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Appendix D3:

Aquatic Assessment

Tate Environmental
Specialist Services

Enviro-Insight CC

Freshwater Biodiversity and Watercourse Delineation

FE Red Sands (Pty) Ltd Project

Solar East and Solar West Projects

August 2022

Document Reference	**Tate R. 2022 Enviro-Insight. Freshwater Biodiversity and Watercourse Delineation. FE Red Sands (Pty) Ltd Project. Solar East and Solar West Projects. August 2022. V3.**	
Front Page Image	Anostraca from a depression in the FE Sands Project Area	
Submitted to	Corné Niemandt – Enviro Insight CC	
Author	Russell Tate (Pr. Sci. Nat. 400089/15)	
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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.

Russell Tate

Water Resource Specialist

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Pr. Sci. Nat – Aquatic Science (Pr. Sci. Nat. 400089/15)

TESS

August 2022

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1 Introduction

Tate Environmental Specialist Services (TESS) was appointed by Enviro-Insight CC to assess the watercourses associated with the proposed FE Red Sands (Pty) Ltd (the applicant) Wind Energy Facility (WEF) and Solar Energy Facility (SEF) Projects located southwest of Aggeneys, Northern Cape Province, South Africa.

The applicant wishes to apply for environmental authorisations for the proposed development of four (4) WEFs and two (2) SEFs as well as the associated infrastructure. The proposed WEFs will have a generation capacity of up to 7.5 MW per turbine, with a hub height of up to 150m and a rotor diameter of up to 200m. Additional ancillary infrastructures will include Battery Energy Storage System (BESS), internal road networks, workshop, storage room, office and laydown area for the construction period.

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 proposed activities. In line with the aims of the study the following Scope of Work (SoW) was established:

1. Assess the nature and extent of the watercourses associated with the proposed development;
2. Establish the Present Ecological Status (PES) of the associated watercourses;
3. Establish the Ecological Importance and Sensitivity (EIS) of the associated watercourses
4. Establish scientific effective buffer zones to reduce anticipated impacts;
5. Provide shapefiles and maps which visualise sensitive habitats;
6. Provide a risk assessment for the completed activities; and
7. Provide recommendations for mitigation and avoidance actions.

This report provides the information applicable to the SEF infrastructure, particularly the FE Red Sands Solar East and Solar West Projects.

1.1 Definitions

According to the National Water Act (NWA) Act Number 36 of 1998 the definition of a 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 are 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 is 32 km south west of Aggeneys, Northern Cape Province, South Africa. The hydrological setting of the project is within the D82C quaternary catchment of the Orange River water management area (Figure 2-2). The specific Area of Interest (AoI) for this project was drainage within the unnamed D82C-04394 and D82C-04152 Sub Quaternary Reaches (SQR). The watercourses do not reach the Orange River and typically terminate in depression lake/pan systems.

The derived catchment areas at the outlet of the project boundary of the considered watercourses was 295 km^2 and 398 km^2 for the D82C-04152 and B82C-04394 SQR's respectively. Mean Annual Precipitation (MAP) was calculated using WaPOR (2022). The results indicated a MAP ranging from 73 mm in 2017 to 165 mm in 2009 whilst the MAP for the period between 2009 and 2021 was calculated to be 129 mm (Figure 2-1). Monthly precipitation trends show peak rainfall periods between June and August where up to 22mm has been recorded. In the 2021/2022 hydrological period a significant rainfall event was noted to have occurred in June 2022 where 39 mm was recorded in the AoI (Figure 2-1).

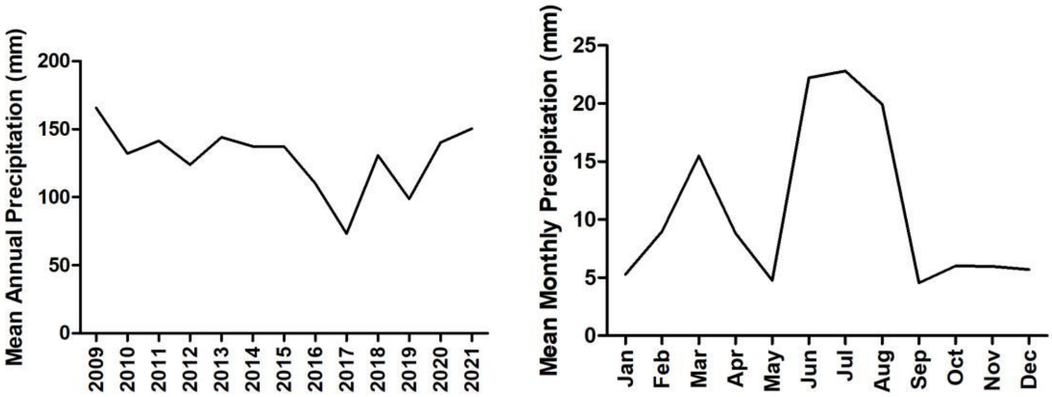

Figure 2-1: Annual (left) and mean monthly (right) precipitation in the watershed between 2009 and 2022 (WaPOR, 2022)

In order to initiate the effective delineation of the watercourses the National Freshwater Ecosystem Priority Area (NFEPA) maps and National Biodiversity Assessment (2018) spatial datasets were unlisted as presented in Figure 2-4 and Figure 2-5. The assessment revealed the presence of multiple depression systems as well as the two identified river systems as defined by the SQR database.

