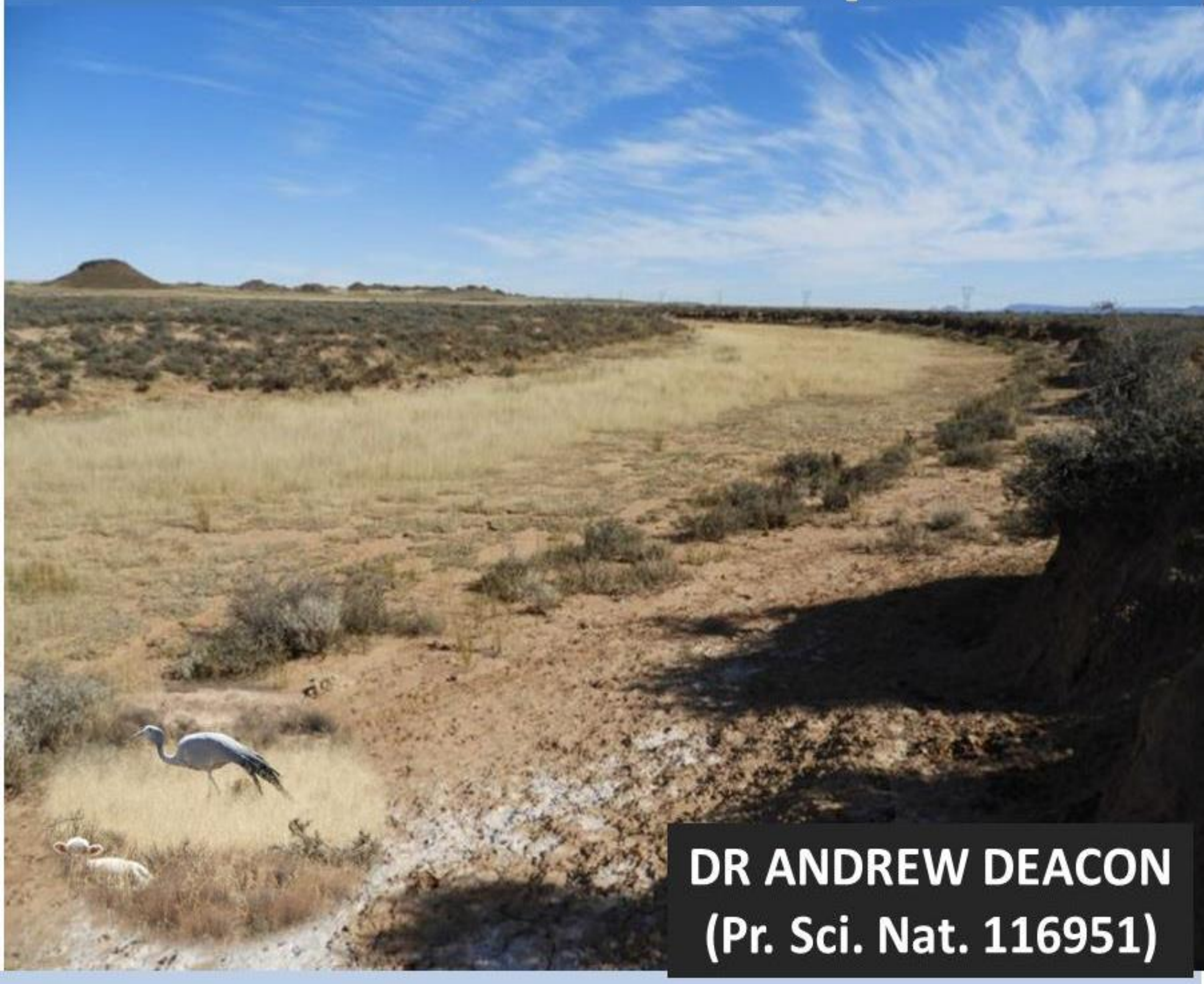
Proposed Development of a 225MW Solar PV Plant Farms in the Hanover District, Northern Cape.



DR ANDREW DEACON
(Pr. Sci. Nat. 116951)

THE PRESENT ECOLOGICAL STATE AND RISK ASSESSMENT FOR THE DRAINAGE SYSTEM AT THE PROPOSED SOLAR PV PLANT: WATER USE LICENSE (WUL) APPLICATIONS



October 2017

Proposed Development of a 225MW Solar PV Plant on Several Portions of Farms in the Hanover District, Emthanieni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape.

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Executive summary

This specialist study, relating to the erection of an electricity pylon of the Soventix project in the Brak River, forms part of the process to assess risk for purposes of General Authorisation registration as part of the Water Use Authorisation (WUA) process, for submission to the provincial Department of Water and Sanitation & Sanitation. Since the activities in the project area will impact on the Brak River, this report will determine the **Present Ecological State (PES) and environmental sensitivity** of these streams, as well as other requirements necessary for the WUAL process.

Task 1.2.3.1. Flow and sediment regimes at appropriate flows: The Brak River drains an area with a very low rainfall. Most of the surface water ecosystems in the study area are thus intermittent or ephemeral, being inundated only for brief periods each year, with periods of drought that are predictable in frequency but unpredictable in duration.

Task 1.2.3.2. Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime: The low rainfall across the study area means that evaporation is the dominant component of the water balance and while rainfall drives the inundation periodicity of the aquatic ecosystems in the area. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017, the river had no water in the drainage system and was not suited to an assessment of aquatic biota present surface.

Task 1.2.3.3. Riparian and In-stream Habitat.

The outcome of the Index of Habitat Integrity resulted in an in-stream IHI of 78.8 (B/C) which classifies as “Largely natural with few modifications” according to the Habitat Integrity index. The riparian IHI of 68.8 (C) falls in a “Moderately modified” category.

Task 1.2.3.3.2 Vegetation

The final scores of the VEGRAI assessment regarding the riparian and marginal zone integrity of the Brak River is 80.2%, which represents an Ecological Class B/C (>77.4 and <82.01). This score reflects a “Largely natural with few modifications.” The C score indicates some impacts at this stage on the riparian habitats:

- Large number of small and medium-sized weirs and dams in the study area;
- Some erosion due to trampling and diversions;
- Small amount of alien vegetation.

The Brak River SQ D62D-05610 is a Critical Biodiversity Area 1, and the area surrounding the ephemeral drainage line, is categorised as a Critical Biodiversity Area 2. Due to this importance rating the management objective for the Northern Cape CBA process suggests following:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological

condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

The 100 m buffer around the delineated riparian area should be measured from the top of the active channel bank. Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another.

Task 1.2.3.4. Biota – Aquatic invertebrates and Fish

At the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. By using PESEIS parameters the macro-invertebrate and fish population integrity was both established as Category D, which equates to "Largely modified". However, by evaluating the changes in the system and the diversity of these ephemeral systems, it is rather a lack of diversity then a case of modification when the instream biota is evaluated ("Low diversity").

Task 1.2.4. Describe the ecological importance and sensitivity (EIS) as well as the Socio-cultural Importance (SI) of the affected reach/es of the watercourse including the functions.

The mean Ecological Importance Class of the Brak River in the SQ reach D62D-05613 is "Moderate" and the mean Ecological Sensitivity Class of the SQ reach is also "Moderate".

Task 1.2.5. Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse.

About 4% of the Nama-Karoo has been cleared for cultivation or irreversibly transformed by building of dams. The many impoundments on the project area ephemeral system consist of small- to medium-sized earthen farm dams, and about 15 of these are found on the project farm alone.

Erosion is moderate (46.2%), very low (32%) and low (20%) in in the area. In the project area, the floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present. Moderate modification to the system are trampling and grazing within river channel by stock

Task 1.2.6. List and map sensitive environments in proximity of the project locality-sensitive environments include wetlands, nature reserves, protected areas, etc.

Information supplied by the Biodiversity Geographic Information System (BGIS) reveals Critical Biodiversity Areas in the study area. Three areas were identified as: Critical Biodiversity Area 1 for the Riverine system, Critical Biodiversity Area 2 for the Drainage area, and Ecological support Area for the surrounding landscape. The Brak River has been identified as having FEPA River Ecosystem Type status according to the Freshwater Ecosystem Protected Areas (FEPA) map for the area.

Task 3.2 Provide an assessment of the risks associated with the water use/s and related activities.

The main concern relating to the project are:

- Wwater quality aspects
  - erosion and siltation of the riverine areas,
  - and surface water pollution
- Alterations to local flow patterns
  - Power lines
  - Roads
- Introduction of invasive alien biota;
- Abstracting groundwater;

Due to adequate planning and proposed mitigation, all these potential impacts are rated " Low Risk".

Present Ecological State or PES

The Brak River of the SQ reach D62D-05613 were evaluated as "Largely modified" with a PES category "D" (Table 27), based on the median of the metrics (DWS, 2014).

Since there was no surface water available in the entire study area along the Brak River during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database. Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): "Largely modified"; mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B "Largely natural with few modifications" and thus the increasing the overall EcoStatus to a C (72.5%): "Moderately modified".

The table below provide the available parameters that was instrumental to establish the PES of the Project Area:

Parameter	Score %	Category	Description
In-stream IHI	78.8	B/C	Largely natural with few modifications
Riparian IHI	68.8	C	Moderate change
VEGRAI (Vegetation)	80.2	B/C	Largely natural with few modifications
MIRAI (Macro-invertebrates)		D	Low diversity
FRAI (Fish)		D	Low diversity
Mean Ecological Importance Class			Moderate
mean Ecological Sensitivity Class			Moderate
EcoStatus	72.5	C	Moderately modified
PES		D	Largely modified

Mitigation

The following mitigation is suggested for the project:

Rehabilitation

Rehabilitation must be conducted in terms of a rehabilitation plan and the implementation of the plan must be overseen by a suitably qualified ECO.

Buffer zone

A 100m buffer zone for the project is suggested on both sides of the river in order to impose a level of best practices when the proposed construction gets under way.

Placing of Solar PV Plant

The project team took great care to position the location and construction footprint in such a way that all the identified sensitive areas were avoided. This realignment of the original project footprint (preferred option Area B) incorporated the 100m buffer zone and most suitable placement of the power line pylons.

Table of contents

Abbreviations

AQV	Aquatic vegetation
BGIS	Biodiversity Geographic Information System
^{0}C	Degrees Celsius
CBA	Critical Biodiversity Areas
cm	Centimetre
DWA&F	Department of Water Affairs (pre-2010)
DWS	Department of Water and Sanitation
E	East
EAP	Environmental Assessment Practitioner
EC	Ecological Category
Ecoclassification	Ecological classification
EcoStatus	Ecological Status
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIARr	Environmental Impact Assessment Rreport
EIS	Ecological Importance and Sensitivity
ELU	Existing lawful use
ESA	Ecological Support Area
ES	Ecological Sensitivity
ESCOM	Electricity Supply Commission
EWR	Environmental Water Requirements
EWRM	Environmental Water Resource Monitoring
FEPA	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
GA	General Authorization
GAI	Geomorphological Driver Assessment Index
ha	Hectare
HAI	Hydrological Driver Assessment Index
HCR	Habitat Cover Ratings
HQI	Habitat Quality Index
IHAS	Integrated Habitat Assessment System
IHI	Index of Habitat Integrity
IIHI	Instream Index of Habitat Integrity
kl	Kilolitre
km	Kilometre
kVA	Kilovolt ampere rating
kV	Kilovolt
LUDS	Land-Use Decision Support Tool
m	Meter
m^3	Cubic meters
m^3s	Cubic meter per second
MAP	Mean annual precipitation
mm	Millimetre
MCDA	Multi Criteria Decision Analysis
MIRAI	Macro-invertebrate Response Assessment Index
MTS	Main Transmission Station
MV	Marginal vegetation
MW	Megawatt
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
ONA	Other Natural Areas
PAI	Physico Chemical Driver Assessment Index

PES	Present Ecological State
PESEIS	Present Ecological State, Ecological Importance and Ecological Sensitivity
PV	Photovoltaic
REC	Recommended Ecological Category
RDM	Resource Directed Measures
RHP	River Health Programme
RIHI	Riparian Index of Habitat Integrity
RMF	Regional Maximum Flood
S	South
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SI	Socio-cultural Importance
SIC	Stones in current
SHI	Site Fish Habitat Integrity Index
SOOC	Stones out of current
SQ	Sub-quaternary
SQR	Sub-quaternary reach
VEGRAI	Riparian Vegetation Response Assessment Index
WMA	Water Management Area
WRUI	Water Resource Use Importance
WUL	Water Use License
Yr	Year

Glossary of Terms/definitions

EcoClassification - refers to the determination and categorisation of the Present Ecological State of various biophysical attributes of rivers relative the natural or close to the natural reference condition.

Ecological category - It is use to define and type the ecological condition of a river in terms of the deviation of biophysical components from the natural reference condition.

Ecological importance - The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales.

Ecological integrity - Ecological integrity is the ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, and biotic components on a temporal and spatial scale that is comparable to the natural characteristics of ecosystems of the region.

Ecological sensitivity - Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience).

EcoStatus - The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services.

Environmental Water Requirements (EWR) - Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and the human livelihoods and well-being that depend on these ecosystems.

Fish Response Assessment Index (FRAI) - The FRAI is an assessment index based on the environmental intolerances and preferences of the reference fish assemblage and the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers.

Habitat integrity - Habitat integrity then refers to the maintenance of a balanced, integrated composition of physico-chemical and habitat characteristics on a temporal and spatial scale that is comparable to the characteristics of natural habitats of the region.

Index of Habitat Integrity (IHI) – The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region The IHI is used as a surrogate for drivers in river ecology.

Integrated Habitat Assessment System (IHAS) - IHAS is a widely-used aquatic macro-invertebrate habitat assessment method evaluating biotope availability and habitat quality.

Macro-invertebrate Response Assessment Index (MIRAI) – The MIRAI provides a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community (assemblage) from the reference condition.

Present Ecological State (PES) - The PES of the river is expressed in terms of **drivers** (physico-chemical, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic invertebrates), as well as an integrated state, the EcoStatus.

Reserve - The Reserve refers to the quantity and quality of water required to (i) supply basic human needs and (ii) protect aquatic ecosystems.

