

5.5.1 Cumulative Impact Statement

The expected cumulative impacts for the proposed project on aquatic biodiversity are minimal where the avoidance and mitigation measures are to be implemented. When considering the additional applications immediately upslope of the project, increased surface areas of hardened surfaces are expected to be developed thereby altering the watershed roughness factors. However, given that the proposed project has avoided direct impacts to watercourses despite additional applications in within the 30km cumulative impact framework, no significant impact to aquatic biodiversity can be expected.

5.6 Irreplaceable Loss

Should the mitigation and avoidance actions as recommended in this study be implemented, no irreplaceable loss of aquatic biodiversity can be expected.

6 Aquatic Ecology Minimum Requirements Statements

The National Environmental Management Act (NEMA) has established minimum criteria that must be considered in aquatic biodiversity studies (RSA Government, 2020). Although these aspects were largely covered in this report, specific aspects relating to the anticipated impacts remain. The following table was compiled to directly address the remaining aspects not already covered by the impact and risk assessment (Table 6-1).

Table 6-1: Additional aspects required by the minimum report requirement notice

Condition	Response
2.5.1: Is the proposed development consistent with maintaining the priority aquatic ecosystems in its current state and according to the stated goal.	No NFEPA areas to be affected.
2.5.2: Is the proposed development consistent with maintaining the resource quality objectives.	No applicable Resource Quality Objectives anticipated to be impacted.
2.5.3a: How will the project impact on the hydrological functioning at a landscape level.	The project will likely reduce infiltration rates and increase the catchment hardness.
2.5.3a: Will the proposed development change the sediment regime of the aquatic ecosystem.	A minor increase in sediment yields can be expected from the project.
2.5.3c: What will the extent of the modification in relation to the overall aquatic ecosystem be.	Should avoidance be implemented limited impacts to watercourse extents can be expected.
2.5.3d: To what extent will the risks associated with water uses and related activities change.	There will be a minimal impact to water users associated with the project.
2.5.4a: How will the proposed development effect base flows.	Minimal impacts to baseflow are anticipated.
2.5.4b: How will the proposed development effect the quantity of water.	It is expected that an increase peak flow will occur in the associated watercourses.
2.5.4b: How will the proposed development effect the hydrogeomorphic characteristics of the watercourse.	There are no likely impacts to the hydrogeomorphic features.
2.5.4b: How will the proposed development effect the quality of water.	No to minor effects on water quality are expected.
2.5.4b: How will the proposed development effect habitat fragmentation.	There is unlikely to be habitat fragmentation in the watercourses considered.
2.5.4f: How will the proposed development effect unique or important aquatic features.	No unique or important features are likely to be impacted.
2.5.5a: How will the proposed development impact on flood attenuation.	No impact to flood attenuation can be expected given the depression systems.
2.5.5b: How will the proposed development impact on streamflow regulation.	Limited impacts to streamflow are anticipated.
2.5.5c: How will the proposed development impact on sediment trapping.	Sediment trapping of natural vegetation will be reduced by the project. The project will have a limited impact on sediment trapping.
2.5.5d: How will the proposed development impact on phosphate assimilation.	Phosphate assimilation is expected to be retained where limited impacts to assimilation processes can be expected.
2.5.5e: How will the proposed development impact on nitrate assimilation.	Nitrate assimilation is expected to be retained where limited impacts to assimilation processes can be expected.
2.5.5f: How will the proposed development impact on toxicant assimilation.	Toxicant assimilation is expected to be retained where limited impacts to assimilation processes can be expected.
2.5.5g: How will the proposed development impact on erosion	The proposed project will implement erosion/surface water controls

Condition	Response
control.	and will therefore minimise erosion risk.
2.5.5h: How will the proposed development impact on carbon storage	Carbon storage in watercourses is unlikely to be impacted.
2.5.6: How will the proposed development impact on freshwater ecology with regards to the community composition	The proposed project is unlikely to affect freshwater ecology.

7 Recommendations and Monitoring

The following monitoring plan is provided Table 7-1.

Table 7-1: Monitoring plan for the project

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
Crossing points associated with linear infrastructure	Determine if erosion is occurring	Once every 2 years	Habitat condition
Depression wetland system	Determine if avoidance has been implemented and if activities are having a negative impact	Once in the high rainfall period every 2 years	It is proposed that live invertebrate sampling take place and water quality measured. Should no water be present, substrate zooplankton sampling and hatching must take place. Standard wetland PES assessment must then be completed.

The following are recommendations made in support of this study:

- It is recommended that floodlines are determined on the riverine habitats associated with the project. The floodline delineation will provide inputs into the suitable design and implementation of river crossings and will likely be required for further water related applications..
- General authorisations are recommended for the proposed culvert/river crossings where required.

8 Conclusion

The outcome of this assessment delineated 3 watercourse HGM units within the AoI. Where the summarised information is presented in Table 8-1. These watercourses were derived to range from largely natural (class B) and largely modified (class D) PES. The watercourses were classified as having High EIS ratings. A scientific buffer was calculated for the watercourses, where a 40m buffer for depressions and 30m for rivers was utilised to protect these sensitive environments.

Table 8-1: PES and EIS Summaries

Watercourse Unit	PES	EIS	Buffer
HGM1	**Class C**	High	30m
HGM2	**Class D**	High	30m
HGM3	**Class B**	Very High	40m

8.1 Impact Statement

The outcomes of the risk assessment indicate minor impacts from the proposed activities. The minor impacts can be attributed to the avoidance of the sensitive habitats and implementation of buffer zones. Should avoidance and basic mitigation actions be implemented, limited impacts to aquatic biodiversity can be expected.

In the view of the proposed new activities, should the proposed mitigation actions be implemented, no fatal flaw was identified. In line with the recommendations, avoidance must be implemented.

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