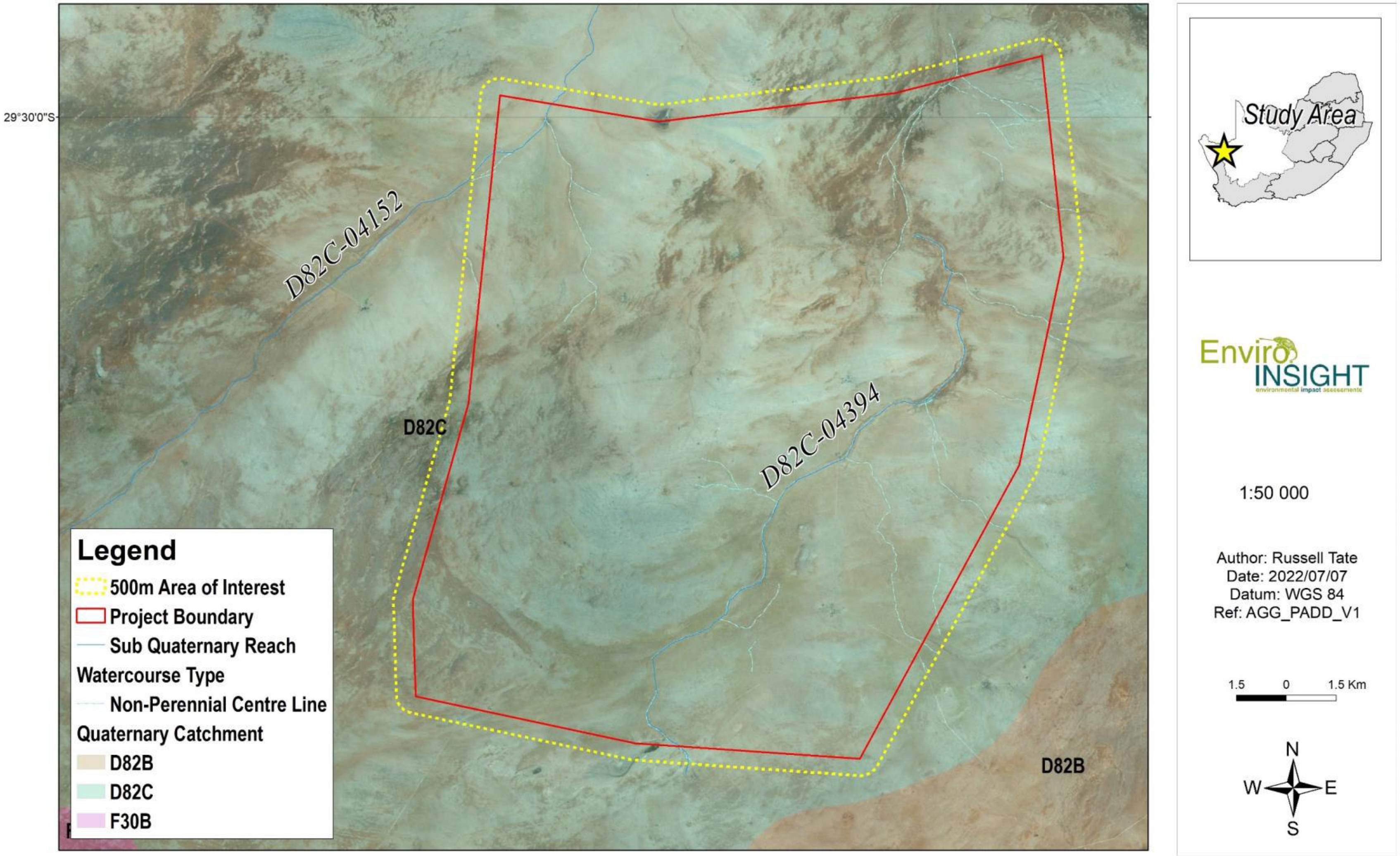

Figure 2-2: Hydrological setting of the Study Area

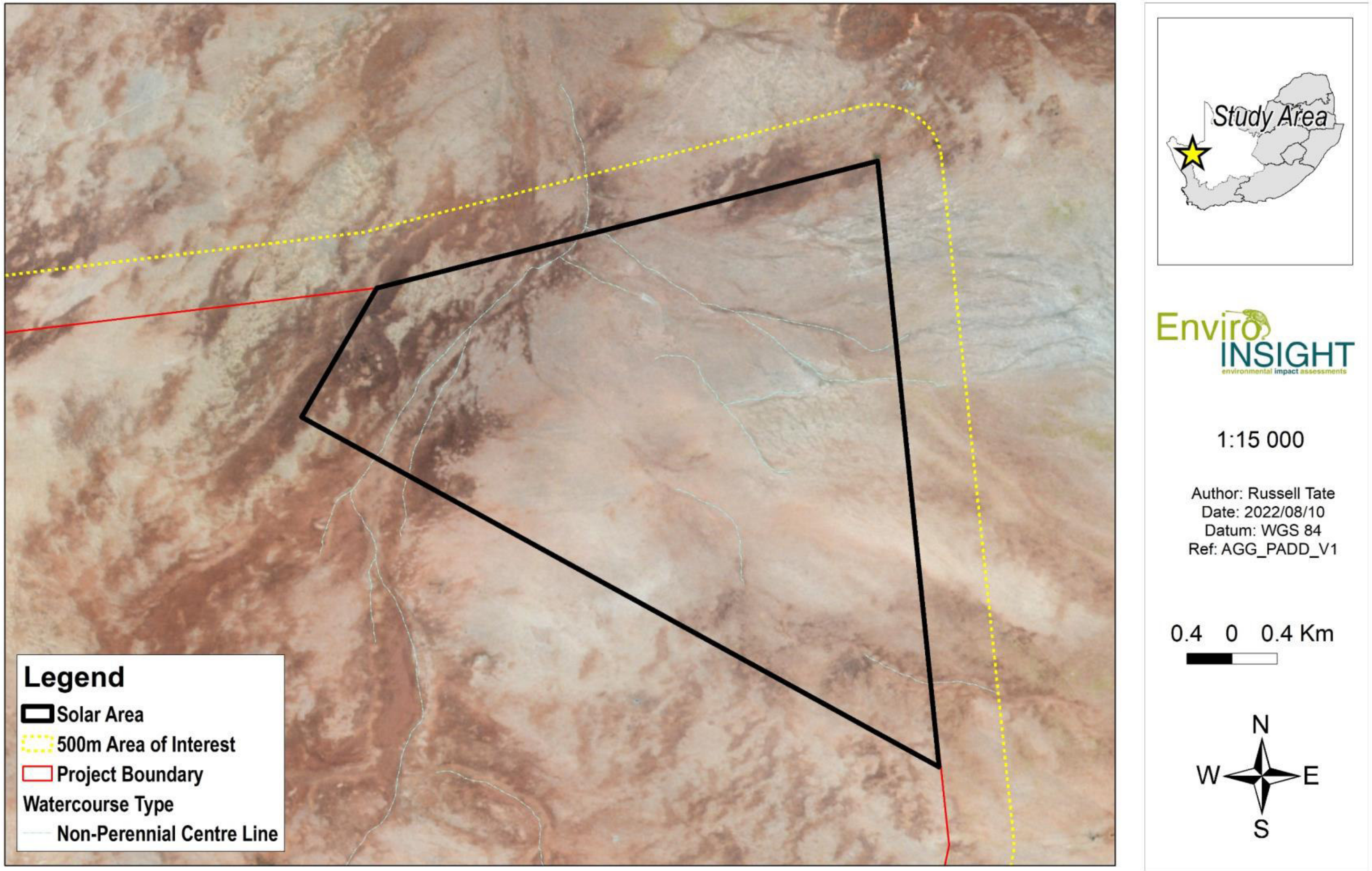

Figure 2-3: Hydrological setting of the Solar East and Solar West Study Area

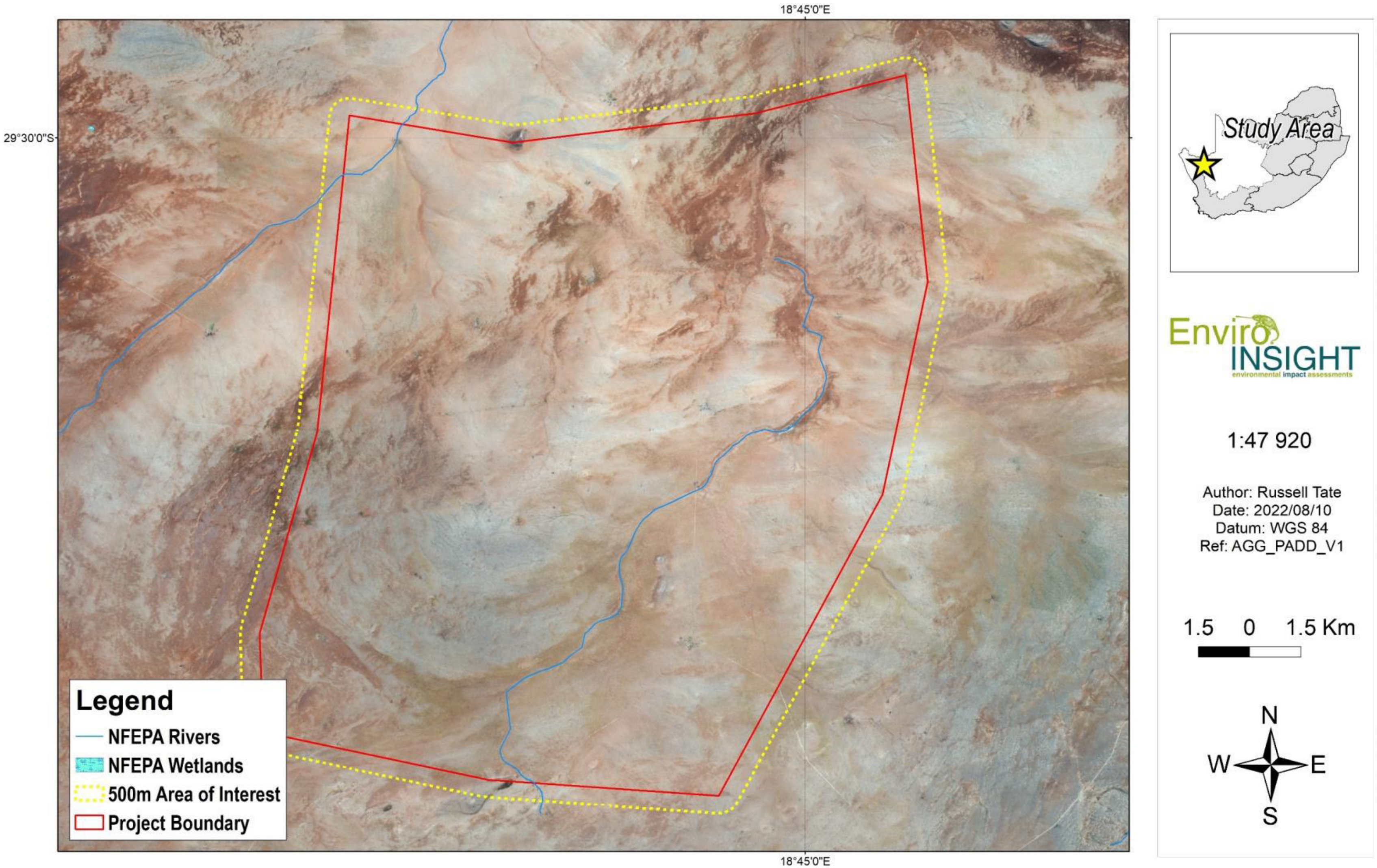

Figure 2-4: Desktop Wetlands (NFEPA, 2011)

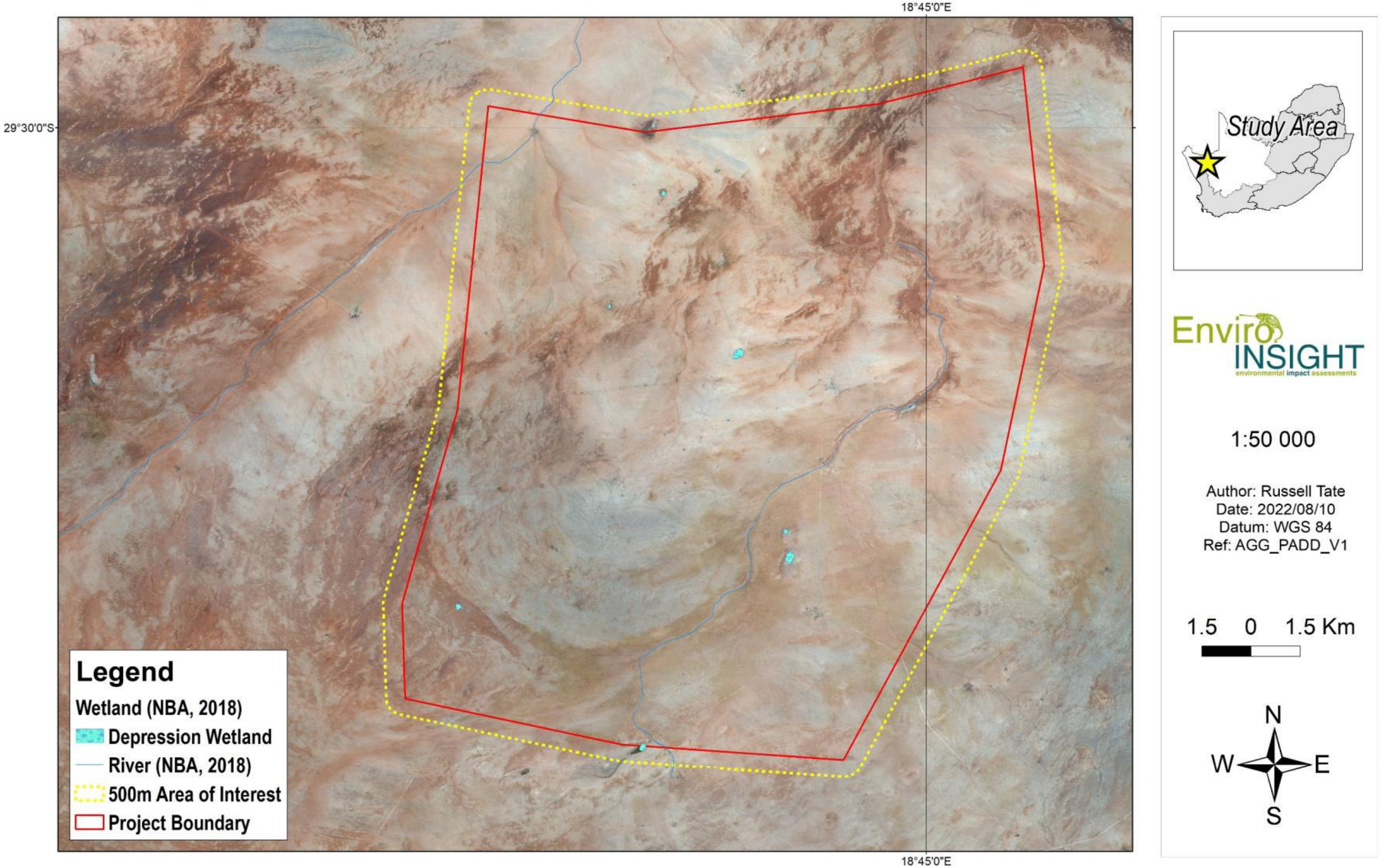

Figure 2-5: Desktop Wetlands (NBA, 2018)

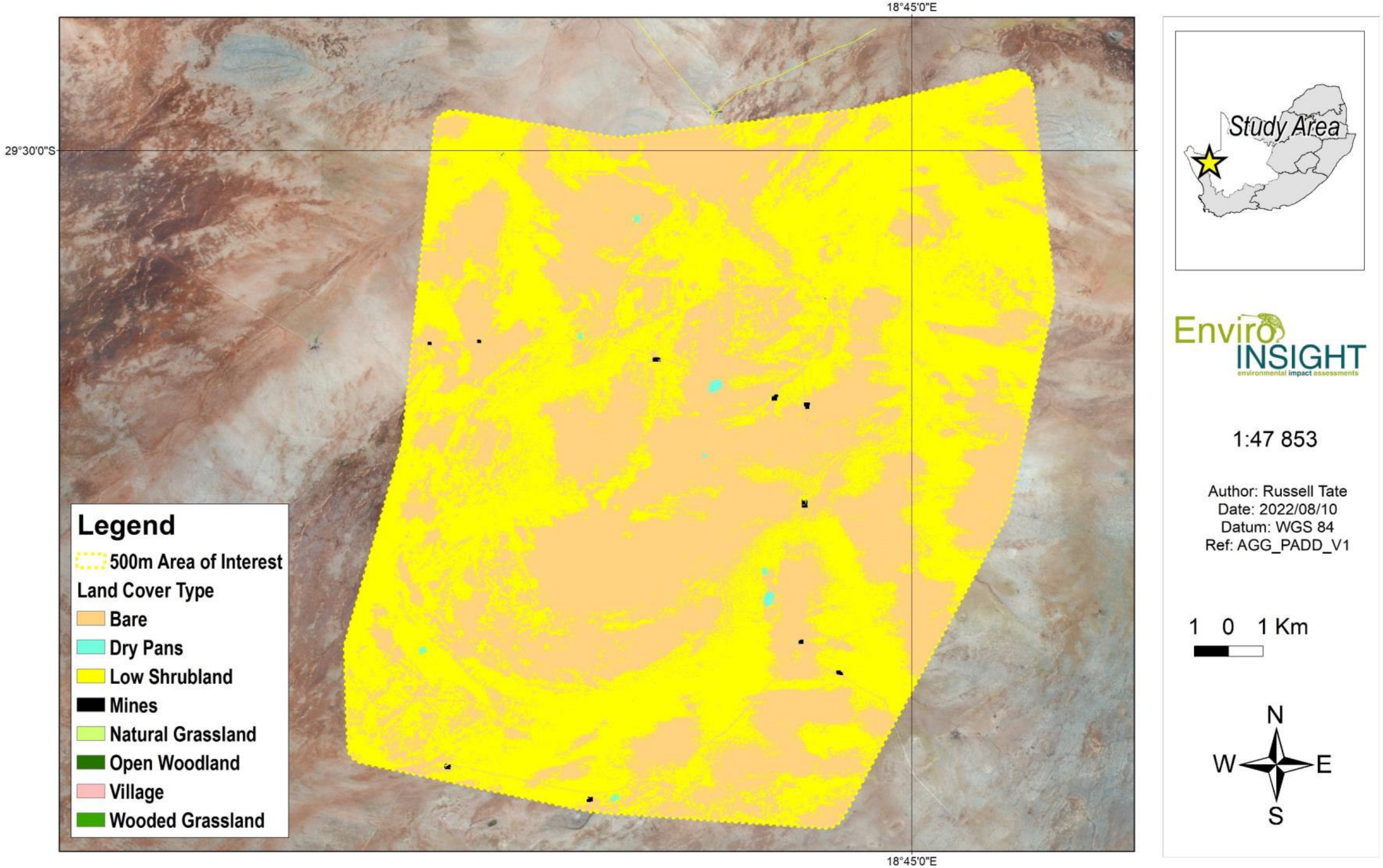

Figure 2-6: Landcover of the project area (Thompson, 2019)

3 Methods

3.1 Survey and Sample Points

A single site survey was completed for this study which took place between the 18th and 20th of July 2022. In order to characterise the greater project area, three sample points were selected in inundated depression systems as presented in Table 3-1. The sample points included an unnamed system (S1) as well as Kliphakskeen Se Vlei (S2) and Spioenkop Se Vlei (S3).

3.2 Wetland and Riparian Ecology

To accurately define the PES, the spatial framework of the wetland PES must be characterized. To complete this, the wetland delineation protocols established by DWAF (2005) were utilised. The area considered included a 500m regulated area around the project boundary. This was then further refined to directly impacted and indirectly impacted areas. Wetlands which were not directly impacted, were assessed on a desktop scale, whilst the anticipated directly impacted wetlands were assessed using a level 2 analysis.

The wetland areas were delineated in accordance with the DWAF (2005) guidelines, a cross section of a typical wetland is presented in Figure 3-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The terrain unit indicator was used to identify the areas of the landscape where wetlands are likely to occur;
- The soil form indicator, utilises the soil classifications provided by the Soil Classification Working Group (1991) whereby focus is drawn to soils that are associated with prolonged and frequent saturation;
- The soil hydromorphic indicator was utilised to study the morphological signatures of the soil profiles;
- The vegetation indicator was used to identify hydrophilic vegetation associated with frequently saturated soils.