Riparian - A ***riparian*** zone or ***riparian*** area is the interface between land and a river or stream. ***Riparian*** is a buffer zone, and ***riparian*** strip are used to characterize a ***riparian*** zone.

South African Scoring System (SASS5) - This is a biotic index based on the presence of selected families of aquatic macro-invertebrates and their perceived sensitivity to water quality changes.

Sub-Quaternary Reach - Quaternary Catchment. A fourth order catchment in a hierarchal classification system in which a primary catchment is the major unit.

Trend - Trend is viewed as a directional change in the attributes of the drivers and biota (as a response to drivers) at the time of the PES assessment.

Riparian Vegetation Response Assessment Index (VEGRAI) - VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results.

1. Introduction

1.1 Background to the Solar Photovoltaic (PV) Plant Project

The bulk of the information related to the project description was obtained from the Environmental Impact Assessment rReport (EIArR): Proposed Development of a 225MW Solar PV Plant on Several Portions of Farms in the Hanover District, Emthanieni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape (Ecoleges Environmental Consultants, 2017).

Proposed activity.

The proposed activity entails the construction of a 225MW solar photo-voltaic (PV) farm, in the form of 3 interconnected 75MW plants; connected to a sub-station that ties into the existing ESKOM 400 kV or 132 kV overhead power lines. Several potential locations have been considered, but 3 alternatives have been identified within the preferred site in consultation with the EAP, Client and Landowner (Ecoleges Environmental Consultants, 2017).

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity. A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module (solar panel). The facility will include areas used for management, security and control room, maintenance and canteen as well as changing facilities. An on-site substation will be required with the necessary infrastructure to feed the electricity generated, via cut and tie-in, into the immediately adjacent 132 kV or 400 kV Eskom network.

The purpose of the new Solar PV system includes the establishment of De Aar as a Renewable Energy Hub, which can be achieved by providing different renewable energy options. The aforesaid Hub has to be within close proximity to existing Eskom infrastructure. Locally, the establishment of the proposed project would strengthen the existing electricity grid for the area, providing power in a short space of time (potentially less than two years to commissioning). Should the proposed project be approved it would result in long-term benefits for the De Aar area, e.g. creation of employment and business opportunities (Ecoleges Environmental Consultants, 2017).

- **Proposed development footprint:** The land use is currently agriculture, and will retain in part its agricultural use for livestock grazing, but will convert significant sections for commercial Solar PV for a fixed-term. The size of the proposed development footprint is approximately 520ha. Several potential sites have been considered, but 3 sites (Figure 1) have been identified as preferred in consultation with the EAP, Client and Landowner. The alternative sites must also be assessed to ensure the preferred sites do not result in unacceptable biodiversity impacts relative to the alternatives.

- **Access roads:** Vehicle service tracks will be created between the panel arrays as well as around the perimeter of the facility on the inside of the fence that will require limited vegetation removal, but will exceed collectively 1 hectare. Existing roads will be used for main access, which may need to be enlarged to allow large equipment to access the site during construction. The permanent roads would be in the order of 4 m wide and remain un-surfaced, which would facilitate the infiltration of storm water into the soil. Precast box culverts or pipes may be required where the access roads pass through the drainage channels on site. Any fill material required would be obtained from the current borrow pits on site.

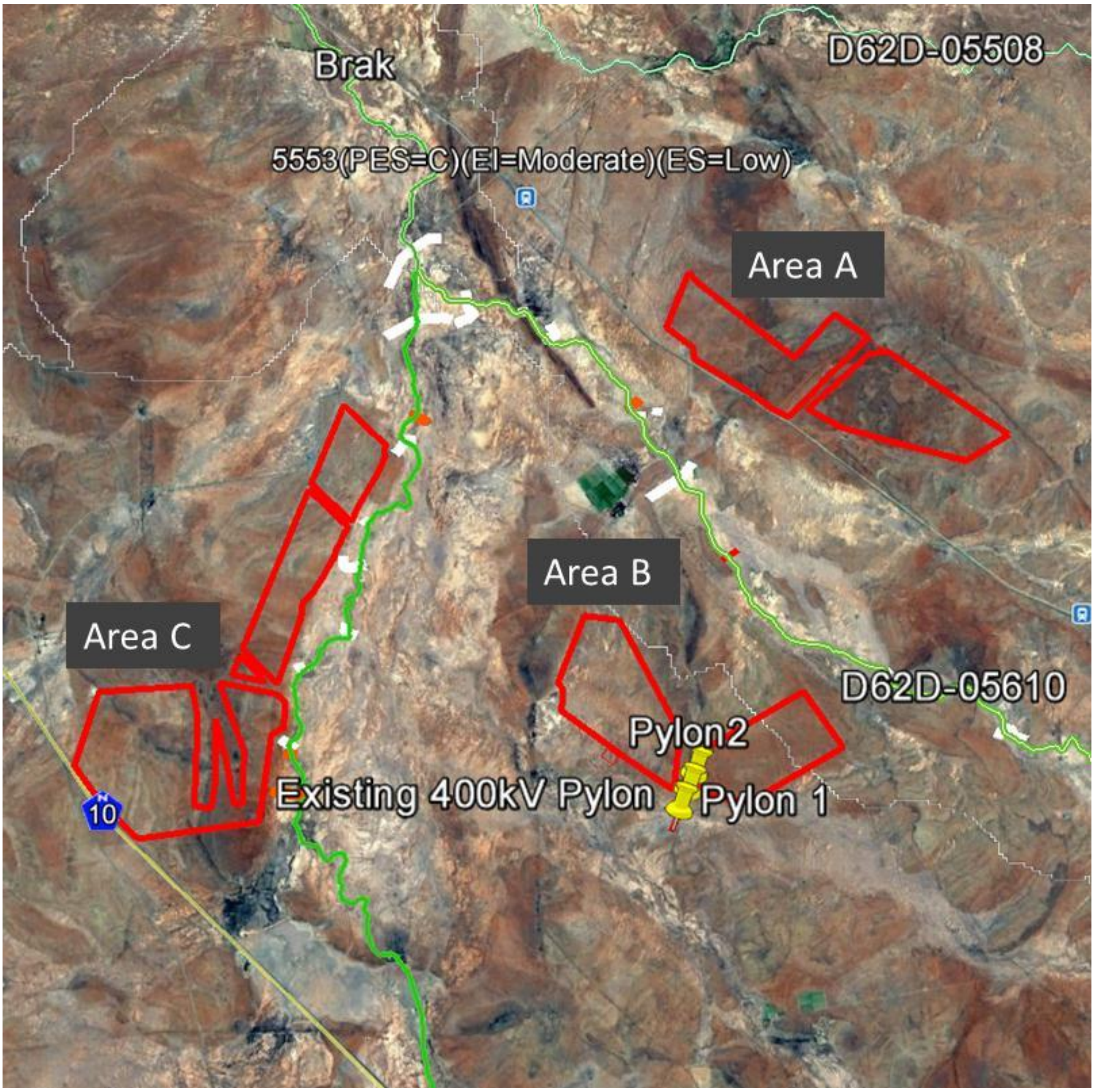
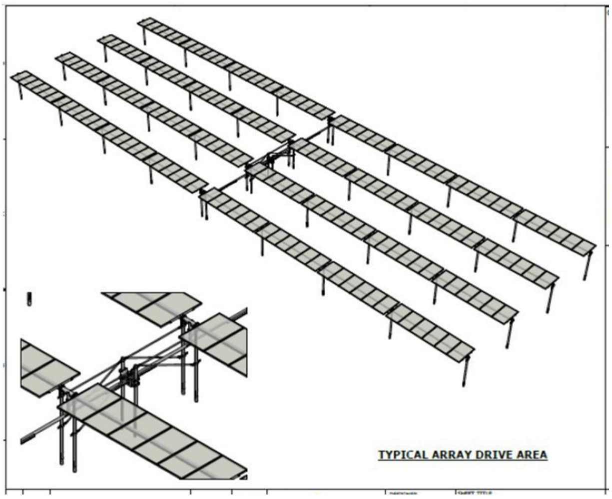


Figure 1: Several potential sites have been considered, but 3 sites (Areas A - C) have been identified as preferred sites.

- **Solar panels:** This area includes three 75MW solar PV plants (170ha each), with associated infrastructure, as well as the sub-station that will tie into the ESKOM overhead 400 KV power lines. The solar PV installation will be a minimum of 75 MW with additional phases in increments of 75 MW possible totally 225 MW per footprint. Solar panels arranged in units with a total generating capacity of approximately 225 MW to be constructed as three separate yet integrated facilities of 75 MW each and totalling a footprint of approximately 520 ha.

- **Solar arrays:** Solar arrays would be orientated in a northern direction, offset at a maximum of 15 degrees either to the east or west and would have a maximum height of approximately 2.5 to 3 m (technology dependent) above ground level and placed approximately 7.4 m apart (Figure 2). The racks would have either a ballasted or piled foundation. Modules would be arranged in 1.25 MW blocks of approximately 2.5 ha each and would be tilted at a 30 degree angle, with each 75MW footprint covering a total area of 170 ha (including rack frame, access roads etc.). Solar arrays would be placed over the vegetation, where possible. However, vegetation over 60 cm in height beneath the modules would need to be removed or cropped. In addition, vegetation within the proposed footprint of rack foundations, access roads, pylons and the internal underground cables (some of which are in the road verges) would also have to be partially removed.

Figure 2: Illustration of the solar array layout and spacing.



- **Power lines:** The on-site substation per facility with the necessary infrastructure to feed the electricity generated, via cut and tie-in, into the immediately adjacent 400kv Eskom network. The one set of overhead ESKOM lines are 400kVA and the tie-in from the substation to the ESKOM overhead lines will thus need to be 400kVA. The current overhead ESKOM transmission lines that the Solar PV plant will feed into run within an expansive drainage system, requiring limited work within this system to enable the tie-in. The proposed photovoltaic plant would be connected to the Eskom network via either a 132 kV power line that feeds directly or via loop-in loop-out into Hydra Main Transmission Station (MTS) near De Aar or to the 400 kV power line between Hydra and Poseidon MTS, via a loop-in and loop-out connection. A couple of pylons will need to be planted within the project area to link the sub-station to the existing ESKOM power lines (Figure 1).

- **Buildings:** Each 75 MW facility will have an operations building to be constructed within a <1000 m² lay down area for each facility. The facility will include areas used for management, security and control room, maintenance and canteen as well as changing facilities. Various operations and maintenance buildings would be constructed, including:
  - Main building including offices and workshops (± 0.70ha), which would be shared by control and security staff,
  - Main electrical substation,
  - Transformers (max 500 m^2 fenced area) and Inverter structures in between arrays (each ± 15 m^2) – prefabricated concrete or steel structures, and
  - Transformer structures – small concrete or steel structures. The buildings would be single storey and would be constructed from brick or stone with metal sheet roofing.

  No accommodation facilities will be constructed. Staff will be required to leave the site at the end of the day.

- **Fencing:** The proposed plant would be fenced off with a 2.5 m high wire mesh security fence or clear view fencing, with access gained via a security gate.

- **Water supply:** Groundwater would be used for construction and operational purposes. There are several existing boreholes on site, which would be used to abstract groundwater. This water would be stored in an aboveground JoJo type storage tanks with a capacity not exceeding 100 cubic metres (100 m^3), which would be located near the office buildings. It is anticipated that approximately 100 kL of water would be required every 3 months during the operational phase. This water would be used to clean the modules / solar array and general office use (e.g. toilets, drinking water, etc.) and supply water to the sheep that will retain access to the solar farm for grazing purposes as a complementary vegetation management tool. Construction phase water requirements would depend on where the fabrication of certain components of the project would take place. This would require approximately 50 to 75 kl of water per day during the construction phase, including dust suppression along access roads. The affected properties fall within the D62D catchment. General Authorisation GN 538, GG 40243, 2 September 2016 allows for 2000m^3 per property per year of surface water and 45m^3 per hectare per year of groundwater abstraction and storage. Hence, the water volumes required for the construction phase and operational phases fall well within the promulgated limits.

- **Sewerage treatment:** Installation of bio-box package plant for treatment of effluent to special limits would be used to treat sewage and wastewater from the office buildings. It is envisaged that a maximum of 2 kl of sewage and wastewater would be generated per day.

- **Waste disposal:** All non-recyclable waste would be disposed of at the De Aar licensed landfill site.

1.2 Project brief

This specialist study, relating to the Present Ecological State (PES) and environmental sensitivity of the drainage areas in the project area forms part of the process to compile the Water UseAuthorisation License (WUL) documentation application, and amendments which will be reviewed by the relevant competent authorities, mainly the Department of Water & Sanitation (DWS).

The term **EcoClassification** is used for the **Ecological Classification (EC)** process and refers to the determination and categorisation of the **Present Ecological State** (**PES**). The PES of the river is expressed in terms of various components i.e. drivers (physico-chemical, geomorphology, hydrology) and biological responses (fish, riparian vegetation and aquatic invertebrates) as well as an integrated state, the **Ecological Status** or **EcoStatus** of a river.

The EcoStatus refers to the integration of physical changes by the biota and as reflected by biological responses. The individual drivers and biological responses are referred to as **components** while the individual attributes within each component that are assessed, to determine deviation from the expected natural reference condition, are referred to as ***metrics***.

DWS Section 21 (c) & (i) Supplementary information Requirements

This assessment takes into consideration specific requirements of the DWS document DW775/781, titled: *"Supplementary Water Use Information (Section 21 (c) and (i) Water Uses; Section 21(c) - impeding of diverting the flow of water in a watercourse; Section 21 (i) - altering the bed, banks, course or characteristics of a watercourse)."*

The following tasks list certain activities required to determine the PES & EIS and are based on this DWS document referred to above. Throughout this report reference is made to the below list of **tasks and is included as headings to the relevant sections in this report.**

1.1 Locality

*1.1.1. Provide a description of the **location** of the watercourse at which the water use/s is to take place*
*1.1.2 Provide a **locality map/s** indicating the relevant catchment, surrounding land use, towns, infrastructure etc.*
*1.1.3 Provide the **catchment reference number**.*

1.2 Description

*1.2.1 Provide the name and/or **description** of the affected watercourse.*
*1.2.2 Provide a **map** indicating the segment and affected reach/es of the watercourse in which the water use/s is to take place and which indicates/delineates the regulated area, including:*
1.2.2.1 The extent of the riparian habitat.

1.2.3 Describe within context of the immediate catchment and segment, the historic as well as current state (Present Ecological State or PES) of the affected reach/es of the watercourse with regards to the following characteristics (attributes):
*1.2.3.1 **Flow** and **sediment regimes** at appropriate flows*
*1.2.3.2 **Water quality** (including the **physical, chemical and biological characteristics** of the water) in relation to the flow regime*
*1.2.3.3 Riparian and In-stream **Habitat**.*
*1.2.3.3.1 **Morphology** (physical structure)*

1.2.3.3.2 ***Vegetation***
1.2.3.4 ***Biota***

*1.2.4 Describe the ecological importance and sensitivity (**EIS**) as well as the **Socio-cultural Importance (SI)** of the affected reach/es of the watercourse including the functions*
*1.2.5 Discuss existing **land and water use impacts** (and threats) on the characteristics of the watercourse*
*1.2.6 **List and map sensitive environments** in proximity of the project locality- sensitive environments include wetlands, nature reserves, protected areas, etc.*

3.2 **Risk Assessment:**

3.2.1 Provide an assessment of the risks associated with the water use/s and related activities.

Task 3.6 **Monitoring and Compliance:** Provide a detailed Biomonitoring programme for the Project.

Table 1: Background studies and Fieldwork:

Section 21 (c) & (i) Supplementary Requirements	**Specialist Comments**
1.2.3.1. Flow and sediment regimes at appropriate flows:	To be obtained from existing DWS data base and other relevant studies.
1.2.3.2. Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime:	To be obtained from existing DWS data base (PES of the Brak River catchment) and other relevant studies.
1.2.3.3 Riparian and In-stream Habitat. 1.2.3.3.1 Morphology (physical structure): 1.2.3.3.2 Vegetation:	Identification and **delineation of wetlands and riparian areas**. The delineation process requires that the following be taken into account: • **Topography** associated with the watercourse; • Vegetation; • **Alluvial soils** and deposited material. Riparian habitat surveys will incorporate the Riparian Vegetation Index (**VEGRAI**).
1.2.3.4 Biota	**Aquatic biota and associated habitats** Fish and macro-invertebrates are good indicators of river health. By making use of established and accepted survey methods and incorporate the habitat aspects, a proper basis for biological diversity could be obtained. The following recognized bio-parameters and methods will be used: • General **habitat assessment** to assess the general physical habitat condition of the rivers and identify

	potential sources and impacts responsible for deterioration of the aquatic ecosystem. The general habitat assessment and biota specific habitat assessments also evaluated the condition and availability of habitats for specific biotic groups. • **Fish communities**: All applicable non-destructive fish sampling methods will be applied at sites along the relevant rivers in an attempt to gain a representation of the fish assemblage per river. All fish was identified to species level and returned unharmed back into the aquatic ecosystem. The fish results will be interpreted using existing fish indices such as the Fish Response Assessment Index (FRAI). • Aquatic macro-invertebrates by the application of the SASS5 (South African Scoring System) protocol. The Integrated Habitat Assessment System (IHAS) method will be used to assess the invertebrate specific habitats.

2. Biophysical background of the Brak River catchment

Ecoregion and River Characteristics

The study area lies near the eastern edge of the Nama Karoo biome, and is mapped according to the national vegetation types (Mucina and Rutherford, 2006) as being of the vegetation type Northern Upper Karoo (NKu 3) (Figure 3) which is considered to be least threatened. This Karoo unit is found on floristic and ecological gradients between the Nama-Karoo, arid Kalahari savanna and arid highveld grasslands.

The vegetation cover is generally dominated by sparse dwarf karroid scrub and tufted grass with bare patches of sand in between. Portions of the area are in a disturbed condition, most likely as a result of livestock grazing.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System. The ephemeral Brak River flows in an arc from south-east to north-west, eventually feeding into the Orange River basin. The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic.

The river flows to the north of the study area with a number of its tributaries crossing the area as it flows in a northerly direction. All the small tributaries in the area are ephemeral or intermittent and most are discernible only as slightly shallow depressions with no clear associated vegetation and slightly clayey soils (Figure 18b).

Intermittent rivers have a far less predictable flow regime compared to perennial or seasonal rivers, and are frequently dry for long periods in arid regions. The ephemeral tributaries of the Brak River are considered to be in a largely natural ecological state, with a low ecological importance and sensitivity.

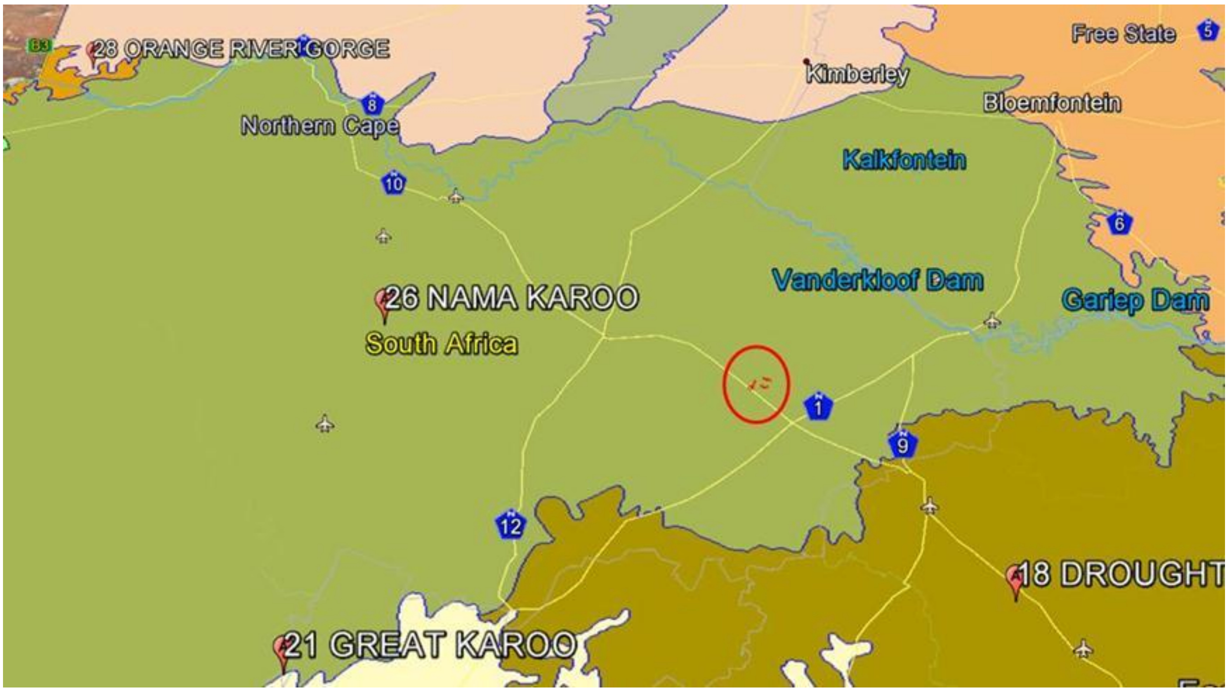


Figure 3: The position of the Project Area (red circle) in the Nama Karoo ecoregion according to the Water Resource Classification System (DWS, 2014).

The Brak River confluence with the Orange River is downstream of the Orange-Vaal confluence, and is a river which flows non-perennially from the south and is in turn fed by the Ongers River, rising in the vicinities of Hanover and Richmond respectively.

The Brak River drains shrubland vegetation in an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017, the river had no surface water available, not even in the earthen dams. Even if isolated pools were present, these will not be suited to an assessment of water quality or aquatic biota present.

The fauna of the more seasonal to ephemeral ecosystems is not well known, but they have been found to provide aquatic habitat to a diverse array of faunal species that depend on brief periods of inundation for hatching, mating, feeding and refuge. For instance, many frogs of the Karoo region breed in temporary pools associated with watercourses and wetlands, this includes the Karoo Toad *Vandijkophrynus gariepensis* and Karoo Dainty Frog *Cacosternum Karooicum*.

A great number of other organisms are not confined to these temporary systems, but derive crucial benefits from them, like migratory birds and many invertebrates that migrate from permanent to temporary habitats on a regular basis.

Non-perennial (seasonal, intermittent, ephemeral and episodic) rivers are systems which place extreme stress on biota occupying them by exhibiting highly variable chemical and physical attributes. The most important of these are the unpredictable and highly variable flow patterns. These flow patterns determine the habitat available for biota such as aquatic invertebrates.

Habitat available can be diverse during flow but a very low diversity could be available during dry periods. The reduction in flow causes major habitat types (eg. stones-in-current, marginal vegetation) to dry out and become unavailable to biota. The habitat type mostly available in temporary rivers is pools, in which invertebrates can survive the dry period and from where they can recolonise the stream as flow returns.

Climate:

The climate of the study area can be regarded as warm to hot with a summer rainfall and dry, cold winters. Temperatures vary from an average monthly maximum and minimum of 32.6ºC and 15.4ºC for January to 16.8ºC and 0.3ºC for July, respectively. Temperature ranges are large with lows of -10°C in winter to mid 40°C in summer. The long-term average annual rainfall in this region of the Northern Cape is only 289mm, of which 201 mm (70%) falls from November to April. Frost occurs most years, 30 days on average, between late May and early September.

. **Vegetation & Landscape Features:**

The area is characterised by wide open plains with relatively flat topography typical of the Central Karoo. The site is relatively flat (average slope gradient is less than 10% from the east to the west) with some isolated hills and low rocky ridges in the east and north-east of the site. There are a few shallow drainage lines present on site. The site is located at an altitude of approximately 1 300 m to 1 340 m above sea level. The shrubland is dominated by dwarf karoo shrubs, grasses and low trees.

It is evident that the Vegetation Map (Figure 4) provides an oversimplification of the vegetation of the site and there are at least three distinct vegetation types present on the site. The open plains of the site correspond with the Northern Upper Karoo vegetation type, but the dolerite hills and koppies present have vegetation more closely allied with Upper

Karoo Hardeveld, while the floodplain of the Brak River is clearly characterised by an a zonal vegetation type, allied with Upper Gariep Alluvial Vegetation (Ecoleges Environmental Consultants, 2017). The floodplain has however been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

Along the Brak River the common reed *Phragmites australis* dominates the instream habitat, while there is very little discernible riparian vegetation. The ephemeral streams have no visible aquatic vegetation. *Phragmites australis* reeds grow in the beds of several of the ephemeral rivers.

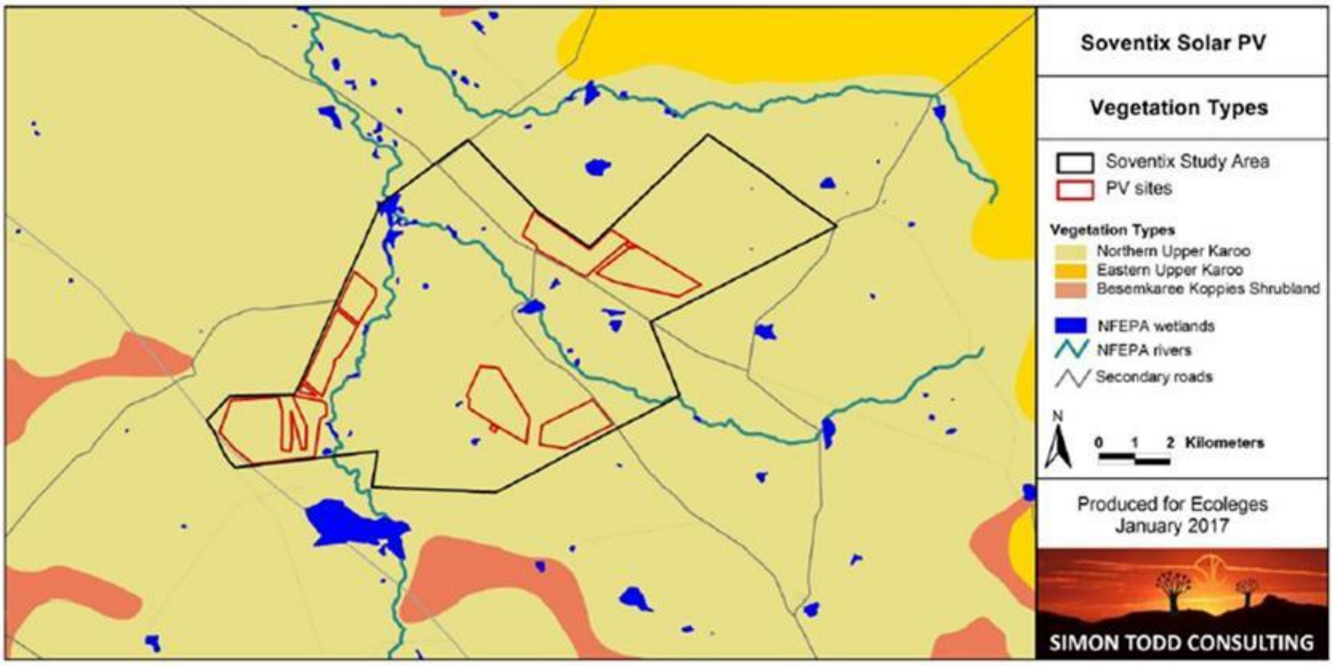


Figure 4. Broad-scale overview of the vegetation in and around the Soventix PV site (Mucina & Rutherford, 2006) (Nel et al. 2011).

Geology & Soils

Shales form the underlying geology while Jurassic Karoo Dolerite silts and sheets support this vegetation complex in places. Wide stretches of land are covered by superficial deposits including calcretes of the Kalahari Group. Soils are variable from shallow to deep, red-yellow apedal, freely drained soils to very shallow Glenrosa and Mispah forms.

The dolerite intrusions (dykes and sills) are more resistant to weathering than the sandstones and shales, thus causing the formation of the characteristic Karoo koppies.