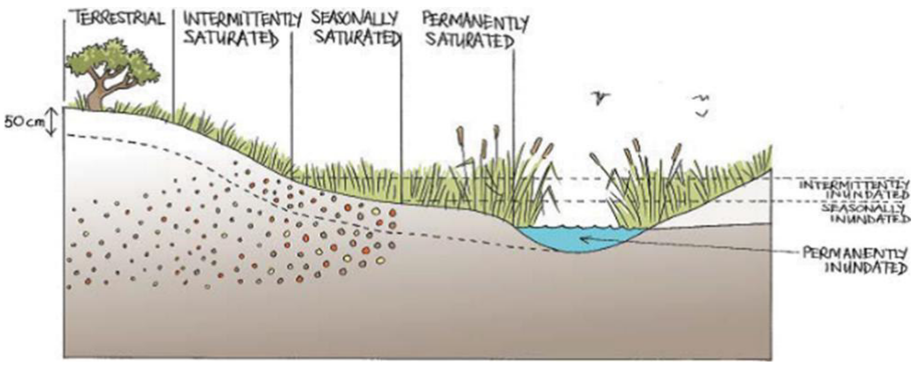

Figure 3-1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al., 2013)

Table 3-1: Details pertaining to sample points (July 2022)

Site	X-Coordinate	Y-Coordinate	Photograph
S1	18.64737	-29.55707	
S2	18.6631	-29.54909	
S3	18.67807	-29.51823	

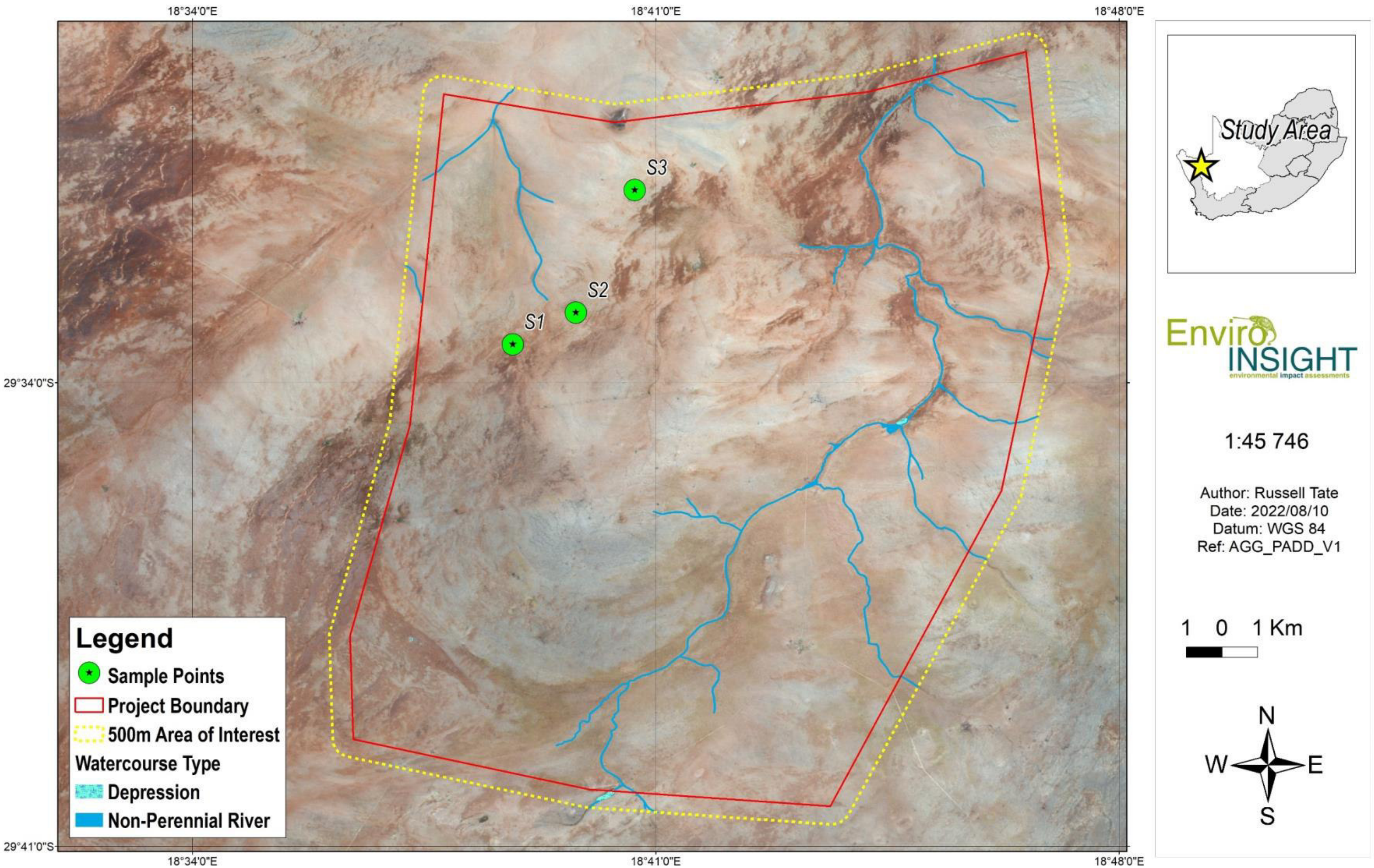

Figure 3-2: Invertebrate and Water Sample points

3.2.1 Ecological Classification and Description of the Wetland

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) was considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the Hydro Geomorphic (HGM) Unit approach at higher levels and includes structural features at the lower levels of classification (Ollis et al., 2013).

3.2.2 Determining the Wetland Present Ecological Status

The overall approach was to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a PES score. This takes the form of assessing the spatial extent of the impact of individual activities and separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The WET-Health Version 1.0 (Macfarlane, 2008) was utilised to derive the PES. The PES categories are provided in Table 3-2.

Table 3-2: The Present Ecological Status categories, (Macfarlane, 2008)

Impact Category	Description	Impact Score Range	PES
None	**Unmodified, natural**	**0 to 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.	**1.0 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 Determining the Ecological Importance and Sensitivity of the wetland

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**

3.2.4 Wetland Functional Assessment and Ecosystem Services

Wetland functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands, as well as for humans. Ecosystem services serve as the main factor contributing to wetland functionality.

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Version 2.0) (Kotze et al., 2020). An assessment was undertaken that examined and rated the following services according to their degree of importance and the degree to which the services are provided (Table 3-4).

Table 3-4: 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

Considering there was a channelled system associated with the project, it was deemed important to derive the condition of the instream habitat.

3.2.5 Catchment Characteristics and Habitat Condition

The overall catchment characteristics considered in this assessment included aspects such as:

- Catchment area;
- Run-off characteristics; and
- Land cover

These aspects provide critical information pertaining to the factors which drive ecological health and diversity. Furthermore, changes in the above features can result in periodic influences in the watercourse which are often not evidenced by standard biological monitoring. Moreover, subtle changes and indications provided by observed geomorphological structures can be better understood.

Using the downstream outlet of the 500m screening zone as the "pour point" the catchments of the sample sites were derived.

The Intermediate Habitat Integrity Assessment (IHIA) as described by Kleynhans (1996) was used to define the ecological condition of the riparian/wash habitats of the considered areas. The IHIA was informed by the results of the land cover assessments and direct observations of changes to the washes. The IHIA considers both the riparian and instream habitat condition but for this report only the riparian habitat was considered. The method relies on the study of reference condition or natural watercourses within a similar setting. The spatial framework of the assessment was applicable to the HGM delineations as provided in Figure 4-4. The integrity categories of the method are provided in Table 3-5.

Table 3-5: 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

3.2.6 Water Quality

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

3.2.7 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 pans 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 Day et al. 1999.

3.3 Limitations and Assumptions

The following limitations and assumptions form part of this study:

- 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.
- The results of this study were derived from rapid ecological assessments.
- The area was extensive, and depression pan systems very small. It is therefore probable that minor pan systems would have been missed during the survey.
- Areas directly affected by the project were surveyed, whilst within the 500m screening area, desktop information was also utilised.
- No closure or decommissioning phases were considered.
- The layout of the proposed transmission and grid connection infrastructure was not considered in this study.
- The risk assessment was completed with the assumption that avoidance and mitigations actions are implemented.

4 Results

4.1 Watercourse Type and Classification

It is important to state that the watercourses classified in this study do not conform to standard wetland definitions and classifications provided in Ollis et al. (2013) where typical indicators such as redoximorphic and hydrophytic vegetation indicators were absent (See 4.3). Despite this, active inundation, landform indicators and at times hydrophytic vegetation indicators provided sufficient evidence to support the classification and delineation of the watercourses. The watercourse types observed in the study area and their respective classifications are provided in Table 4-1 and Figure 4-4. A total of 26 hydrogeomorphic (HGM) units were delineated in this study consisting of two watercourse types including depressions (Figure 4-1 and Figure 4-2) and non-perennial wash systems (Figure 4-3). Within the solar activities areas specifically, two HGM units were derived, a depression and non-perennial watercourse type. The HGM units were HGM23 and HGM24.

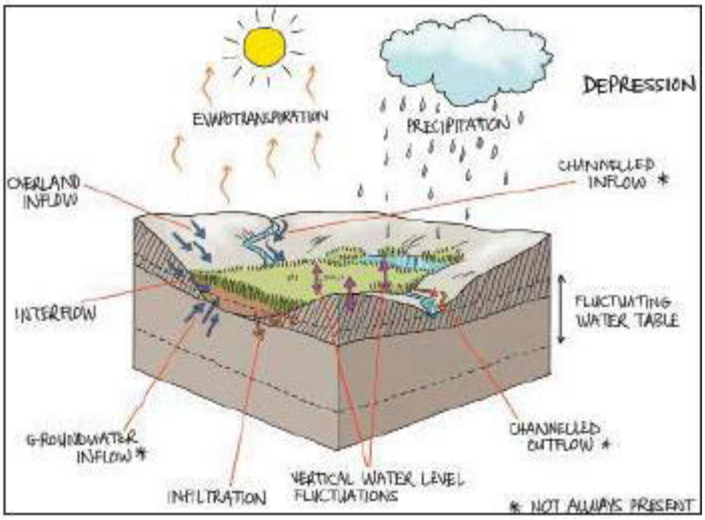

Figure 4-1: Depression HGM unit as indicated in the study area (Ollis et al., 2013)

Figure 4-2: A typical bedrock depression system in the FE Sands Project area (July 2022)

Figure 4-3: A non-perennial wash HGM type (July 2022). Note *Striptagrostis sp.* grasses indicating the soil change and valley bottom extent.

Table 4-1: Wetland classification within 500m screening zone of the Solar Project Area

Wetland System Unit	Hectares	Level 1	Level 2		Level 3	Level 4		
		System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM1	0.44	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM2	0.11	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM3	0.09	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM4	0.01	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM5	0.01	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM6	0.03	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM7	0.08	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM8	0.40	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM9	0.05	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM10	0.05	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM11	0.34	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM12	0.01	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM13	0.01	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM14	0.05	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM15	5.78	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Exorheic	With channel inflow
HGM16	0.02	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM17	0.09	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM18	2.83	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Exorheic	With channel inflow
HGM19	0.06	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow

Wetland System Unit	Hectares	Level 1	Level 2		Level 3	Level 4		
		System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM20	0.03	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM21	0.07	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM22	0.02	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM23	0.02	Inland	Nama Karoo	Bushmanland Bioregion	Plain	Depression	Endorheic	Without channel inflow
HGM24	362.28	Inland	Nama Karoo	Bushmanland Bioregion	Valley Bottom	Wash	Non-perennial	Riparian
HGM25	49.52	Inland	Nama Karoo	Bushmanland Bioregion	Valley Bottom	Wash	Non-perennial	Riparian
HGM26	5.88	Inland	Nama Karoo	Bushmanland Bioregion	Valley Bottom	Wash	Non-perennial	Riparian