Conservation

This is a least threatened unit with a conservation target of 21%. None conserved in statutory conservation areas. About 4% has been cleared for cultivation (the highest proportion of any type in the Nama-Karoo) or irreversibly transformed by building of dams. Erosion is moderate (46.2%), very low (32%) and low (20%). *Prosopis glandulosa,* regarded as one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type.

3. Standard Methods proposed for the DWS licensing requirements protocolauthorisation process

As partial requirement for the DWS licensing requirements protocol, specific biodiversity surveys were recommended by the environmental consultant. The terms included for this investigation are as follow:

- Assess the ecological status, importance and sensitivity of the site as required for section 21 (c) and (i) water uses license applications by the Department of Water and Sanitation (DWS),

- Aquatic and riparian surveys are proposed in the riverine habitats in the vicinity of the proposed development. The objective of this survey is to provide information on the aquatic environment of the proposed development regarding the fish and macro-invertebrate integrity, integrity of the aquatic habitat and possible impacts and mitigation.

For the purposes of this report, the site was assessed during 18-22 October 2017.

Tasks undertaken during this study are listed below and indicated according to the task numbering in the Section 21 (c) & (i) Supplementary Water Use Information directive (DW775/781. Edition 7 July 2009).

1.1 Locality

Task 1.1.1. Provide a description of the location of the watercourse at which the water use/s is to take place

This information was obtained during the field study survey and from the Environmental Impact Assessment Rreport (EIARr) (Ecoleges Environmental Consultants, 2017).
.

Task 1.1.2 Provide a locality map/s indicating the relevant catchment, surrounding land use, towns, infrastructure etc.

Make use of existing information and information from the Environmental Impact Assessment Rreport (EIARr) (Ecoleges Environmental Consultants, 2017).

Task 1.1.3 Provide the catchment reference number.

Obtain the catchment reference number from the DWS documents.

1.2 Description

Task 1.2.1 Provide the name and/or description of the affected watercourse.

Obtain the name from the DWS documents (if the stream course is named) and the description of the affected watercourse was obtained during the field study survey.

Task 1.2.2 Provide a map indicating the segment and affected reach/es of the watercourse in which the water use/s is to take place and which indicates/delineates the regulated area.

Obtain the map from of existing resources and information from the Environmental Impact Assessment Rreport (EIARr) (Ecoleges Environmental Consultants, 2017).

Task 1.2.2.1 The extent of the riparian habitat.

Riparian delineation was done – see Task 1.2.3.3.2. Wetland information obtained from the Environmental Impact Assessment Rreport (EIARr) (Ecoleges Environmental Consultants, 2017).

Task 1.2.3 Describe within context of the immediate catchment and segment, the historic as well as current state (Present Ecological State or PES) of the affected reach/es of the watercourse with regards to the following characteristics (attributes):

Following are additional aspects and processes that play a role in the determination of the current state (Present Ecological State or PES) of the affected reach/es of the watercourse.

a) **EcoClassification**

EcoClassification refers to the determination and categorisation of the Present Ecological State (PES) (health or integrity) of various biophysical attributes of rivers compared to the natural (or close to natural) reference condition. The purpose of EcoClassification is to gain insight into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

The state of the river is expressed in terms of biophysical components:

- Drivers (physico-chemical, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (fish, riparian vegetation, riverine fauna (other than fish) and aquatic invertebrates).

During recent years DWS has published the *River EcoClassification* series of methods used to determine the health of rivers and streams in South Africa. As part of this series the methods for ecological status determination and the classification of riparian and aquatic systems, is published in Module A: *EcoClassification and EcoStatus Determination* (Kleynhans *et al*, 2009). The following sections are extracted and modified (where appropriate) from the last mentioned authors.

b) **Present Ecological State (PES)**

The PES of the river is expressed in terms of various components: That is, **drivers** (physico-chemical, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic invertebrates), as well as an integrated state, the EcoStatus. A rule-based procedure is followed to assign each component an Ecological Category for the PES (on a scale of A to F) using the following information:

- Biophysical surveys conducted during the project.
- Information and data from historical surveys, databases and reports.
- Aerial photographs and videos.
- Land-cover data.
- Internal Strategic Perspective (ISP) reports of DWS.
- Expert knowledge is regularly used to estimate the degree of change to a particular component.

Different processes are followed for each component to assign a category from A→F (where A is natural, and F is critically modified) (Table 3) (DWA, September 2013).

Table 2 Ecological Categories (ECs) and descriptions (see also Appendix 2)

EC	Description of EC
A	Unmodified, natural.
A/B	Boundary category between A and B.
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.
B/C	Boundary category between B and C.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
C/D	Boundary category between C and D.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
D/E	Boundary category between D and E.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E/F	Boundary category between E and F.
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

It must be emphasised that the A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D etc. The B/C boundary category, for example, is indicated as the light green to dark-blue area in Figure 5.

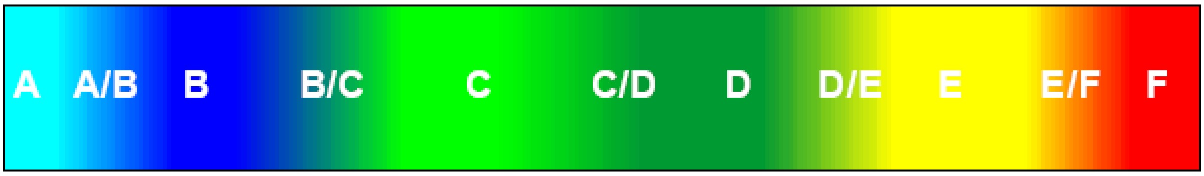


Figure 5: The continuum on an A to F scale for rating Ecological Category

The models for each component all use a swing ranking system in which key ecological components are ranked and weighted to provide consistent results.

c) **Trend**

Trend is viewed as a directional change in the attributes of the drivers and biota (as a response to drivers) at the time of the PES assessment. A trend can be absent (close to natural or in a hanged state but stable), negative (moving away from reference conditions) or positive (moving back towards natural - when alien vegetation is cleared, for instance). The ultimate objective is to determine if the biota have adapted to the current habitat template or are still in a state of flux. Generally such an assessment can be approached from a driver perspective. This means that there can be a positive or negative trend response from the biota if the drivers (specifically geomorphology and water quality) are still in a directional state of change (+ or -).

Task 1.2.3.1 Flow and sediment regimes at appropriate flows.

Flow and sediment regimes at appropriate flows will be obtained from existing project documents and other relevant studies, including the Environmental Impact Assessment Rreport (EIARr) (Ecoleges Environmental Consultants, 2017).

PES supporting information

Comments summarising the activities that result in the PES were provided for the sub-quaternary (SQ). In addition, the Ecosystem Services summary as well as the Water Resource Use Importance (WRUI) summary per SQ were also utilised to identify what the impacts were and whether they were flow or non-flow (including water quality) related. This study also viewed each SQ using Google Earth^{TM} to provide the flow and non-flow impact assessment and to identify the key PES drivers. Information was extracted in a 'master spread sheet' that incorporates all the PESEIS (DWA, 2014) results, as well as the additional information required for this project.

Task 1.2.3.2 Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime.

Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime will be obtained from existing DWS data base (PES of the tributaries and drainage lines in the Brak River catchment) and other relevant studies.

Task 1.2.3.3 Riparian and In-stream Habitat.

Aquatic habitat assessments

Habitat assessments have been carried out to identify situations in which changes in habitat are responsible for changes in faunal populations. The nature and diversity of habitats available at the sampling point are factors of overwhelming influences on the biota present. The diversity of available biotopes itself is often incorporated in information on the conservation status of the river.

The habitat indices to be used in this survey are the Invertebrate Habitat Assessment System (IHAS) and the Habitat Quality Index (HQI).

a) IHAS (Integrated Habitat Assessment System)

b) HQI (Habitat Quality Index)

- **IHAS** (Integrated Habitat Assessment System, version 2) habitat assessments were performed in conjunction with the SASS5 assessment to determine the role of habitat in the observed biotic integrity based on the macro-invertebrates.

- General **habitat assessment** (including photographic assessment) to assess the general physical habitat condition of the sites and identify potential sources and impacts responsible for deterioration of the aquatic ecosystem.

Task 1.2.3.3.1 Morphology (physical structure).

During the survey of the Soventix project, the drainage line environment was surveyed by doing six riparian transects in the project area. Three transects were surveyed on the D62D-05613 SQ of the Brak River (Figures 20 to 22), two were surveyed on the D62D-05610 SQ of a Brak River tributary (Figures 23 to 24), and Transect 6 evaluated the drainage area where the proposed power line pylons will be situated (Figure 25). At each of these survey sites a transect was surveyed: from the edge of the riparian area (left and right bank), and through the streambed to the other side.

Unfortunately, at the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of the Index of Habitat Integrity (IHI) model, Habitat Cover Ratings (HCR) and Site Fish Habitat Integrity Index (SHI).

Task 1.2.3.3.2 Vegetation.

a) Riparian delineation

It is important to differentiate between wetlands and riparian habitats. Riparian zones are not wetlands, however, depending on the ecosystem structure, wetlands can be also be classified as riparian zones if they are located in this zone (e.g. valley bottom wetlands). Although these distinct ecosystems will be interactive where they occur in close proximity it is important not to confuse their hydrology and eco-functions.

Riparian delineations are performed according to *“A practical field procedure for identification and delineation of wetlands and riparian areas”* as amended and published by the Department of Water Affairs and Forestry (2005); (Henceforth referred to as DWAF Guidelines (2005).

Aerial photographs and land surveys were used to determine the different features and riparian areas of the study area. Vegetation diversity and assemblages were determined by completing survey transects along all the different vegetation communities identified in the riparian areas.

Riparian areas are protected by the National Water Act (Act 36 of 1998), which defines a riparian habitat as follows:

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

Riparian areas include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes, or drainage ways. Due to water availability and rich alluvial soils, riparian areas are usually very productive.

Tree growth rate is high and the vegetation is lush and includes a diverse assemblage of species. The delineation process requires that the following be taken into account:

- Topography associated with the watercourse;
- Vegetation;
- Alluvial soils and deposited material.

A typical riparian area according to the DWA&F Guidelines (2005) is projected in Figure 6.

In addition to the DWA&F Guidelines (2005) and DWA&F updated manual (2008), the unpublished notes: *Draft riparian delineation methods prepared for the Department of Water Affairs and Forestry, Version 1* (Mackenzie & Rountree, 2007) were used for classifying riparian zones encountered on the property according to the occurrence of nominated riparian vegetation species.

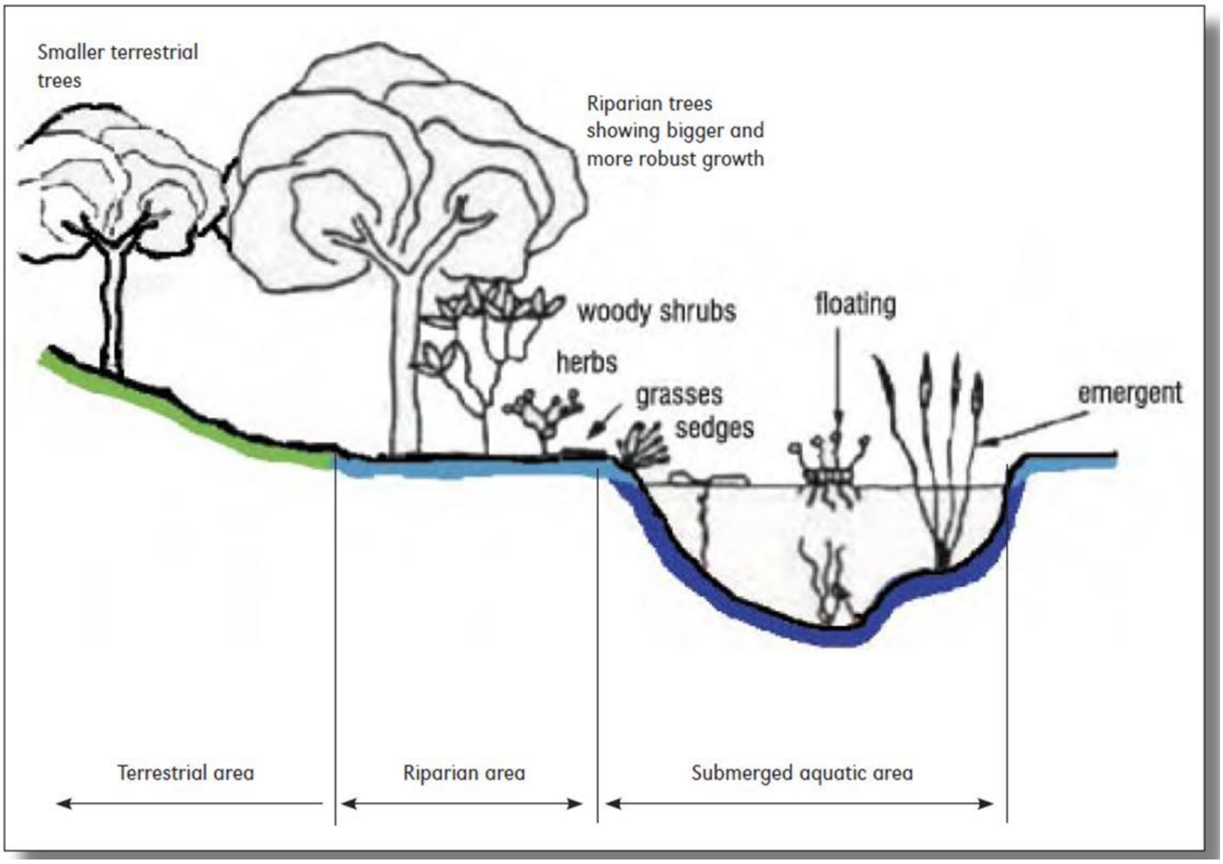


Figure 6: A cross section through a typical riparian area (DWA&F Guidelines, 2008).

b) Riparian habitat surveys (Riparian Vegetation Index — VEGRAI)

The general components of the VEGRAI are specified as following:

- It is a practical and rapid approach to assess changes in riparian vegetation condition.
- It considers the condition of the different vegetation zones separately but allows the integration of zone scores to provide an overall index value for the riparian vegetation zone as a unit.
- The vegetation is assessed based on woody and non-woody components in the respective zones and according to the different vegetation characteristics which include, inter alia:

  - Cover
  - Abundance

- Recruitment
- Population structure
- Species composition

- It provides an indication of the causes for riparian vegetation degradation.
- It is impact based. This means that the reference condition will only be broadly defined and based on the natural situation in the absence of impacts. Where possible, however, reference conditions should be derived based on reference sites or sections.

The index is based on the interpretation of the influence of riparian vegetation structure and function on in-stream habitat.

Although biodiversity characteristics are used in assessing the riparian vegetation condition, it is not a biodiversity assessment index *per se.*

For this study the Level 3 VEGRAI will be used as Level 3 is applied by the River Health Programme (RHP) and for rapid Ecological Reserve purposes. This level will be aimed at general aquatic ecologists.

Task 1.2.3.4 Biota – Aquatic invertebrates and Fish

Aquatic surveys

Macro-invertebrates and fish are good indicators of river health. By making use of established and accepted survey methods (SASS5 for invertebrates and FRAI-based surveys for fish) and incorporate the habitat aspects, a proper basis for biological diversity can be obtained.

The different components of the proposed development and its impact on the aquatic environment will be assessed for the river in the project area. The following recognized bio-parameters and methods will be used:

- Aquatic invertebrates: South African Scoring System version 5 (SASS5).
- Fish communities: Fish Response Assessment Index (FRAI). Applicable fish habitat assessments such as the Habitat Cover Ratings (HCR) and Site Fish Habitat Integrity Index (SHI) will be used to assess the habitat potential and condition for fish assemblages.
- Riparian vegetation: Riparian Vegetation Index (VEGRAI)

At the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS 2014) will be used to establish some background for the PES determination. Due to the fact that the methods prescribed for these parameters were not implemented, the methodology will be moved to the appendices. Methods to survey these components are available in Appendix 3.

Task 1.2.4 Describe the ecological importance and sensitivity (EIS) as well as the Socio-cultural Importance (SI) of the affected reach/es of the watercourse including the functions.

Ecological Importance and Sensitivity (EIS)

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity.

EIS/PES data was used in the eco-classification process of DWS (key process in the determination of the Reserve) to determine ecological sensitivity of a river reach as well as the present ecological state of such a river reach. From this an indication is provided whether the river reach is in a health category that is commensurate with its ecological importance and sensitivity. This relates to the determination of the eco-status of the river which refers to its overall condition or health and is based on its biophysical characteristics. The EIS/PES data for the Brak River was obtained from the extensive documentation compiled in: Department of Water and Sanitation (DWS, 2014). A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa.

This approach estimates and classifies the ecological importance and sensitivity of the streams in a catchment by considering a number of components surmised to be indicative of these characteristics.

The following ecological aspects were considered as the basis for the estimation of ecological importance and sensitivity:

- The presence of rare and endangered species, unique species (i.e. endemic or isolated populations) and communities, intolerant species and species diversity should be taken into account for both the instream and riparian components of the river.
- Habitat diversity should also be considered. This can include specific habitat types such as reaches with a high diversity of habitat types, i.e. pools, riffles, runs, rapids, waterfalls, riparian forests, etc.
- With reference to the first two points, biodiversity in its general form should be taken into account as far as the available information allows.
- The importance of the particular river or stretch of river in providing connectivity between different sections of the river, i.e. whether it provides a migration route or corridor for species should be considered.
- The presence of conservation or relatively natural areas along the river section should also serve as an indication of ecological importance and sensitivity.
- The sensitivity (or fragility) of the system and its resilience (i.e. the ability to recover following disturbance) of the system to environmental changes should also be considered. Consideration of both the biotic and abiotic components is included here.

This system should be regarded as a guideline for the professional ecological judgement of individuals familiar with a particular area. The assessors scored a number of biotic and habitat determinants considered to be important for the determination of ecological importance and sensitivity. The median of these scores will be calculated to derive the ecological importance and sensitivity category. Assessors were then required to compare this with their overall estimation of the ecological importance and sensitivity category.

Assessors were required to substantiate and document their judgement to a reasonable degree for future revision. It was essential that this assessment was conducted by biologists familiar with the particular area in question or comparable areas.

The final reports addressed and analysed the EIS/PES data for all WMAs and indicate priority areas for further attention in terms of protection and management to achieve resource quality objectives and preliminary management class. The report also specify per resource and quaternary catchment descriptions of the characteristics and parameters that defines a PES state and the EIS importance. A table was produced to indicate the most significant changes/impact on the present state and the main indicator that drives a quad. Cross reference to high conservation areas targeted for biodiversity conservation was made by aligning the attributes (to be investigated) that makes up the EIS/PES.

More detail and tables regarding the assessment of ecological importance and sensitivity can be obtained from the document by Kleynhans et al (DWA&F, 1999).

Ecological Category (EC)

The basis of the assessment of the importance of the metrics of biophysical components in determining the EC and EcoStatus is a Multi Criteria Decision Analysis approach (MCDA). The MCDA process allows the development of consistent rating systems or indices for the categorisation of ecosystem components and aggregates these mathematically in a theoretically justifiable way.

The Desktop level EcoClassification was modified for use in the PESEIS project to deal with numerous SQ river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PESEIS project is illustrated in Figure 7 (DWA, September 2013).

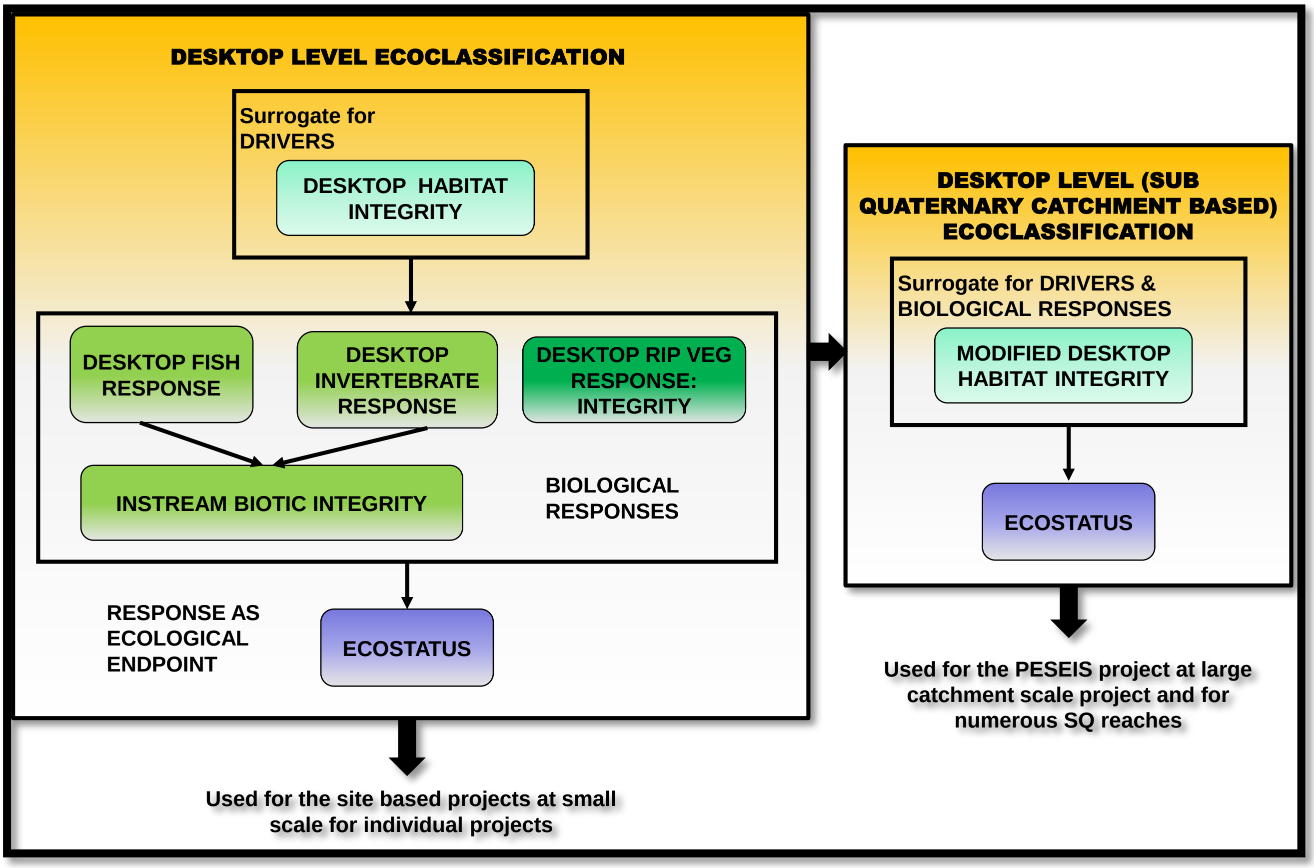


Figure 7: Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES.

The PES is assessed according to six metrics that represents a very broad qualitative assessment of both the instream and riparian components of a river. The metrics used in the PES model and an explanation of what they refer to is explained in Table 3 (DWA, 2013). Each metric is scored from zero to five.

Table 3: PES metrics and explanations (DWA, September 2013)

Metrics	Comment
Potential instream habitat continuity modification	Modifications that indicate the potential that instream connectivity may have been changed from the reference. Indicators: Physical obstructions (e.g. dams, weirs, causeways). Flow modifications (e.g. low flows, artificially high velocities, physico-chemical "barriers").
Potential riparian/wetland habitat continuity modification	Modifications that indicate the potential that riparian/wetland connectivity may have been changed. Indicators: Physical fragmentation, e.g. inundation by weirs, dams; physical removal for farming, mining, etc.
Potential instream habitat modification activities.	Modifications that indicate the potential of instream habitats that may have been changed from the reference. Includes consideration of the functioning of instream habitats and processes, as well as habitat for instream biota specifically. Indicators: Derived likelihood that instream habitat types (runs, rapids, riffles, pools) may have changed in frequency (temporal and spatial). Assessment is based on flow regulation, physical modification and sediment changes. Land use/land cover (erosion, sedimentation), abstraction etc. may indicate the likelihood of habitat modification. The presence of weirs and dams are possible indicators of causes of instream habitat change. Certain introduced biota (e.g. carp, crustacea and mollusca) may also cause habitat modification. Eutrophication and resulting algal growth as well as macrophytes may also result in substantial changes in habitat availability.
Potential riparian/wetland zone modifications	Modifications that indicate the potential that riparian/wetland zones may have been changed from the reference in terms of structure and processes occurring in the zones. Also refers to these zones as habitat for biota. Indicators: Derived likelihoods that riparian/wetland zones may have changed in occurrence and structure due to flow modification and physical changes due to agriculture, mining, urbanization, inundation etc. Based on land cover/land use information. The presence and impact of alien vegetation is also included.
Potential flow modification	Modifications that indicate the potential that flow and flood regimes have been changed from the reference. Indicators: Derived likelihood that flow and flood regimes have changed. Assessment based on land cover/land use information (urban areas, inter-basin transfers), presence of weirs, dams, water abstraction, agricultural return flows, sewage releases, etc.
Potential physico-chemical modification activities	Activities that indicate the potential of physico-chemical conditions that may have changed from the reference. Indicators: Presence of land cover/land use that implies the likelihood of a change of physico-chemical conditions away from the reference. Activities such as mining, cultivation, irrigation (i.e. agricultural return flows), sewage works, urban areas, industries, etc. are useful indicators. Algal growth and macrophytes may also

	be useful response indicators.

A six-point rating system (0-5) is followed, where metrics of the drivers and biological responses are scored in terms of the degree to which they have changed compared to the natural or close-to-natural reference (if necessary, half points such as 1.5 and so on can also be used):

0 = No discernable change from reference/close to reference
1 = Small modification from reference
2 = Moderate modification from reference
3 = Large modification from reference
4 = Serious modification from reference
5 = Extreme modification from reference

These qualitative ratings are expert knowledge-based, and are assessed by the relevant expert in a particular speciality. It is preferable that the relative difference between for example, 0 – 1 be the same as between 3 – 4. However, this is difficult to control and is currently exclusively based on expert knowledge.

The calculation of the Ecological Categories of drivers and biological responses is done by totalling the weighted scores and expressing this as a percentage of the maximum. This value indicates the percentage change away from the expected reference and must be subtracted from 100 to arrive at the percentage value that represents the EC. This value is used to place the EC of the component in a particular category that ranges from A to F (Table 4).

Table 4: Generic ecological categories for EcoStatus components (Kleynhans et al, 2009).

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
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.	80-89
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 have occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Critical/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

After the Ecological Categories of the driver and biological response components are determined, there remains the issue of how to integrate these to provide an indication as to the EcoStatus. Deriving the EcoStatus from the Ecological Categories of components is based on the following principles (Kleynhans *et al*, 2005):

- The Ecological Categories of the physical drivers (hydrology, geomorphology and physico-chemical integrity) are not integrated to provide an indication of the EcoStatus purely based on the drivers.
- Information on the driver metrics, i.e. how different they are from the reference is considered when assessing the biological responses. This is an expert knowledge approach and the attributes and environmental requirements of the biota should be considered when doing this.
- The biological responses are considered to provide the best indication of the EcoStatus of the river because it integrates the effect of the driver components

The steps in deriving the EcoStatus are:

- Criteria are considered that provide an indication of the relative indicator value of the two instream biological groups, fish and invertebrates. These criteria are used to weigh the relative importance of these two groups as indicators of in-stream health. The Ecological Categories of the two biological groups are proportioned according to these weights and combined to provide the in-stream Ecological Category.
- A suitable index to get an indication of riparian vegetation Ecological Category within the EcoStatus context is not yet available. Consequently the riparian vegetation zone can only be considered conceptually and in terms of its influence on the in-stream EC. In this regard the influence, importance and integrity of the riparian vegetation zones, i.e. marginal, lower and upper vegetation, are considered in terms of its significance for the instream biota. Some indication of the health of the riparian vegetation can also be gleaned from the geomorphological driver where certain metrics of this driver do serve as indicators.
- The riparian vegetation Ecological Category and the instream Ecological Category are integrated based on a proportioning of weights according to the availability of high confidence information. This provides the EcoStatus of the river.
- Where riparian vegetation information is insufficient, the instream EC is used as the best indicator of the EcoStatus of the river.