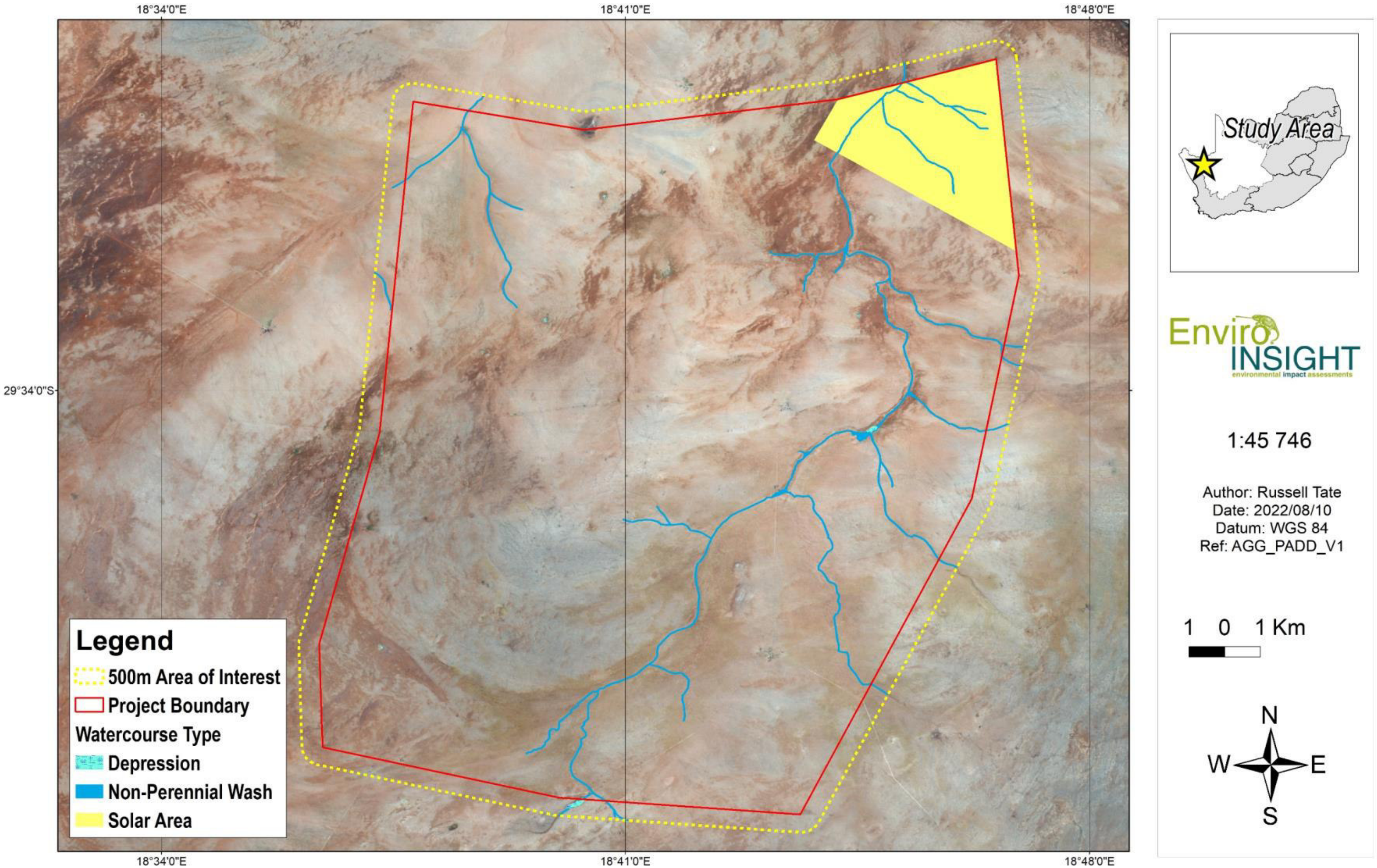

Figure 4-4: Delineation of the watercourses

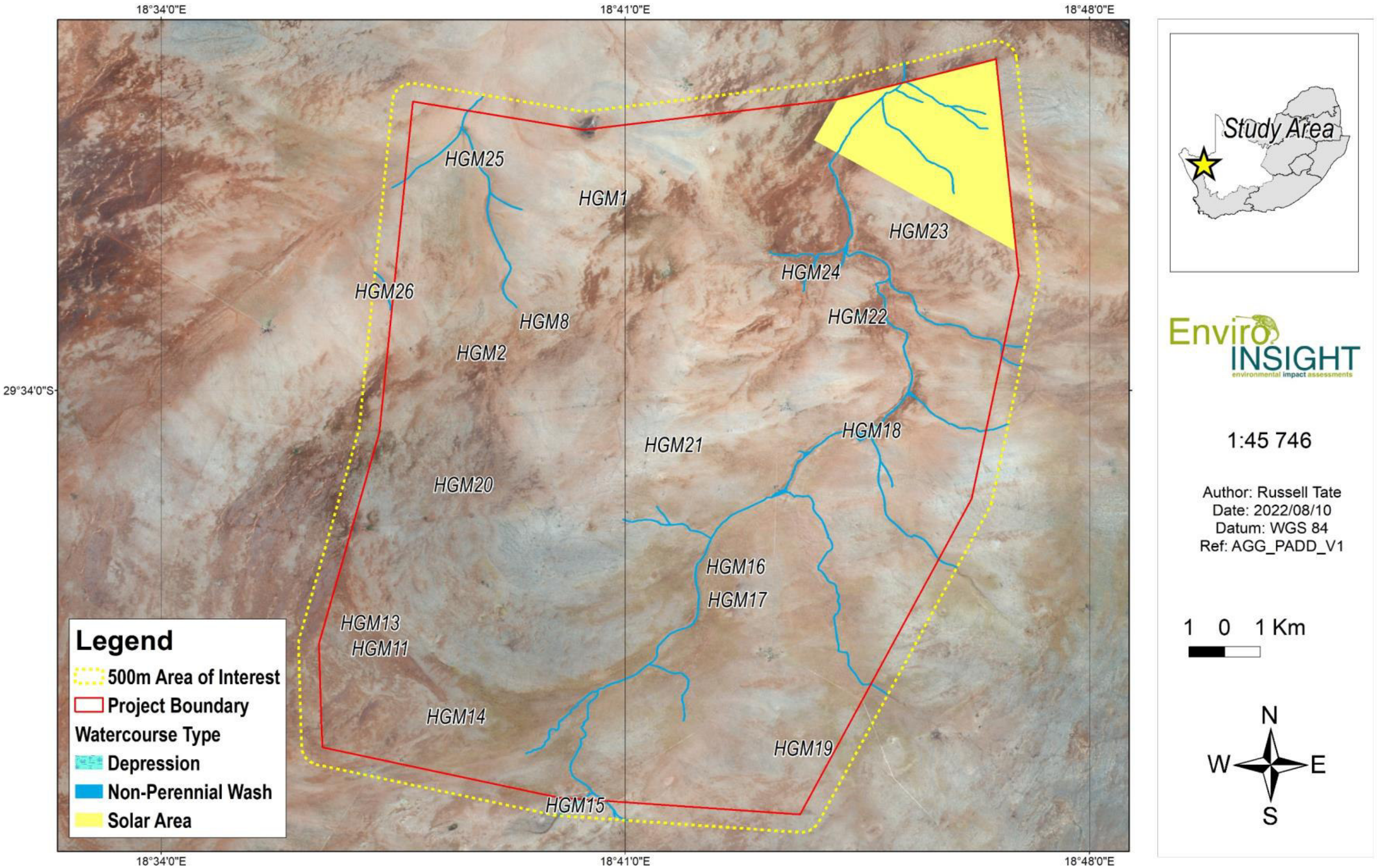

Figure 4-5: HGM Layout of the watercourses

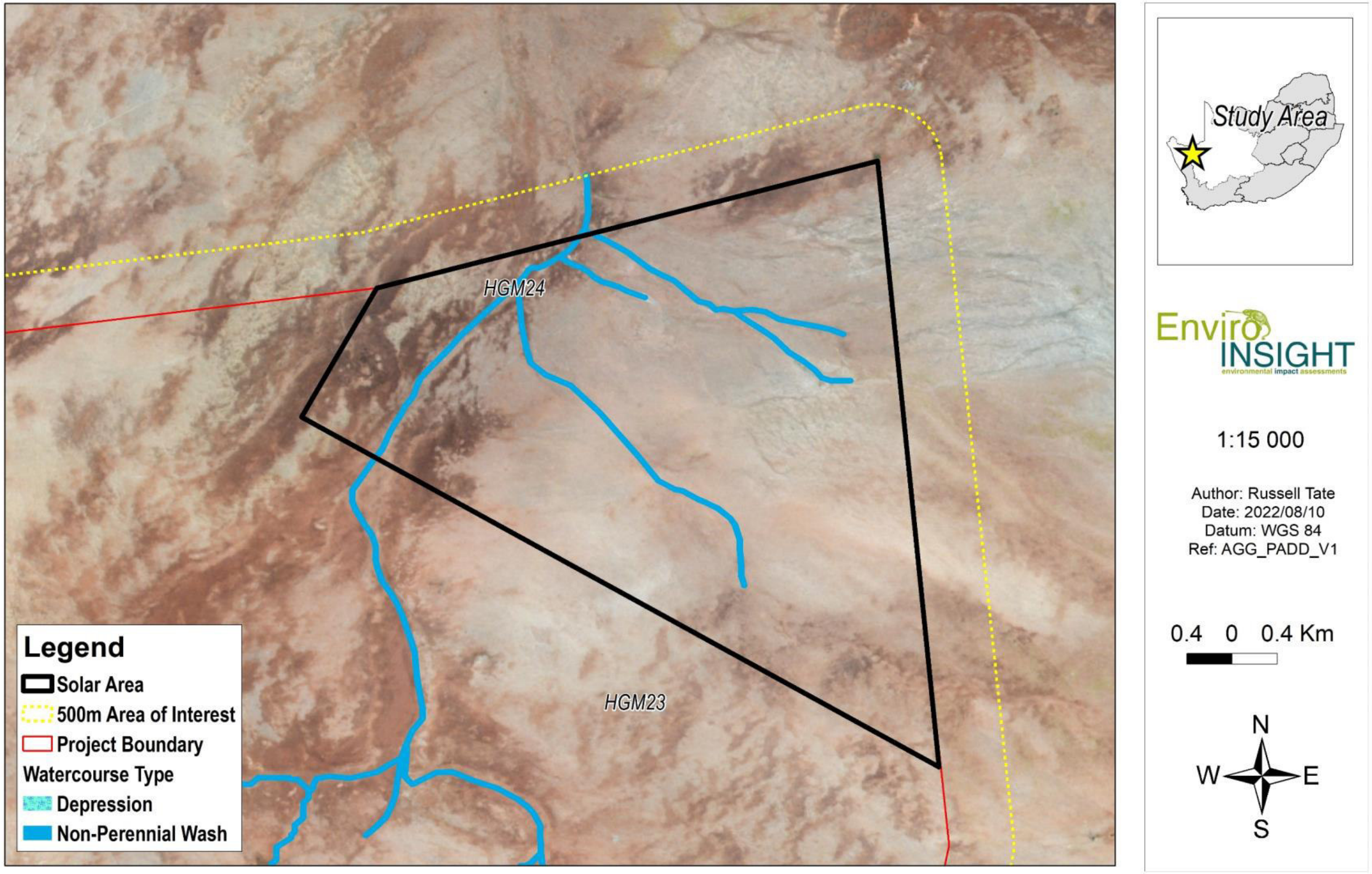

Figure 4-6: HGM layout for areas relevant to the Solar East and Solar West Project

4.2 Geomorphology

The AoI was located on an extensive flat plain where limited valley formation has taken place (Figure 4-7). The valleys, when present, are shallow with gentle slopes (<0.05). The watersheds originate in the south of the project boundary at approximately 1170 metres above mean sea level (mamsl) and exit the project area at 888 mamsl in the north. Over the project area the derived 35 km B82C-04394 SQR profile has a gradient equal to 0.008 clearly showing a flat topography.

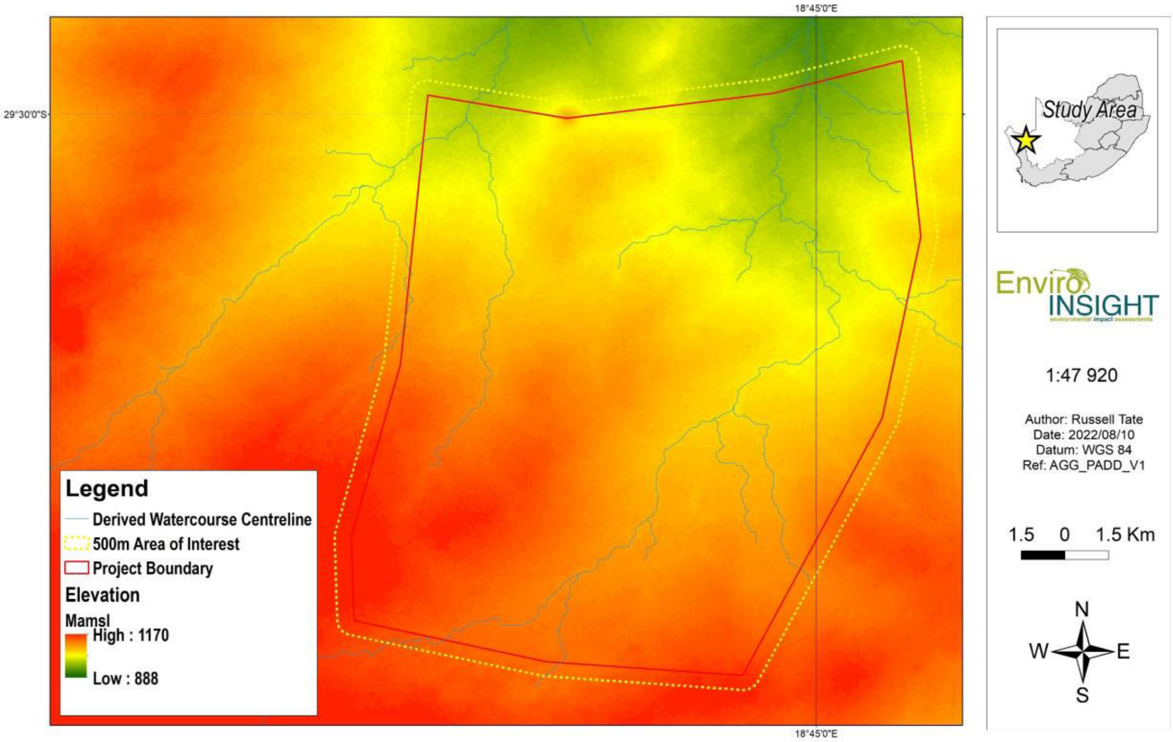

Figure 4-7: The elevation of the project area

The low rainfall and flat topography have resulted in the formation of alluvial washes/floodplains. However, these systems are difficult to define owing to a high degree of geomorphological variation and low gradients. These systems are located in the valley bottom landforms and are characterised by multiple highly variable non-perennial channels. Owing to the flat nature of the landscape, drainage may occur in a network of parallel channels, in shallow surface flows across the valley bottom or in a single confined channel. In the case of the AoI, the gradients were such that no active channels were observed and it was expected that diffuse surface flows occurs without concentrated forces (Figure 4-8).