The *modus operandi* followed by DWS's Directorate: Resource Directed Measures (RDM) is that, if the EIS is high or very high, the ecological aim should be to improve the condition of the river. However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable. This relates to whether the problems in the catchment can be addressed and mitigated. If the EIS evaluated as moderate or low, the ecological aim should be to maintain the river in its PES. Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states (REC - the Recommended Ecological Category) depending on the EIS and PES. Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed.

a) <u>Socio-cultural Importance (SI)</u>

Make use of existing information.

<u>**Task 1.2.5** Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse.</u>

Make use of existing information, especially using the background data from the PESEIS project (DWA, September 2013).

<u>**Task 1.2.6** List and map sensitive environments in proximity of the project locality- sensitive environments include wetlands, nature reserves, protected areas, etc.</u>

a. Land-Use Decision Support Tool (LUDS)

To establish how important the site is for meeting biodiversity targets, a number of resources and tools are used. Specifically, the Land-Use Decision Support Tool (LUDS) used extensively to compile the LUDS Report (BGIS, 2016). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level. Its primary objective is to serve as a guide for biodiversity planning but should not replace specialist ecological assessments.

To establish how important the site is for meeting biodiversity targets, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g. is it in a Critical Biodiversity Areas (CBA) or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

b. The Ecological Importance (EI) and Ecological Sensitivity (ES)

The EIS of SQs are assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and able to recover from various forms of human use.

c. Freshwater Ecosystem Priority Areas (FEPAs)

National Freshwater Ecosystem Priority Areas (NFEPA) map products provide strategic spatial priorities for conserving South Africa’s freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPA maps provide a single, nationally consistent information source for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes. These maps are therefore directly applicable to the National Water Act, feeding into Catchment Management Strategies, classification of water resources, reserve determination, and the setting and monitoring of resource quality objectives. FEPA maps are also directly relevant to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004; RSA, 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act.

The base criteria of the river FEPA are the following: "Rivers had to be in a good condition (A or B PES) to be chosen as FEPAs" (Nel *et al*., 2011).

FEPAs provide an important input into EIAs, informing decision makers on freshwater ecosystems that need to be taken into account in environmental assessments and authorisations (Driver et al, 2011). FEPAs should inform the EIA process in the following way:

- The presence of a FEPA means that a freshwater specialist must be consulted for the assessment.

- Anticipated impacts on a FEPA that may result in an ecological condition lower than A or B should be ranked as having medium to high significance.
- Any activity that will have an overall residual impact on wetland or river FEPAs and their immediate surrounds greater than a low negative significance, is not acceptable from the point of view of managing and conserving freshwater ecosystems, and must be avoided.
- The cumulative effect of development impacts should ideally be considered in the case of sub-quaternary catchments associated with FEPAs (i.e. the specialist should be aware of other developments in the sub-quaternary catchment that are likely in the near future and should highlight possible cumulative impacts).
- Unavoidable development must require special mitigation measures that would reduce the overall impact of the activity or development to low negative significance, or must require a biodiversity offset.

The following four-step process should be followed for taking FEPAs into account in EIAs and will supply information on the Brak River as part of the Department of Environment and Nature Conservation, Northern Cape systematic biodiversity plans:

FEPA Step 1: Consult the FEPA map

- Make an initial desktop assessment of whether the proposed activity is likely to impact on the FEPA as mapped.

See “Critical Biodiversity Areas” under Task 1.2.6.

FEPA Step 2: Site assessment

- Visit the site. Verify that the river/wetland ecosystem types or fish sanctuary for which the FEPA has been selected exist on the ground. Check that the FEPA or fish sanctuary is not heavily modified.

See “2.1.2 Step 2: Conduct the site visit - “The study area” under Task 1.1.1 - Task 1.2.2

- Ground-truth the location of the FEPA (e.g. the river, the associated sub-quaternary catchment, and any wetland FEPAs that fall within the sub-quaternary catchment);

See “Critical Biodiversity Areas” under Task 1.2.6.

- Type the FEPA according to the river and wetland ecosystem types used by NFEPA;

See “Critical Biodiversity Areas” under Task 1.2.6.

- Examine the surrounding sub-quaternary catchment, looking at the condition and location of other FEPAs, and other freshwater ecosystems in good condition, and/or of apparent ecological importance and/or sensitivity;

See “Present Ecological State of the Brak River” under EcoClassification

- Determine current condition (present ecological state) and compare with modelled condition: EcoStatus (Present Ecological State) for rivers – *primary data should be collected wherever possible*.

See “Present Ecological State of the Brak River” under EcoClassification

FEPA Step 3: Delineate the ecosystem

- Map the extent of the FEPA accurately, using the DWA protocol for delineation of wetlands and riparian areas (DWAF, 2005);

See: Results of Ecological Surveys - Vegetation: Riparian delineation under Task 1.2.3.3.2 Vegetation

- Determine the appropriate buffer width, using accepted national protocols.

See: Land-use guidelines under Task 1.2.3.3.2 Vegetation

FEPA Step 4: Assess the significance of the impact of the proposed development

- Determine ecological importance and sensitivity (EIS) using DWA protocol, and compare with FEPA status – examine the reasons why ecosystem has achieved FEPA status, and check whether these are correct and complete, if so, these should be used in the determination of EIS – *primary data should be collected wherever possible*;

See "Present Ecological State of the Brak River" under EcoClassification

- Assess the significance of impacts. The degree of significance will depend on the degree of deterioration in ecological condition that would result from the proposed development as well as its reversibility (e.g. whether the impact is short-term, medium-term or long-term).

See "When significant impacts are unavoidable - CBAs and ESAs" under Task 1.2.5.

- Deterioration of a FEPA from a B ecological condition to a C condition might be considered an impact of medium significance but should never be considered of low significance.

This level of deterioration is not envisaged.

FEPA Step 5: Make recommendations

- Consult the NFEPA ecosystem management guidelines, and apply these to the development application;

See "Step 4: Identify opportunities to conserve biodiversity" under Mitigation.

- Develop suitable and realistic mitigation measures;

See "Step 5: Incorporate biodiversity priorities in EIA report" under Mitigation.

- Determine rehabilitation requirements, in order to meet management objectives for FEPAs;

See "Step 5: Incorporate biodiversity priorities in EIA report" under Mitigation.

Design a monitoring programme that aims to track the impacts associated with the development and how these affect the condition of the affected FEPAs.

Task 3.2 Provide an assessment of the risks associated with the water use/s and related activities.

a) **Section 21(c) and (i) Risk-Based Assessment and Authorisation Guideline (DWS, Edition 02, final October 2014)**

In terms of section 22 of the NWA a person may only use water if it is permissible under Schedule 1, a continuation of an Existing Lawful Use (ELU), a General Authorisation (GA), a licence or the requirement for a licence has been dispensed with under section 22(3).

There are 11 different types of water uses contemplated in terms of the NWA Section 21, but the purpose of this Risk-Based Water Use Authorisation Guideline is to deal with section 21(c) and (i) water uses only.

Water use in terms of section 21(c) and (i) of the NWA is:

- (c) impeding or diverting the flow of water in a watercourse; and
- (i) altering the bed, banks, course or characteristics of a watercourse.

Unlike some water uses referred to in Section 21, e.g. (a) and (b) which are consumptive and which impacts are usually clearly evident, easier to manage and quantifiable, section 21(c) and (i) water uses are non-consumptive and their impacts more difficult to detect and manage. They are also generally difficult to clearly quantify.

However, if left undetected these impacts can significantly change various attributes and characteristics of a watercourse, and water resources, especially if left unmanaged and uncontrolled. Thus, the risks posed by Section 21(c) and (i) water uses on watercourses and water resources are an important consideration during the authorisation of these water uses.

Risk-Based Management is an adaptive management approach used for assessing and managing the impacts of particular water uses on a watercourse, the risks and hazards these pose and actions required to mitigate them. It is a very prudent and effective approach to be used in instances where the easy detection and quantification of impacts and risks are difficult to achieve.

b) **Risk Assessment using the Risk Matrix**

The Risk Assessment was done in accordance with the Risk Matrix (Based on DWS 2014 publication: Section 21 c and I water use Risk Assessment Protocol and as contained as Appendix A in GN509 of 26 August 2016) and it was carried out considering the risk rating of the proposed project activities after implementing mitigation measures.

Detailed methodology regarding the risk assessment is provided in Appendix 4.

4. Results

4.1 Locality

Task 1.1.1. Provide a description of the location of the watercourse at which the water use/s is to take place

The proposed location (Figure 9) is on the Remainder of Farm Goedehoop 26 C, Portion 6 of Leuwe Fountain 27 C, Remainder of Farm Riet Fountain 39 C, Portion 1 of Farm Riet Fountain 39C, Remainder of Kwanselaars Hoek 40 C, Portion 1 of Kwanselaars Hoek 40 C, Portion 4 of Taaibosch Fontein 41C, Portion 1 of Farm Kafferspoort 56C, registration district Hanover, Emthanjeni Local Municipality, Pixley Ka Seme District Municipality; Northern Cape Province (Figure 8).

The 21-digit Surveyor General Codes of each cadastral land parcel are as follows:

- Remainder of Farm Goedehoop 26C C03000000000002600000
- Portion 6 of Leuwe Fountain 27C C03000000000002700006
- Remainder of Farm Riet Fountain 39C C03000000000003900000
- Portion 1 of Farm Riet Fountain 39C C03000000000003900001
- Remainder of Kwanselaars Hoek 40C C03000000000004000000
- Portion 1 of Kwanselaars Hoek 40C C03000000000004000001
- Portion 4 of Taaibosch Fontein 41C C03000000000004100004
- Portion 1 of Farm Kafferspoort 56C C03000000000005600001

The study area lies near the eastern edge of the Nama Karoo biome, and is mapped as Northern Upper Karoo vegetation type. The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic. The vegetation cover is generally dominated by sparse dwarf karroid scrub and tufted grass with bare patches of sand in between. Portions of the area are in a disturbed condition, most likely as a result of livestock grazing.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System which flows in an arc from south-east to north-west, eventually feeding into the Orange River basin.

The river flows to the north of the study area with a number of its tributaries crossing the area as it flows in a northerly direction. All the small tributaries in the area are ephemera or intermittent and are discernible only as slightly shallow depressions with no clear associated vegetation and slightly clayey soils (Figure 16f).

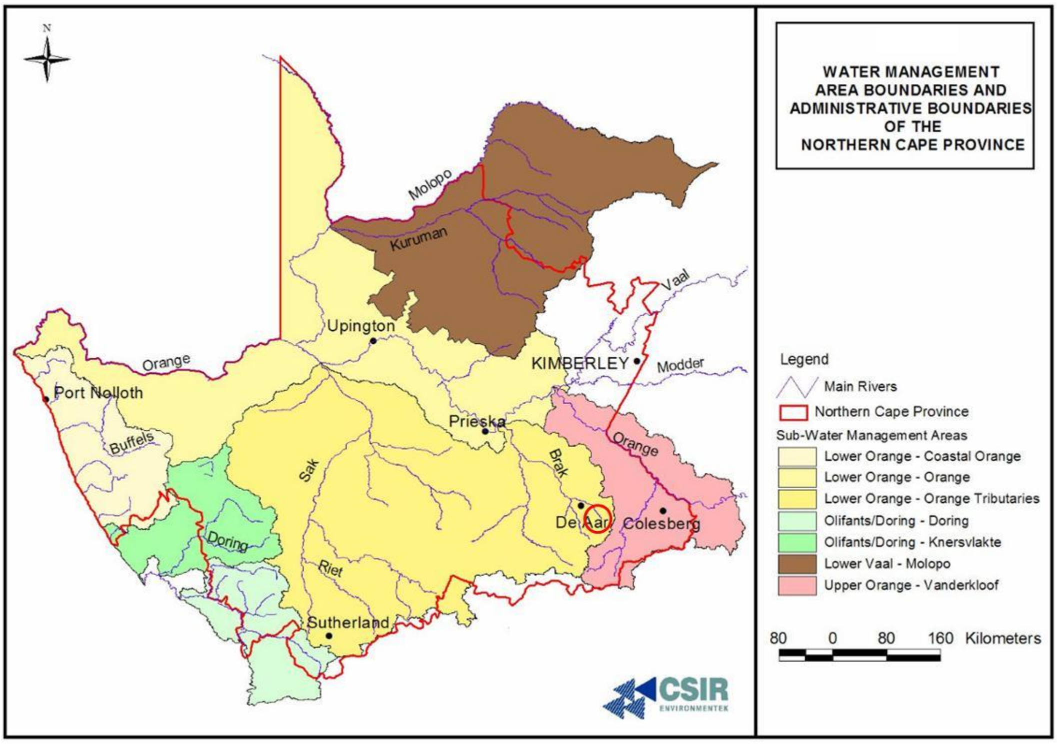


Figure 8: Location of the Soventix Project Area in the Lower Orange Catchment.