Figure 4-8: Flat topography typical of the project area. Note limited valley formation and the absence of channels in the valley bottom (July 2022)

Where topography flattens, alluvial fans form and collected water accumulates in the depression systems such as the Kareedoringpan pictured below (Figure 4-9). These systems typically occur in the valley bottom setting where the source is direct overland flow. The water table for this region does not typically occur above the soil surface. Minor depression systems closely associated with exposed bedrock structures were also noted to be dispersed across the landscape (Figure 4-10). The source of water in these depression systems was catchment driven and they were observed to be endorheic, however it is expected that there may be some groundwater influence (spring fed), which requires further assessment.

Figure 4-9: The Kareedoringpan, a depression system with an inlet (July 2022)

Figure 4-10: Depression systems associated with exposed bedrock structures at Kliphakskeen Se Vlei (July 2022)

4.3 Soils

Two land types were associated with the project area and included the Ae90 and Ag62 land types. Typical soil forms present in the landscape of these land types is presented in Figure 4-11 and Figure 4-12 whilst the spatial layout of the land types are provided in Figure 4-13. The Ag62 land type was the dominant form where watercourses are expected to be present in the valleys (terrain unit 5) which would be represented by Gaudam, Moriah, Portsmouth, Muden, Vergenoeg, Holpan, Hazelwood and Dundee soil forms. It is noted that only the Dundee soil form may harbour wetland characteristics but is noted to form only up to 2% of the total landform. No wetland soils are expected to be present in the Ae90 land type.

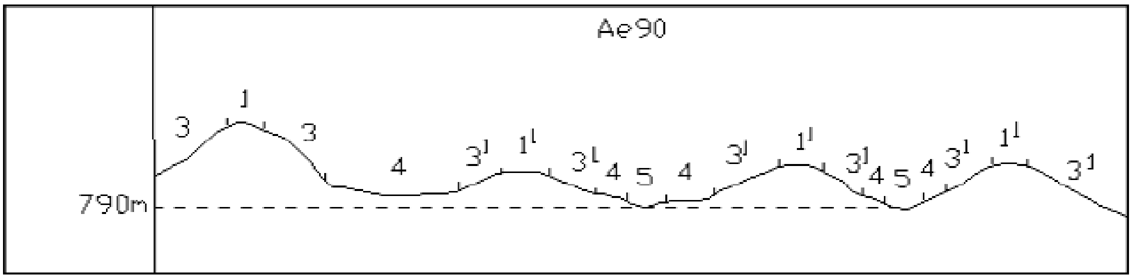

Figure 4-11: Terrain/Soil Forms commonly found in the Ae90 Land type

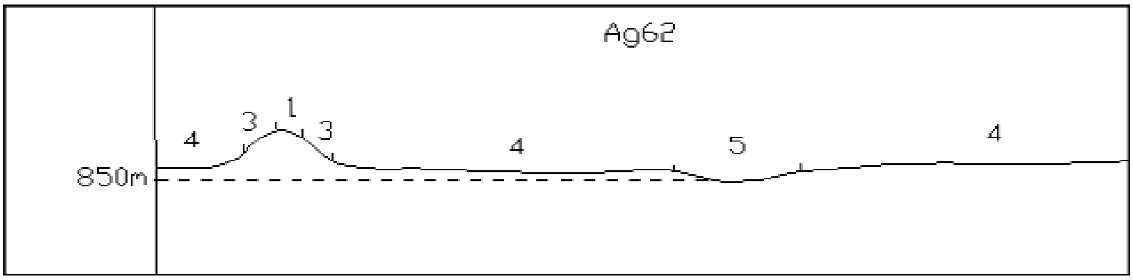

Figure 4-12: Terrain/Soil Forms commonly found in the Ag62 Land type

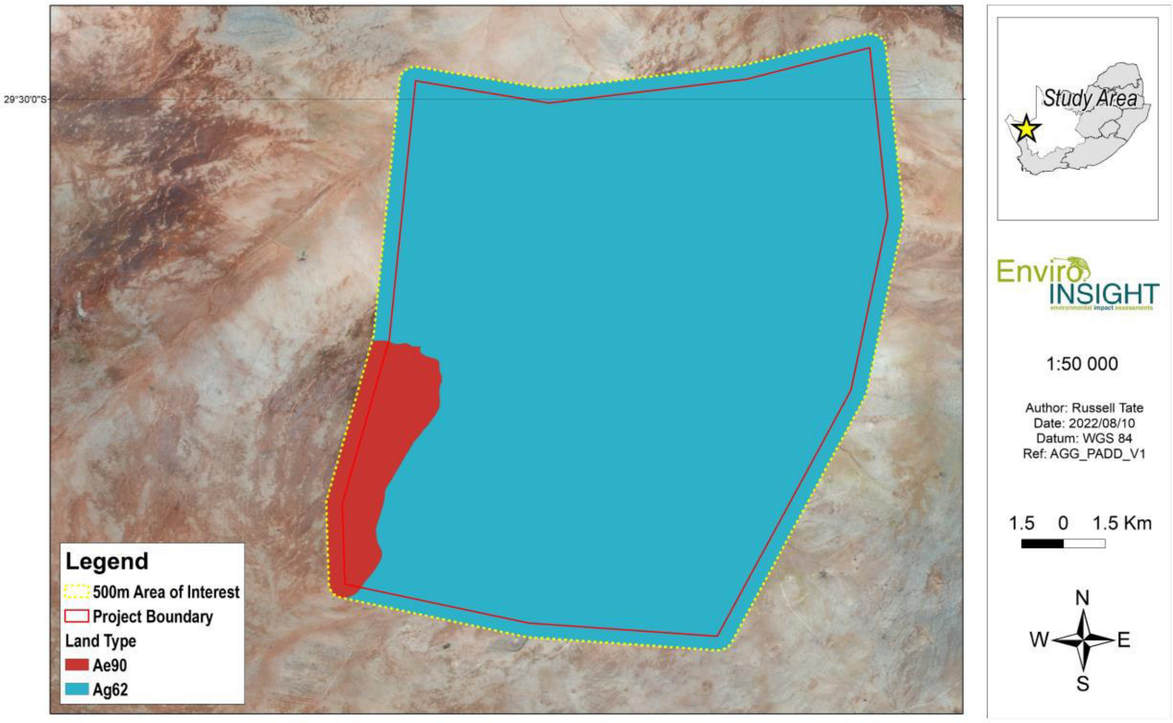

Figure 4-13: Landtype of the Project

The SCS soil classification of the soils is provided in Figure 4-14. Based on the classifications the indicate SCS classes of A and A/B for the Ag62 and Ae90 land types respectively. These SCS classifications indicate that the soil types have low runoff potential and high infiltration rates even when thoroughly wetted (Table 4-2).

Figure 4-14: SCS Soil Classification

Table 4-2: Soil Conservation Services Hydrologic Soil Class Interpretation (SANRAL. 2013)

Class	Description
Class A	Sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
Class B	Silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
Class C	Soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
Class D	Soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Soil forms observed during the survey were consistent with the desktop information where typical hydromorphic soil forms as indicated in DWAF (2005) were absent from the AoI. Soil forms observed included deep freely draining soils. There is potentially regic sand horizons present on the AoI however auger samples for this study only took place to 50cm. No indications of the Dundee soil forms were observed in the AoI, even within the valley landform where soil forms observed included Clovelly, Glenrosa and Mispah soil forms. Soil form within the AoI was therefore not considered a suitable indicator of the watercourse extent. In the case of this project it is presented that the use of the valley bottom and watercourse centreline would suffice as the watercourse extent.

Within the depression systems, surface deposits of silts were noted to occur, however the soil forms present were not indicated to be Rensburg or Arcadia soils but rather Clovelly and Mispah soil forms. Despite this, the presence of the silts in the depressions indicates that the systems are temporarily inundated and would serve an important ecological function. This further supported the classification of the depression systems.

Figure 4-15: Soil types observed in non-perennial washes showing orthic horizons typical in the Clovelly soil form (July 2022)

Figure 4-16: Surface silt deposits which occur over an orthic sandy horizon and bedrock indicative of a Clovelly soil form typical in the depression systems (July 2022)

4.4 Vegetation

The vegetation type present in the AoI is provided in Figure 4-17 and included the Bushmanland Arid Grassland and Bushmanland Basin Shrubland. These habitats are dominated by white grasses belonging to the *Stripagrostis* and *Schmidtia* species (Mucina and Rutherford, 2006).

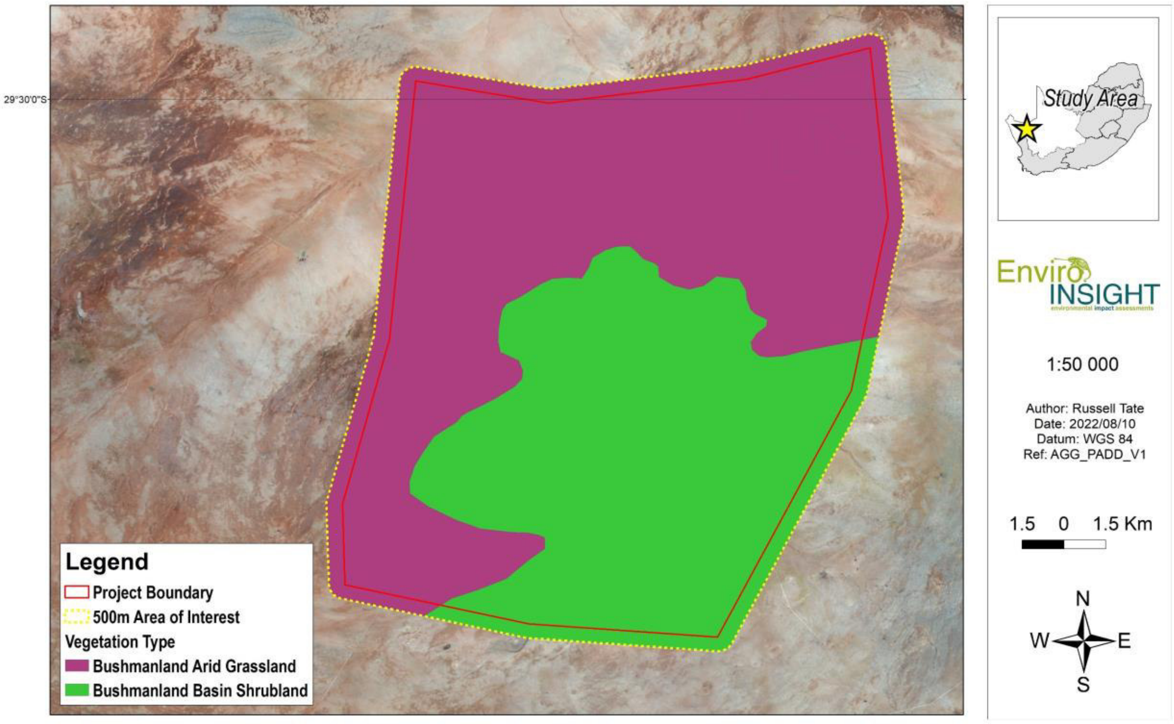

Figure 4-17: Vegetation type of the project area

No active channels within the washes were present thereby limiting the presentation of defined zonation typically present in riparian zones. Typical vegetation observed in the washes however showed clear differentiation from adjacent habitats as indicated in Figure 4-3. *Stripagrostis* grasses, including *Stripagrostis uniplumis, S. ciliata and S. obtusa* were observed in terrestrial vegetation, but grew more densely and vigorously in the riparian zones. Larger specimens of *Rhigozum obvatum* were noted to occur in denser stands within the valley bottom and within depression systems which is visualised in Figure 4-9. The riparian zone indicator species, *Salsola aphylla* was not in the valley bottom landforms within the AoI. These species are considered to be obligate wetland taxa and are typically confined to alluvial soils such as the Dundee soil form (DWAF, 2005). Bedrock depression systems which were inundated were noted to contain *Marsilea cf. macrocarpa*, an aquatic fern which further supports their classification as watercourses. Depression systems were also noted to contain larger specimens of *Rhigozum obvatum* and denser tufts of *Striapgrostis* grasses.

The conclusions drawn from the study indicates that soil and vegetation indicators were severely limited to inform watercourse extent. A greater confidence was placed on landform indicators such as direct inundation observations, silt deposits, and topography.

Figure 4-18: Large *Rhigozum obvatum (left)* and *Salsola aphylla* (July 2022)

Figure 4-19: *Marsilea cf. macrocarpa* in a depression system (July 2022)

4.5 Water Quality

The results of the water quality analysis are presented in Table 4-3.

Table 4-3: *In situ* water quality results (July 2022)

Site	pH	Conductivity (mS/m)	DO (mg/l)	Temperature (°C)
S1	6.4	6.4	4.2	14
S2	7.1	10	4.6	14
S3	6.8	8.2	4.5	15

The results of the water quality analysis of the bedrock depression systems showed neutral pH levels and low concentrations of dissolved solids. The low concentrations of dissolved solids provide an indication that the water present was derived from the recent rainfall events in the month of June 2022 where up to 39 mm were recorded (WaPOR, 2022). The concentrations of dissolved oxygen indicated adequate levels of oxygen to support aquatic life. No perturbations for water quality within the depressions were expected or recorded. It is noted that no water quality guidelines would be applicable to the pan systems.

4.6 Watercourse Condition

Although no channels were observed changes to the condition of the valley bottom wash systems were rated using the IHIA to establish the PES of the watercourses which is required for environmental applications. The results of the IHIA are presented in Table 4-4 and Table 4-5. It is noted that aspects such as channel modification were not considered owing to the absence of these structures in the assessed washes. The results of the PES analysis for depression systems are presented in Table 4-6.

Table 4-4: IHIA for Instream Habitat

Criterion	Water loss	Flow mod	Bed mod	Channel mod	Water quality	Inundation	Exotic veg	Exotic fauna	Solid waste disposal	Condition
HGM24	5	8	5	-	0	5	0	0	5	**87**

Table 4-5: IHIA for Riparian Habitat

Criterion	Indigenous vegetation removal	Exotic vegetation encroachment	Bank erosion	Channel mod	Water loss	Inundation	Flow mod	Water quality	Condition
HGM24	10	5	0	-	5	0	5	0	**87**

Table 4-6: Depression Present Ecological Status (July 2022)

	Hydrology		**Geomorphology**		**Vegetation**		**PES**	**PES**
	Rating	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Class**
HGM23	0.5	None	0.5	None	1.5	Small	0.8	A

4.7 Aquatic Macroinvertebrates

Pans are classified as shallow, usually oval or round, depressions that typically undergo phases of complete desiccation, though some may be continuously inundated (Allan et al. 1995). Most often, pans are defined as endorheic wetlands, though some may seep via diffuse flow paths found below the surface into adjacent valley bottoms. Their endorheic state results in fluctuations in water quality ranging from very low conductivity, due to rainfall, to high conductivity due to evaporation (de Klerk et al., 2012). Due to the endorheic nature of the pans, they are more vulnerable to development.

Invertebrates surviving in these variable conditions therefore are required to be able to survive periods of high temperatures and conductivity and often even desiccation (Liefferink et al. 2014). Due to the fluctuating nature of the water quality dynamics in pan environments, the assessment of aquatic biota, which is adapted to life in the environment, can often provide more accurate data for the determination of the overall ecological state of the considered environments.

Standardised aquatic sampling took place in the larger inundated pan systems to investigate their invertebrate compositions. The invertebrate assemblage was represented by up to 10 taxa including the taxa listed in Table 4-7. The typical taxa observed during the study are presented in Figure 4-20.

Table 4-7: Invertebrate sampling results (July 2022)

Site	Taxa	Chironomidae	Corixidae	Copepoda	Conchostraca	Anostraca	Notostraca	Notonectidae	Gerridae	Culicidae	Cladocera
S1	10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S2	6	✓	✓	✓	--	✓	-	-	-	✓	-
S3	6	✓	-	-	-	✓	✓	✓	-	✓	-

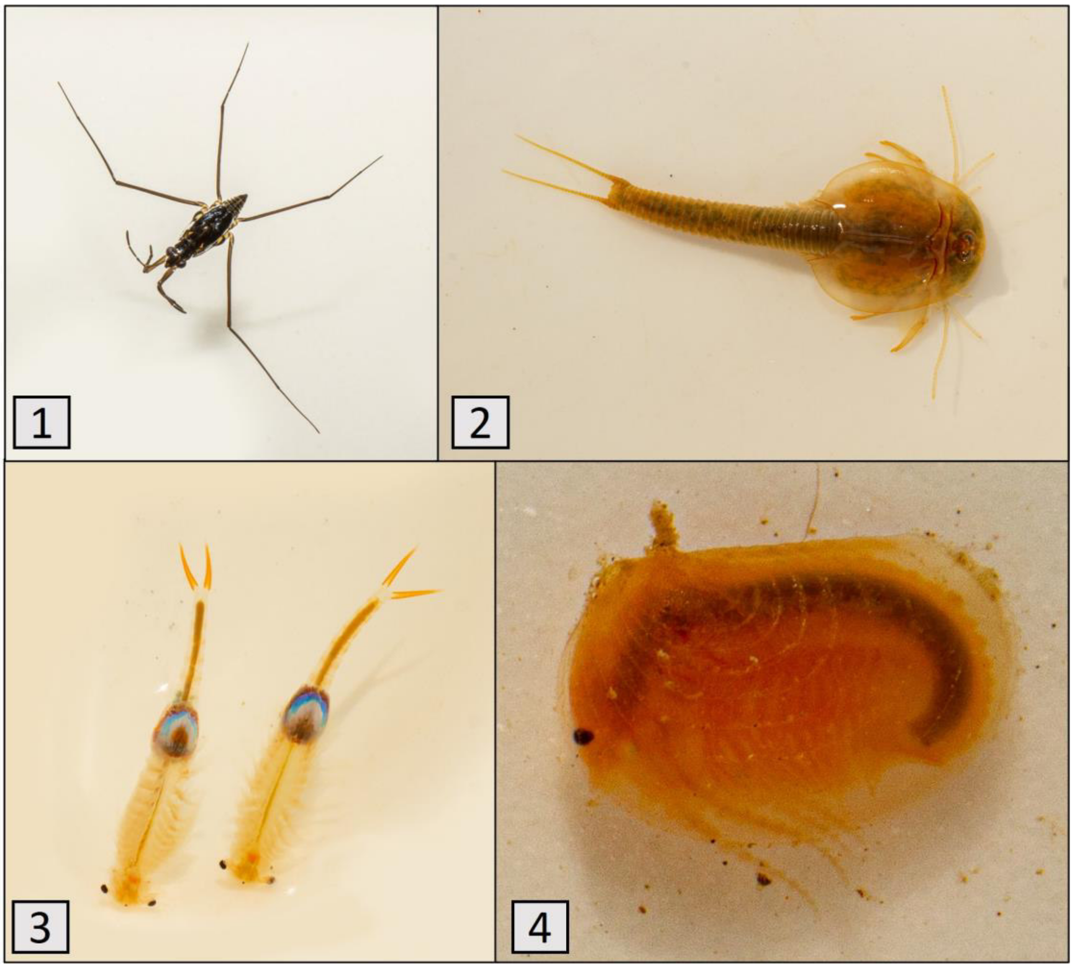

Figure 4-20: Typical aquatic macroinvertebrates sampled in the AoI (July 2022). 1: Gerridae; 2: Notostraca; 3: Anostraca; 4: Concostraca.

The diversity of invertebrates in freshwater systems can largely be related to the inundation duration, temperature and waterbody size (Hamer and Rayner, 1996). Sampled invertebrates included the orders of Copepoda and Cladocera. The observed zooplankton assemblage was typical of small permanent pools of water with free swimming taxa the only observed taxa. The identification of the Cladocera species indicated the presence of *Daphnia barbata* a common species widespread accords Africa (Hamer and Rayner, 1996). Cladocera are known to inhabit the majority of inland freshwater habitats between pH levels of 6.5-8.5 (Day et al. 1999). The abundance of Cladocera at site has been found to be affected by salinity, the abundance of *Daphnia* recorded at the sampling points was therefore confirmation of the non- or limited saline environments.

The majority of species in the order Cyclopoida are adapted to predatory habits and feed on zooplankton, although some may be parasites (Ferreira et al. 2012). The presence of this higher trophic order provides further indication of the current functional status of the assessed waterbodies. Five species of Anostraca are known to occur in the Northern Cape with *Streptocephalus cafer* being commonly observed in Southern Africa. Very limited information pertaining to the exact distribution of these taxa is known.

The presence of the invertebrates within the depression pan systems further supports their classification as important and sensitive landscape features which corroborates their assessment and classification as watercourses. No listed aquatic macroinvertebrates are associated with the proposed project.

4.8 Ecosystem Services

The depression and wash HGM units provided primarily biodiversity and grazing related eco-services. The results of the ecological function assessment are provided in Table 4-8. The results indicated a moderately high importance for biodiversity maintenance for both depression and wash systems. The results also indicted a moderate importance rating for provisioning services, particularly relating to the use of the systems for grazing.

Table 4-8: Ecological Function Assessment Results (July 2022)

ECOSYSTEM SERVICE		Washes	Depressions
REGULATING AND SUPPORTING SERVICES	Flood attenuation	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	Very Low	Very Low
	Biodiversity maintenance	Moderately High	Moderately High
PROVISIONING SERVICES	Water for human use	Very Low	Moderate
	Harvestable resources	Very Low	Very Low
	Food for livestock	Moderately Low	Moderately Low
	Cultivated foods	Very Low	Very Low
CULTURAL SERVICES	Tourism and Recreation	Very Low	Moderately Low
	Education and Research	Very Low	Very Low
	Cultural and Spiritual	Moderately Low	Very Low

4.9 Ecological Importance and Sensitivity

Previous studies have indicated that the depression systems, such as those observed in this study provide crucial services to organisms such as migratory birds and mammals. The Northern Cape conservation plan is provided in Figure 4-21. The plan indicates that the wash habitats are considered to be ecological support areas. The results of the EIS assessment for the watercourses are presented in Table 4-9. The depression pan systems were derived to have very high EIS, whilst the non-perennial washes were derived to be of moderate EIS.

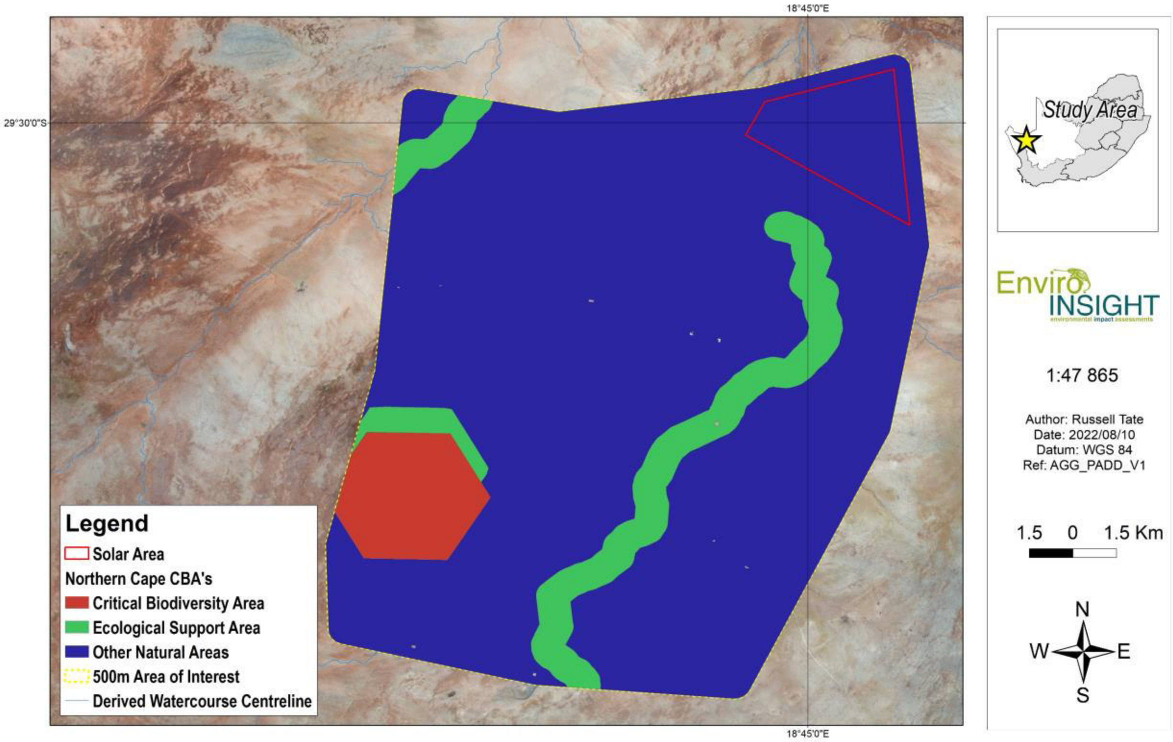

Figure 4-21: Northern Cape Conservation Plan

Table 4-9: Ecological Importance and Sensitivity

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

4.10 Buffers and Regulated Areas

4.10.1 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). In the case of this study, the buffer zones were defined based on the river and wetland ecosystems buffer tool as defined in Macfarlane et al. 2017 and Macfarlane et al. (2009). The results of the buffer tool are provided in Motivation for Buffer Zones

It is important to consider that the buffer tool was not designed to be implemented for the uncharacteristic/arid watercourse types present in the considered project AoI. As described in the watercourse classification component of this study, the watercourses present in the AoI are located within the topographic valley bottom landforms. The watercourses were further noted to be undefined/unconfined and unchanneled systems which flow across an alluvial plain in the valley bottom setting.