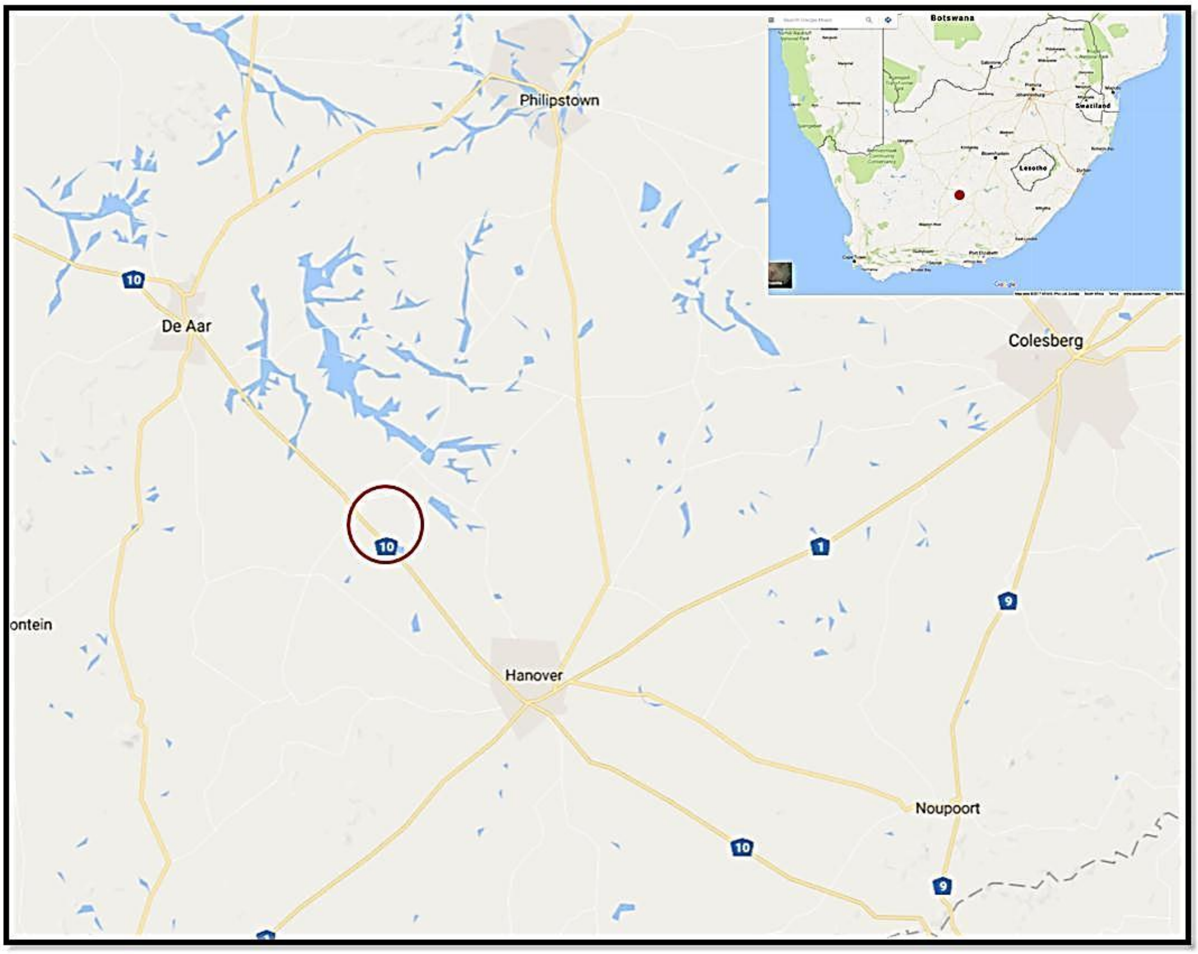


Figure 9: Location of the Soventix Project Area in the Northern Cape.

__**Task 1.1.2** Provide a locality map/s indicating the relevant catchment, surrounding land use, towns, infrastructure etc__.

Figure 10 illustrates the locality of the Brak secondary catchment (D62) with the project area SQ (D62D) situated to the west in the secondary catchment (Figure 11). Surrounding towns is illustrated in Figure 9.

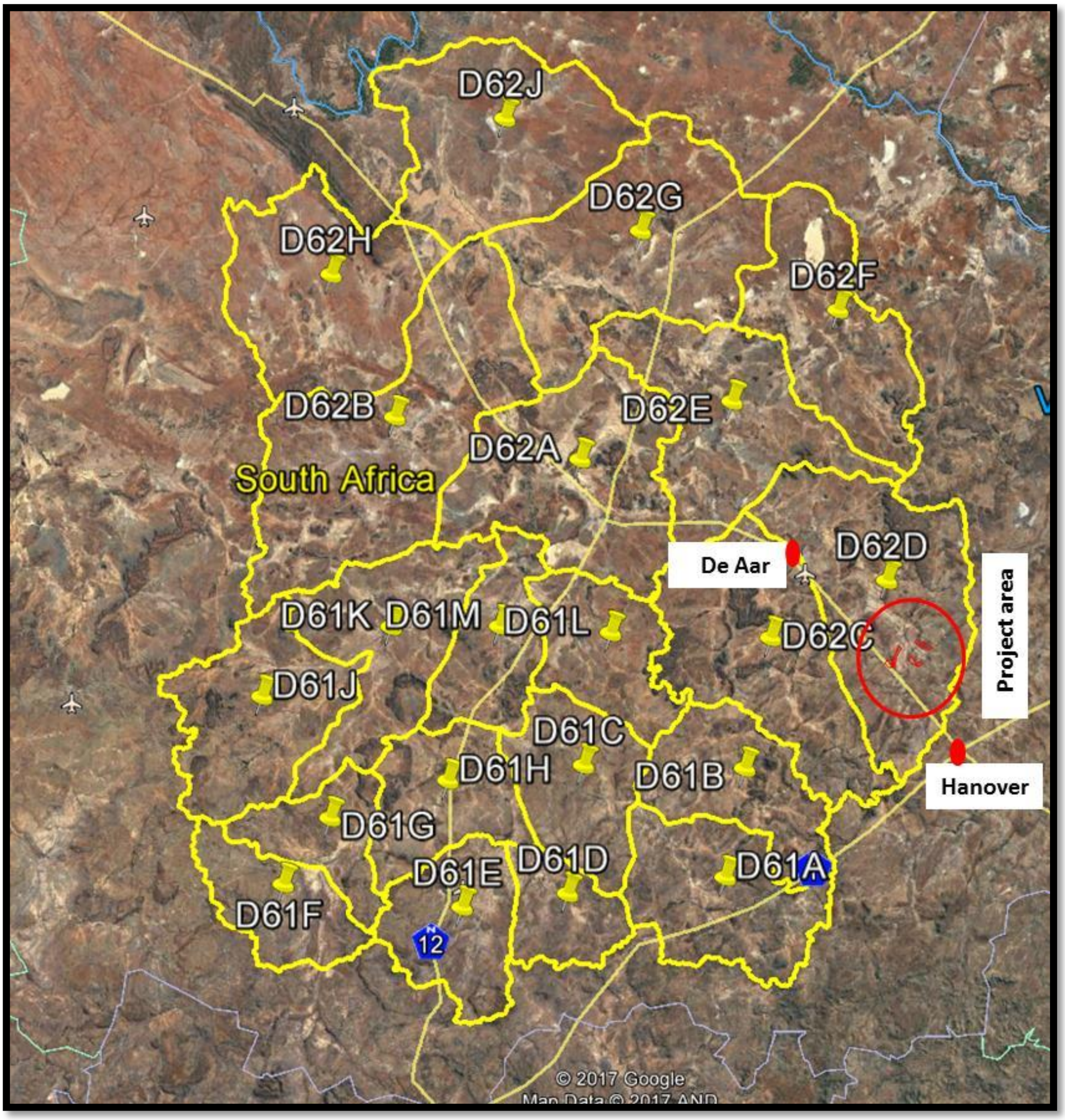


Figure 10: The locality of the Brak secondary catchment (D62) with the project area SQ (D62D) situated to the west in the secondary catchment.

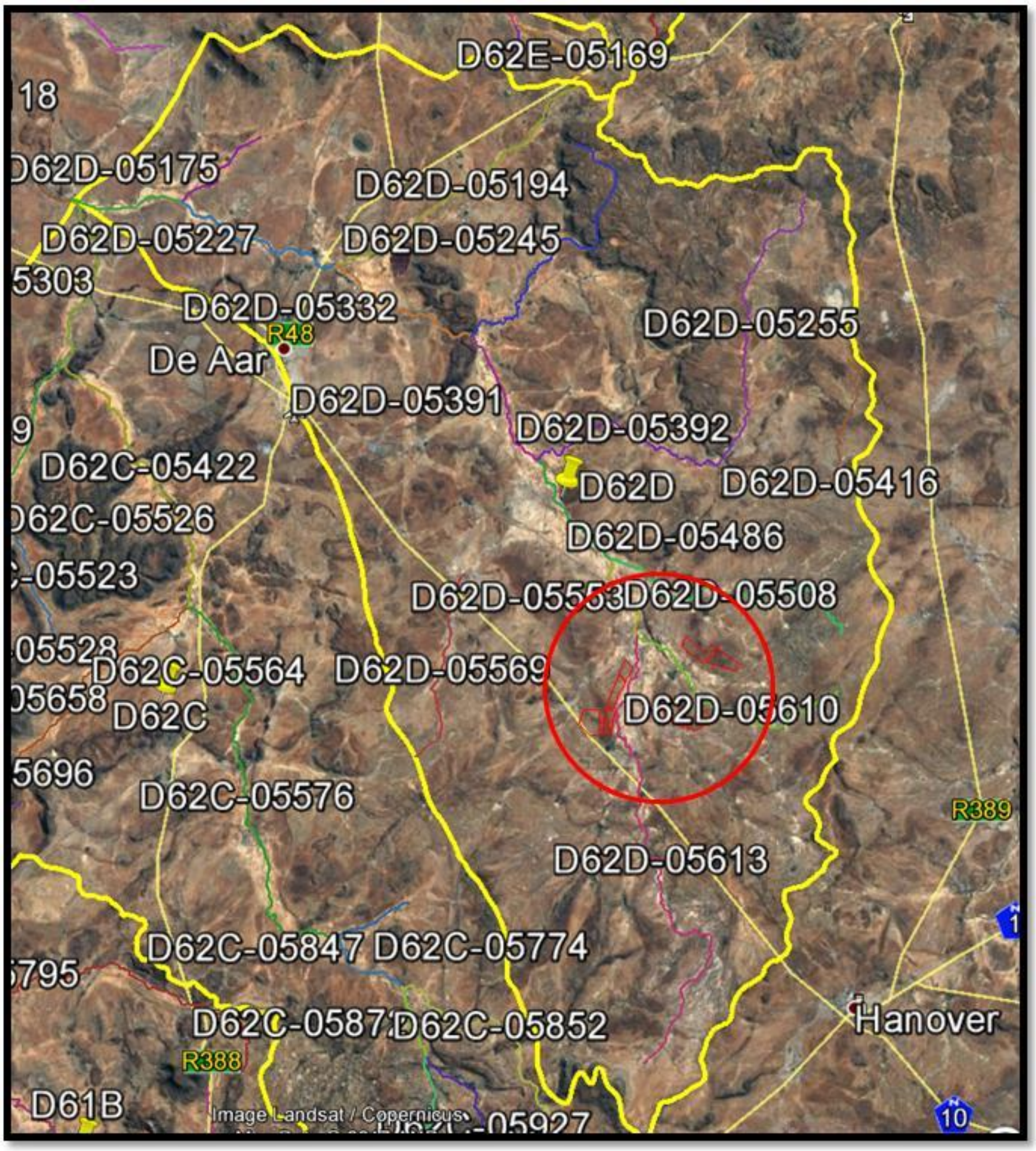


Figure 11: The main SQs in the D62D catchment with the project area circled in red.

Task 1.1.3 Provide the catchment reference number.

The catchment reference numbers were obtained from the DWS PESEIS documents. The Brak River is situated in the D62D catchment, and the Sub-Quaternary Reach that the project is located in, is D62D - 05613 (Figure 12). Another unnamed tributary to the Brak River is D62D – 05610 with its confluence just downstream of the Project Area. After this confluence the Brak River becomes Sub-Quaternary Reach D62D – 05553.

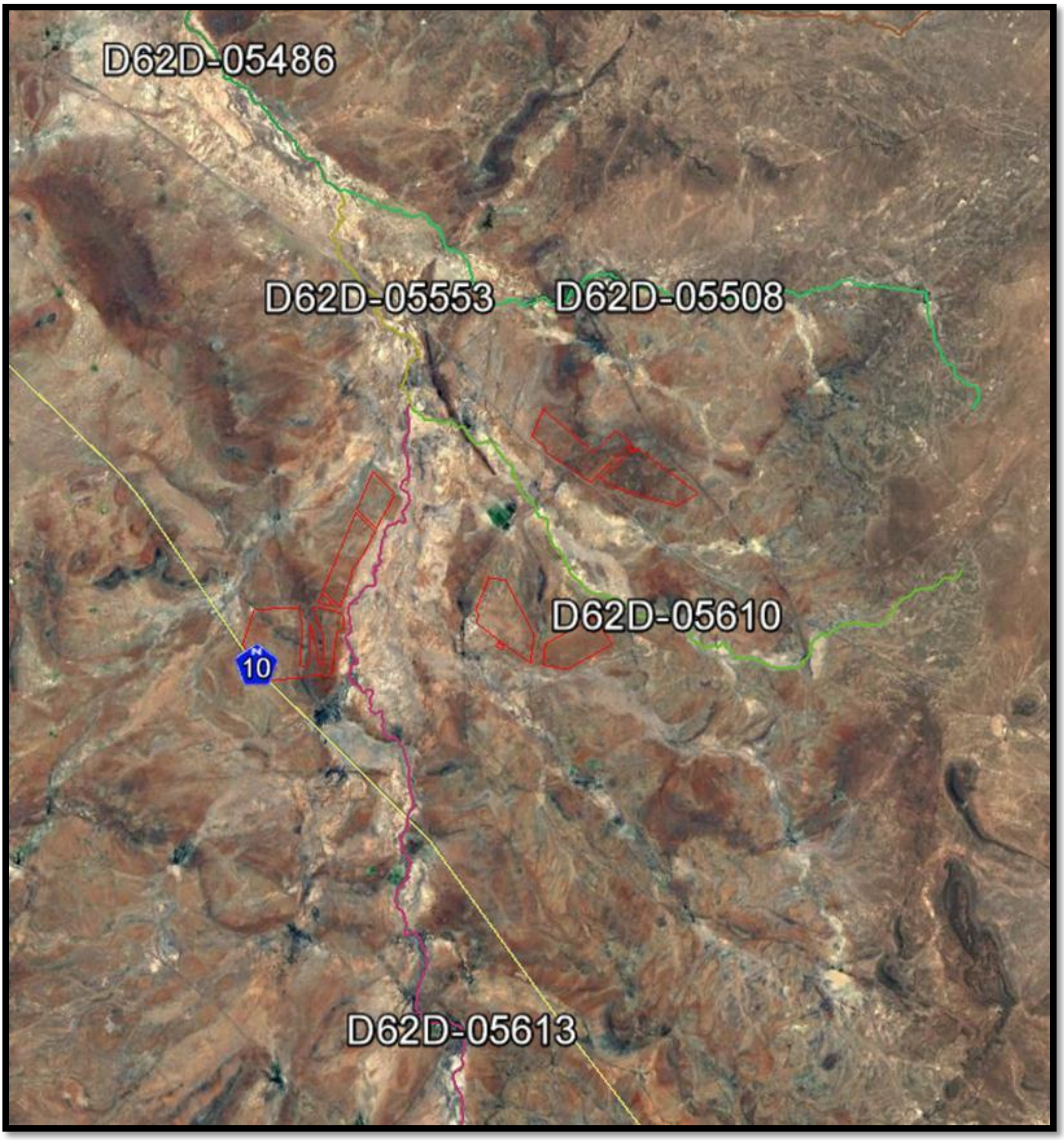


Figure 12: A Google Earth image indicating the location of the Project Area in the Sub-Quaternary Reach D62D - 05613 and D62D – 05610.