As provided in the definition component of this report, the extent of a watercourse is also defined based on the delineation of the flood event for the 100-year return period. Studies in the vicinity of the proposed project completed on a catchment proximate to 1000 km^2 illustrated peak flow rates as provided in Table 4-10 where reasonable estimates indicated a peak flow of 156 m^3/s.

Catchment sizes derived for the watercourses considered in this study were 295 km^2 and 398 km^2, thus expected peak flows are likely to range from 40 m^3/s to 65 m^3/s. Within the valley floor of the project area, it is anticipated that the flood extent would extend further than the expected maximum predicted flow rates of a linear 65m. It is therefore likely that the floodline extent would exceed the delineated watercourses provided in this study. Furthermore, given the uncertainty around modelled floodlines buffer zones are prescribed. Considering the above, as well as the anticipated valley bottom wides a buffer zone of 100m is provided for the washes considered in this study.

It is important to protect the areas where water is likely to flow/collect and thereby prevent impacts to these ecologically sensitive areas. For this reason, it is expected was further justified that buffer zones are increased to 100m for the wash systems. As described above, the width of 100m was derived based on the typical morphology of the wash systems which were typically confined to broad valley landforms. The proposed 100m buffer zone would therefore serve to conserve the necessary area to protect the natural hydrological processes present in the landscape.

The depression systems were provided with a buffer zone of 150m to protect the expected catchment of the systems. This is common practice for depression systems.

This would also ensure protection of the depression systems should these be connected to groundwater resources, allowing for the protection of sufficient catchment to ensure sustained baseflow and effective functioning of the depressions. The provision of the wider buffers aligns with the precautionary approach particularly where indicators for delineation were limited.

Table 4-10: Peak flow volumes for a watercourse in the Aggeneys area (TBC, 2020)

Period/Method	Rational	Rational (alternative)	Unit Hydrograph (m^3/s)	SDF	Empirical
1:2 year	105.64	228.65	16.81	71.23	-
1:5 year	153.44	406.45	30.12	206.81	-
1:10 year	206.33	563.25	46.91	329.88	112.75
1:20 year	269.71	736.38	68.99	467.58	153.14
1:50 year	370.1	973.95	109.69	670.97	212.04

Table 4-11, whilst the buffers are visualised in Figure 4-22.

The buffer zone tool indicated a need of 15m from the washes, whilst a buffer zone of 20m was provided for depressions.

4.10.2 Motivation for Buffer Zones

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1:50 year	370.1	973.95	109.69	670.97	212.04

Table 4-11: Buffer requirements before and after mitigation Washes (metres)

Phase	Before mitigation	After mitigation	Recommended Buffer
Construction	15	15	100
Operation	15	15	100

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

Phase	Before mitigation	After mitigation	Recommended Buffer
Construction	20	20	150
Operation	20	20	150

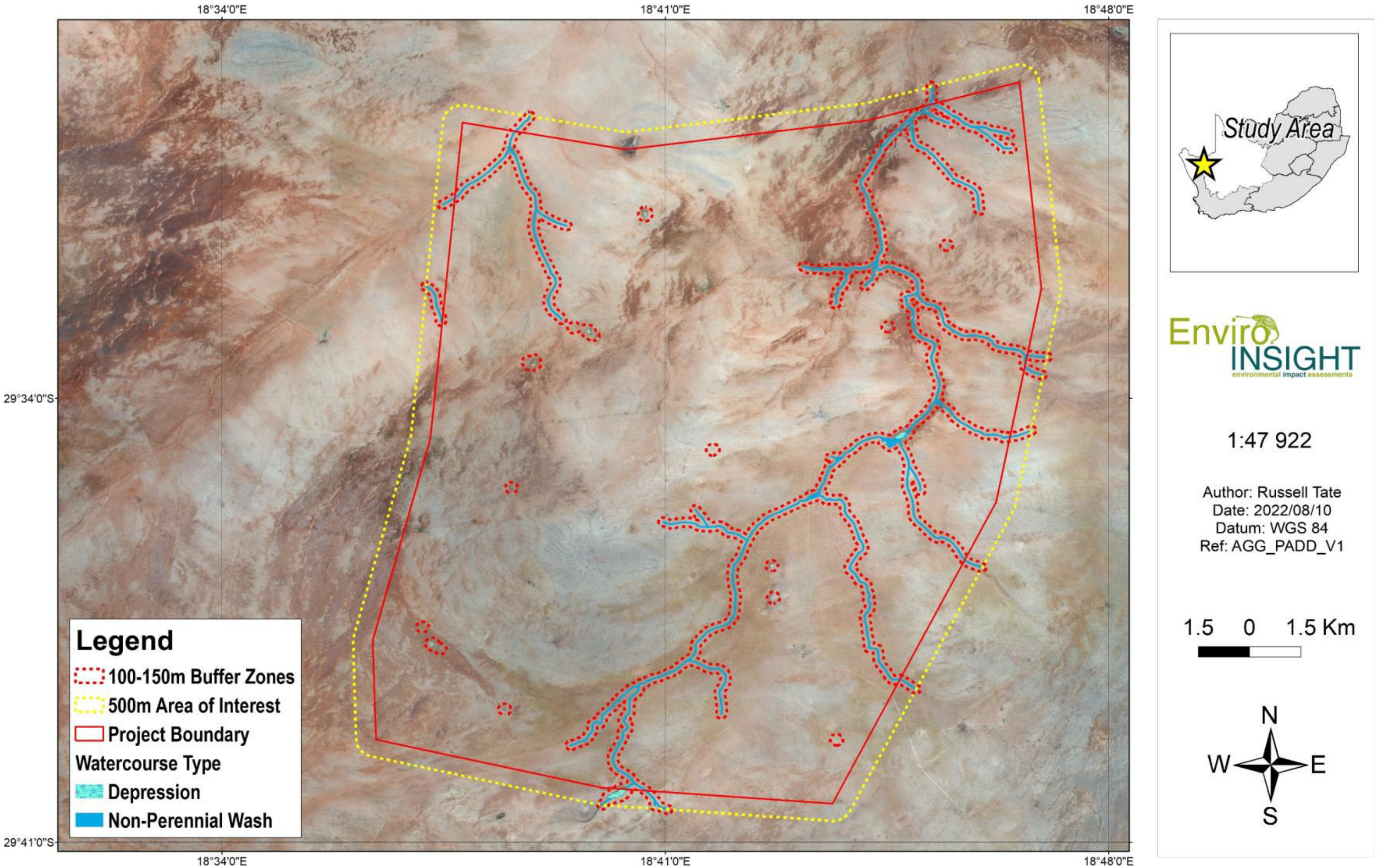

Figure 4-22: 100m and 150m buffer zone for the watercourses

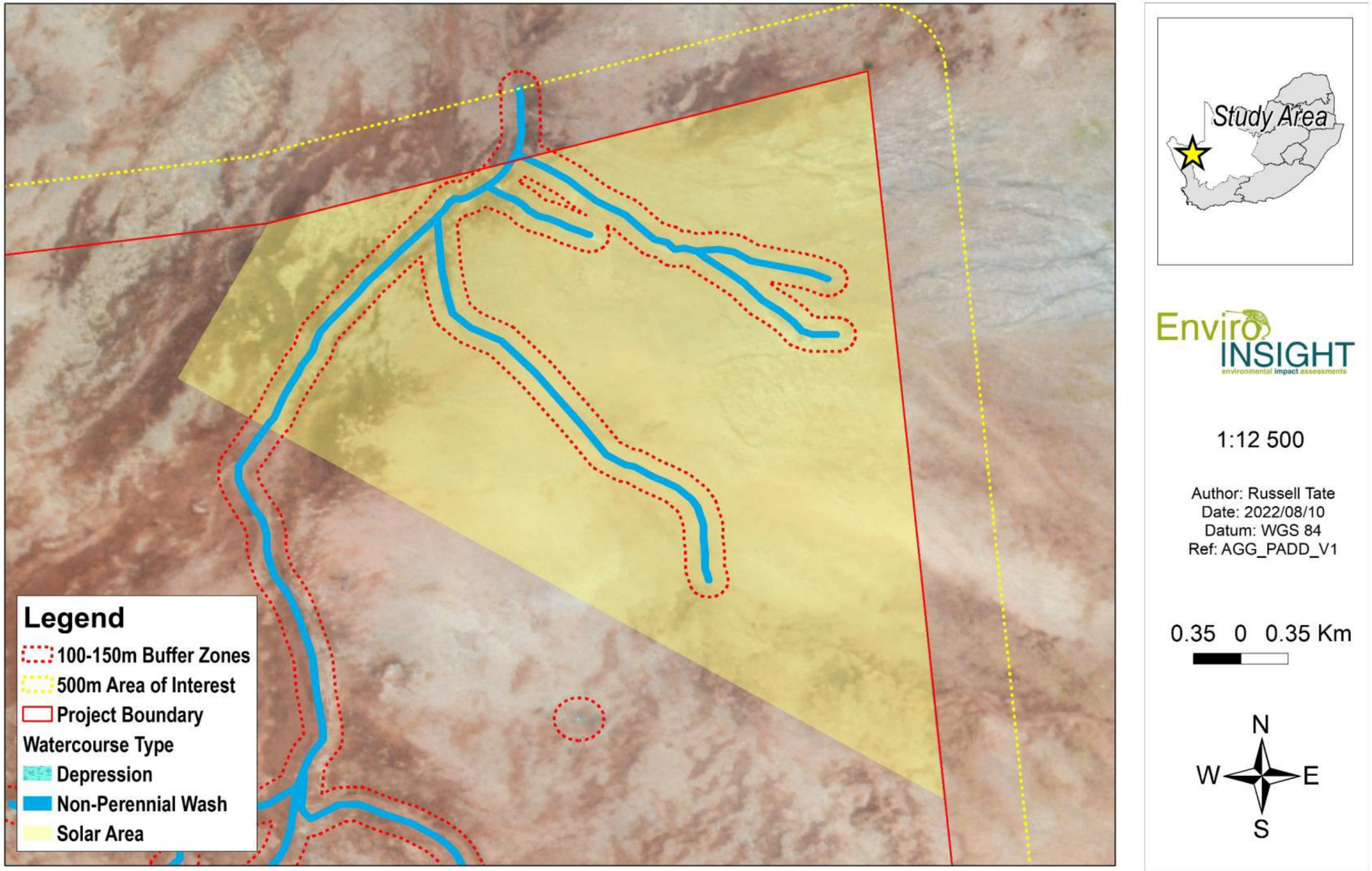

Figure 4-23: Figure 4-24: 100m and 150m buffer zone for the watercourses in relation to the Solar East and Solar West Projects

5 Risk Assessment

5.1 Risk Assessment Methodology

The risk assessment was conducted in accordance with the requirements of the DWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). The significance of the impact is calculated according to Table 5-1. The risk assessment matrix for the National Environmental Management Act (NEMA) is provided in

Table 5-1: Risk Assessment Matrix

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. Wetlands may be excluded.
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. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

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):
    - High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);
    - Moderate irreplaceability of resources;
    - Low irreplaceability of resources; or

- 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	Quantitative Rating
Very Low	Annually or less	1
Low	6 monthly	2
Medium	Monthly	3
High	Weekly	4
Very High	Daily / Permanent	5

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

Consequence (Severity + Spatial Scope + Duration)															
	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 and road infrastructure.

These activities have had a limited impact on the status of the watercourses and these systems are considered to be sensitive. 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 solar and grid connection 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 solar unit foundations;
- Stockpiling and movement of soils and construction materials;
- Storage and use of chemicals, fuels and oils;
- Diversion and crossing of watercourses;

- 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 turbine and grid connection structures. The roadways will require the implementation of wash crossings.

5.3.3.1 Avoidance

5.3.3.1.1 Roads

It is recommended that this study is updated following the finalisation layout of the proposed road network. The proposed road networks must avoid creating excessive crossings of the wash habitats and must avoid the established depression systems.

5.3.3.1.2 Grid Connections

The proposed grid connection pylons must not be placed within the buffer zones stipulated in this study.

5.3.3.1.3 Culverts - Crossings

Drifts are recommended to be utilised as opposed to culverts. It is recommended that rocky drifts are utilised as solid concrete drifts.

5.3.3.2 Construction Phase

The construction phase of linear infrastructure will involve the active clearing of vegetation, altering of valley bottom landforms as well as general catchment drainage modification. Direct unavoidable impacts are anticipated at wash crossing points.

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 conditions and may result in direct instream habitat loss.

5.3.3.2.1 Mitigation Actions

- 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.
- Access routes into or adjacent to the wash must make use of existing road ways and crossings where possible;

- 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 river channel or valley slopes where it is prone to being washed downstream or impeding natural flow;
- The installation of sedimentation/erosion protection measures must be implemented before the start of construction, e.g., several rows of silt traps and fences (this is particularly important in the access roads leading or adjacent to the watercourse);
- 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 one-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 inspection of the drainage channels must be completed within 1 week following the end of activities and within a week after the first rainfall event. Should excessive sediment be transported down the channels it is recommended that sediment screens are implemented;
- Sediment screens must be inspected, maintained and cleared every month or after significant rainfall (>30mm/24hrs);
- 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 off-site area. An inspection should be completed within a week after the phase is completed.

5.3.3.3 Operation Phase

Drainage off the hardened surfaces created by the roadways and pylon structures are anticipated to be silt laden and of a higher runoff velocity during rainfall events. This can result in the erosion, bank destabilisation and sedimentation of downstream watercourses. Similarly, to the construction phase, the operation phase of the crossing points 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 Mitigation Actions

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;
- The access road and silt traps (if installed) must be inspected monthly for signs of erosion. When erosion is observed, the area should be rehabilitated within 7 days. In addition, inspections following a >80mm/24 hr rainfall event must occur within 7 days of the event;
- An annual audit of the roads for signs of environmental disturbance outside of the footprint area must be conducted; and
- Alien invasive management programmes should continue throughout the duration of the activity.
- Watercourse monitoring should take place annually 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.

5.3.4.2 Construction Phase

The construction phase of the solar farm 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 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.
- All stockpiles and hazardous waste storage areas must be bunded by either a cut-off trench or berm directed to a Pollution Control Dam 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.
- All stockpiles and hazardous waste storage areas must be bunded by either a cut-off trench directed to a Pollution Control Dam or via a berm.

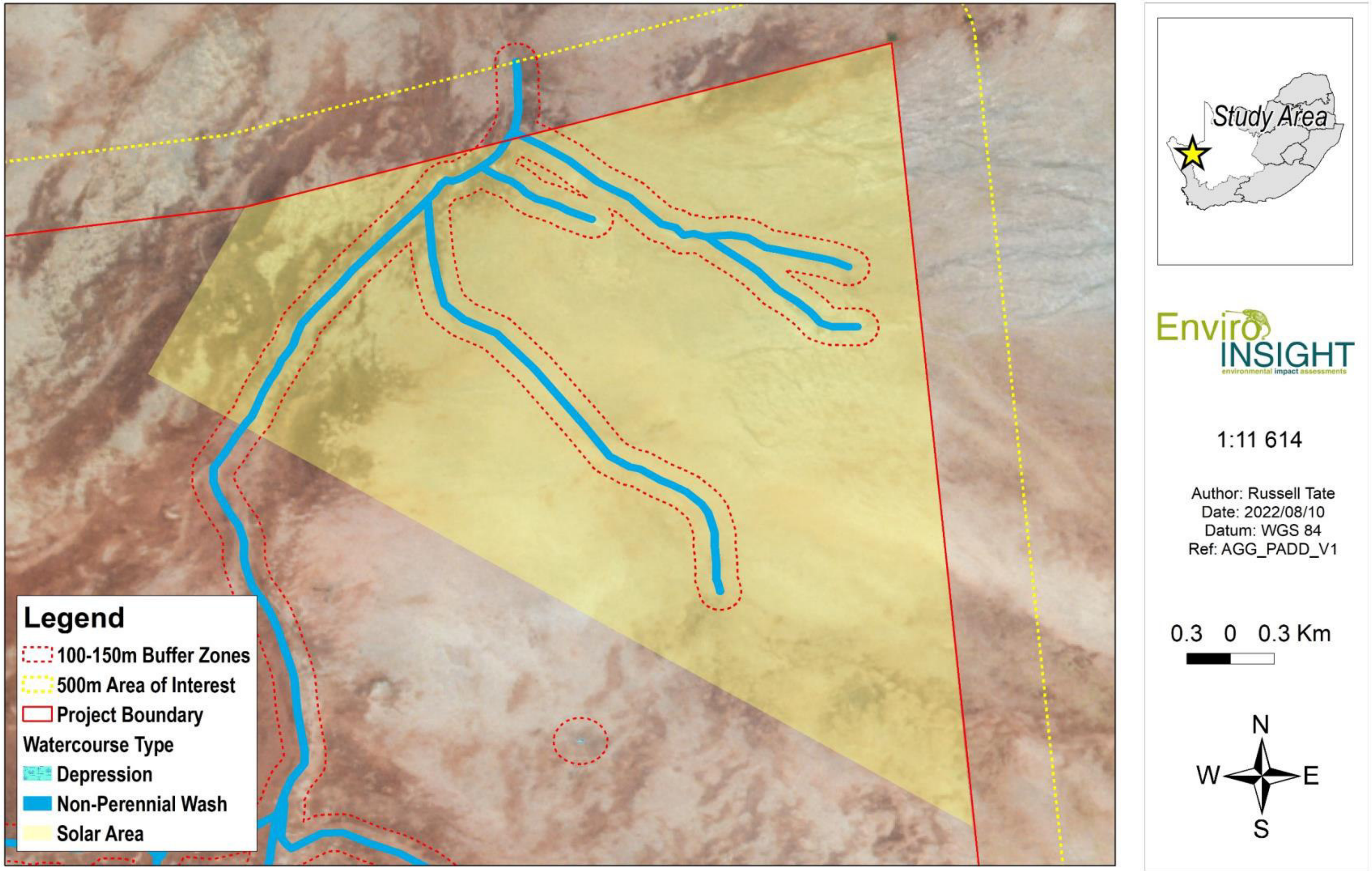

Figure 5-1: Proposed Project Layout for the Solar East and Solar West Projects

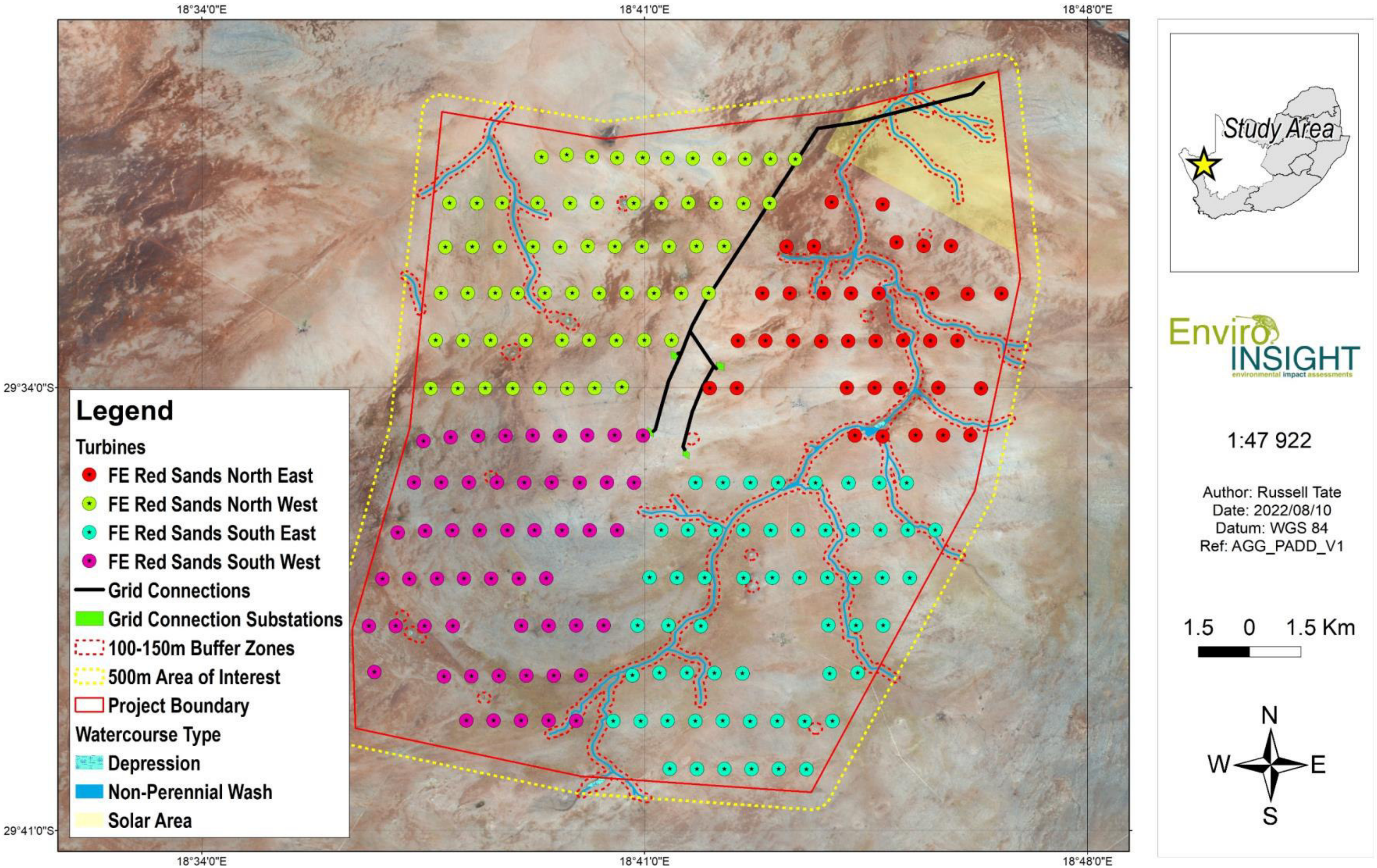

Figure 5-2: Cumulative Project Layout

5.3.5 Risk Assessment Tables

Table 5-11: Department of Water and Sanitation Risk Assessment Compiled by Russell Tate (Pr. Sci. Nat.) – Linear and Solar Activities

Aspect	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase								
Operation of equipment and machinery	1	1	2	1	1.25	1	3	5.25
Clearing vegetation	1	1	2	1	1.25	1	3	5.25
Stockpiling of and placement construction materials	1	1	2	1	1.25	1	3	5.25
Excavating/shaping landscape	2	1	2	2	1.75	1	1	3.75
Final landscaping, backfilling and postconstruction rehabilitation	2	1	2	2	1.75	1	1	3.75
Operational Phase								
Alteration of drainage	1	1	1	1	1	1	1	3
Alteration of surface water flow dynamics	1	1	1	1	1	1	1	3
Establishment of alien plants on disturbed areas	1	1	1	1	1	1	1	3

Table 5-12: Department of Water and Sanitation Risk Assessment Compiled by Russell Tate (Pr. Sci. Nat.) – Linear and Solar Activities

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Operation of equipment and machinery	2	2	0	3	7	36.75	Low	Low

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Clearing vegetation	2	2	0	3	7	36.75	Low	Low
Stockpiling of and placement construction materials	2	2	0	3	7	36.75	Low	Low
Excavating/shaping landscape	2	2	0	3	7	36.75	Low	Low
Final landscaping, backfilling and postconstruction rehabilitation	2	2	0	3	7	36.75	Low	Low
Operation Phase								
Alteration of drainage	3	2	0	3	8	24	Low	Low
Alteration of surface water flow dynamics	3	2	0	3	8	24	Low	Low
Establishment of alien plants on disturbed areas	3	2	0	3	8	24	Low	Low
In accordance with General Notice 509 "Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below								

Table 5-13: NEMA Impact Assessment – Solar Project 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 5-14: NEMA Impact Assessment – Solar Project 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

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 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 5-15 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 5-15: 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 Statement

The expected cumulative impacts for the proposed project on aquatic biodiversity are minimal should the avoidance and mitigation measures be implemented (Figure 5-2). The nature of the soils, gentle topography and aridity of the region has significant effects on the runoff potential during storm events whereby anticipated impacts are minimal.

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 effected.
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.	Baseflows are likely to be reduced via the activities.
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 aridity of the region.
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. Sediment trapping in watercourses was already regarded as limited and therefore 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 control.	The proposed project will implement erosion/surface water controls 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 effect 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 systems	Determine if avoidance has been implemented	Once every 2 years	It is proposed that live sampling take place and water quality measured. Should no water be present, substrate zooplankton sampling and hatching must take place

The following are recommendations made in support of this study:

- Several areas associated with the proposed grid connection were not surveyed during the study, it is recommended that access to the farms is obtained and the study updated.
- It is recommended that the avoidance actions proposed in this study are implemented where-after final road and turbine layouts must be re-assessed.
- It is recommended that floodlines are determined for the project.
- General authorisations are recommended for the proposed wash crossings where required.

8 Conclusion

The outcome of this assessment delineated 26 watercourse units within the AoI. These watercourses were considered to be minimally modified and in a largely natural PES. The watercourses were classified as having Very High and Moderate EIS ratings. A scientific buffer was calculated for the watercourses, however inline with the precautionary principle, and given the highly variable nature of the washes, it was proposed that a 150m buffer for depressions and a 100m wash buffer was utilised to protect these sensitive environments.

8.1 Impact Statement

The outcomes of the risk assessment indicate minor impacts from the proposed activities. The minor impacts can be attributed to low runoff potential, gentle topography and arid conditions. 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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