4.2 Description

Task 1.2.1 Provide the name and/or description of the affected watercourse.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System. The Soventix project area has no permanent perennial water source although in favourable seasons the Brak River may flow.

The Brak River (Figure 13) is clearly characterised by an azonal vegetation type, allied with Upper Gariep Alluvial Vegetation (Ecoleges Environmental Consultants, 2017). The floodplain has however been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

The Karoo landscape is heavily influenced by the occurrence of dolerite dykes, sills and rings for a description of these geological features which control surface and subsurface drainage patterns and the occurrence of watercourses and wetlands.

According to the definitions in the National Water Act (Act No. 36 of 1998), "water resource" includes a **watercourse**, surface water, estuary, or aquifer. Where an application for a water use license is being applied for, all wetlands within 500 m of the proposed development should ideally be mapped. Seasonal or intermittent rivers are included in the National Wetland Classification System (SANBI, 2009) with the Rivers and streams category:

"Rivers and streams: This type of water resource is described as a channel (river, including the banks) in the National Wetland Classification System (SANBI, 2009). This is defined as *"an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterizes the hydrodynamic nature of these units."* According to the classification system, channels generally refer to rivers or streams (including those that have been canalized) that are subject to concentrated flow on a continuous basis **or periodically during flooding**. This definition is consistent with the NWA (Act No. 36 of 1998) which makes reference to (i) a river or spring and (ii) a **natural channel** in which water **flows** regularly or **intermittently** within the definition of a water resource. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks which can be identified and delineated."

It is important to note that 'Riparian habitat' may be associated with either of these systems and is regarded by DWS as part of the water resource and 'regulated area'. **Riparian habitat** is defined in the NWA (Act No. 36 of 1998) as *"the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."* Areas of riparian habitat which are saturated or flooded for prolonged periods would be considered 'wetlands' (in terms of the NWA) and should be mapped as such. Some riparian areas, however, are not 'wetlands' (e.g. where characteristic riparian trees have very deep roots drawing water from many metres below the surface). These areas do however provide a range of important services that maintain basic aquatic processes, services and values requiring protection in their own right. Where present, the boundary of the riparian habitat should therefore also be clearly delineated (Macfarlane et al 2010.).

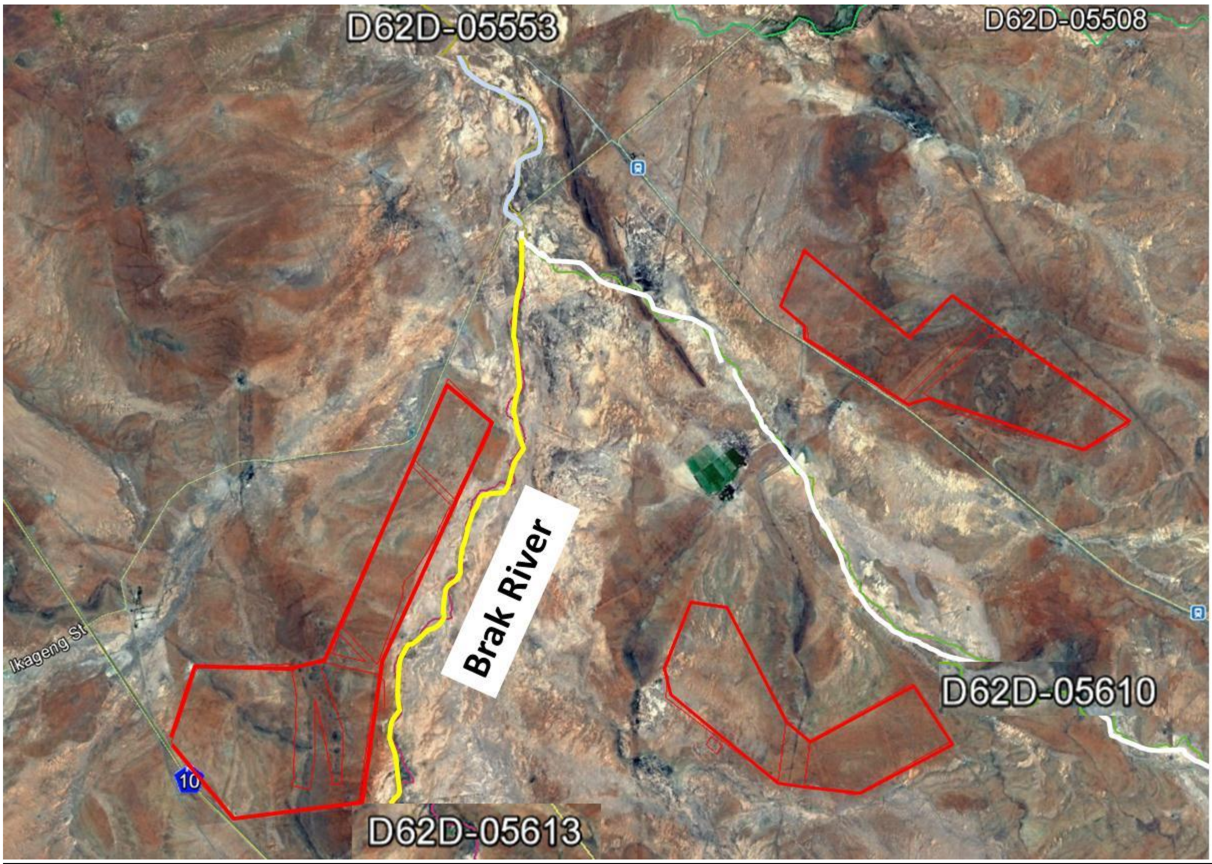


Figure 13: The location of the Brak River and tributaries in the Project Area.

Task 1.2.2 Provide a map indicating the segment and affected reach/es of the watercourse in which the water use/s is to take place and which indicates/delineates the regulated area.

Figure 14 illustrates the map indicating the segment and affected reach/es of the watercourse in which the water use/s.

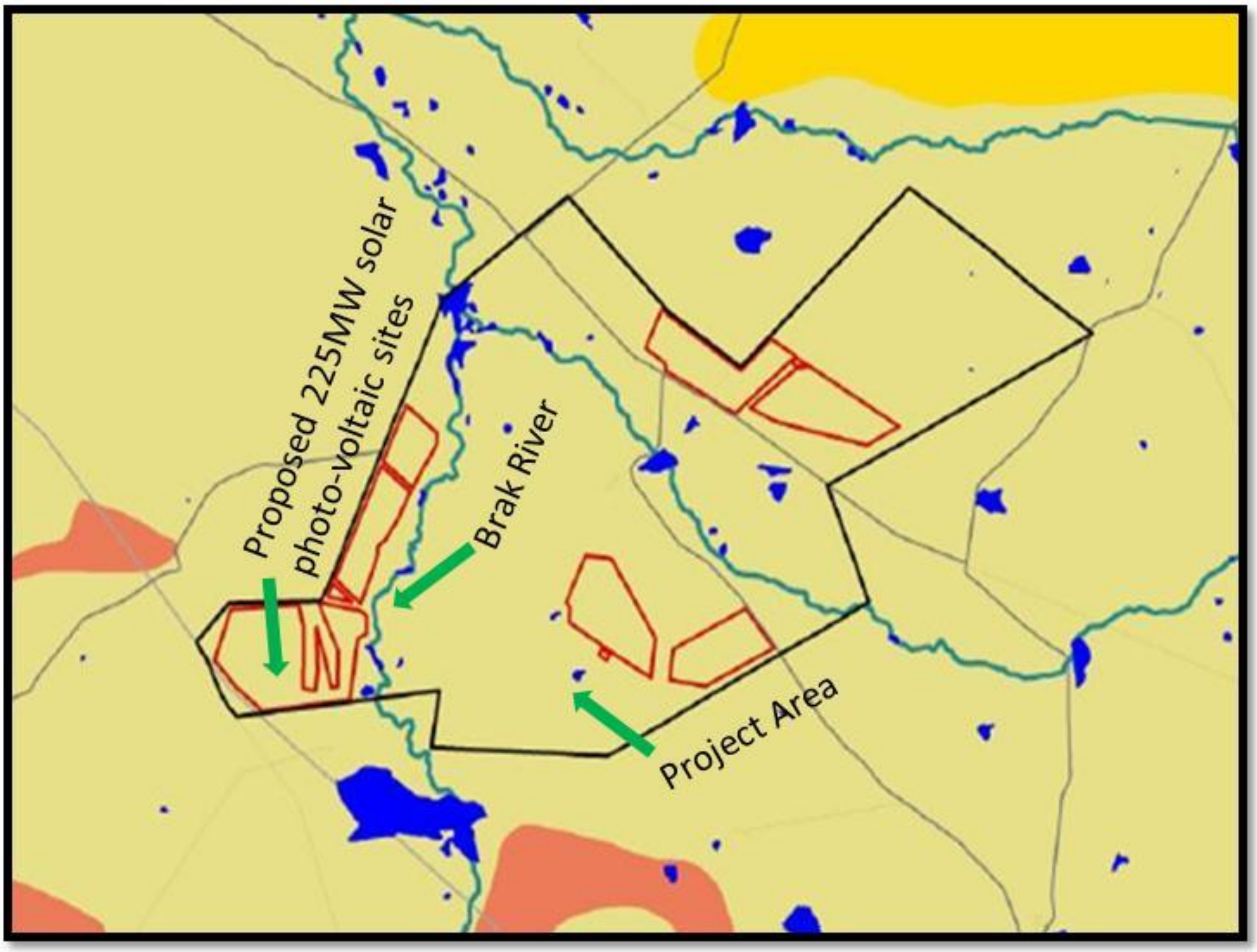


Figure 14: The Project Area on Several Portions of Farms (black demarcated segment), the proposed 225MW solar photo-voltaic (PV) sites (red polygons = three alternative sites) and the Brak River and associated tributaries running through the Project Area.

Task 1.2.2.1 The extent of the riparian habitat.

During the survey of the Soventix project, the drainage line environment was surveyed by doing six riparian transects in the project area. Three transects were surveyed on the D62D-05613 SQ of the Brak River (Figures 20 to 22), two were surveyed on the D62D-05610 SQ of a Brak River tributary (Figures 23 to 24), and Transect 6 evaluated the drainage area where the proposed power line pylons will be situated (Figure 25).

Figure 15 consists of a map which was compiled by using a Google Earth image and it indicates the survey transects on the drainage lines for the Soventix project and also supplies an indication of the many weirs on these drainage lines. These impoundments consist of small- to medium-sized earthen farm dams on the ephemeral rivers and drainage lines (Figure 15). The floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

A dominant feature of the Karoo landscape is the alluvial floodplains, washes and fans. The wetland map compiled for the project area (Figure 19) indicates the extent of these prominent alluvial fans and additional draining channels in the erodible and very dry landscape (Ecoleges Environmental Consultants, 2017). The active channel is only a fraction of the illustrated wetland area. The area analysis of the wetland map is illustrated in Figure 19 (Van den Berg & De Wet, 2017).The alluvial fans (Figure 16c) and erosion dongas (Figure 16d) covers most of the demarcated “wetland” and due to their function, slope and consistency, these areas will only be briefly inundated with surface water during rainy events and the surface water will be rapidly transported to the low-lying active channel of the system. Precipitation in this semi-desert occurs predominantly in the summer months and is unpredictable and sporadic.

These alluvial fans are usually bare soil flats or conduits (Figure 16e), however, in higher lying portions dwarf karroid scrub and tufted grass will colonise. These systems are difficult to classify, as their hydrological characteristics (the way water flows into, through and out of these features) are difficult to determine. They are characterised by multiple channels that traverse a floodplain, valley floor or alluvial fan. Surface water may flow along a particular channel in one year, but owing to little topographic definition or gradient across the landscape, a parallel channel may be eroded the following year, leading to a network of channels. The ecological functioning and importance of these alluvial features are not known.

Viewing the Google Earth image in Figure 15, the outline of the eroded river bed of the Brak River is indistinct and there is very little discernible riparian vegetation (Figure 16f). The ephemeral streams have no visible aquatic vegetation present. The active channel of the Brak River (D62D-05613) is the only natural (excluding artificial dammed areas) drainage line in the study area with weak indicators of riparian vegetation in the river bed and on the river banks. Reeds (Figure 17a) and tall hygrophilic grass can be found in certain areas in the river bed which indicates areas of extended surface water accumulation, or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) can be found in a narrow band in a narrow band along the embankment (Figure 17c) and in some wet patches further away between drainage lines (Figure 17d).

The “riparian zone” is between 1 and 5 meters wide (Figure 17c) and the river bed (Figure 17f) is between 5 and 30 meters wide (Figures 20 to 25). The river bed is only inundated with water during heavy rain downpours or due to damming effects of the many small dams in the system (Figure 16a). Patches of sedges are scattered between dwarf karroid scrub and tufted grass on the river bank (Figure 18a). The lengths of the two prominent drainage lines running through the project area are as follow: D62D-05613 is 9.3 km and D62D-05610 covers 9.0 km.

All the smaller tributaries in the area are ephemeral or intermittent and most are discernible only as slightly shallow depressions (Figure 18b) with no clear associated vegetation and slightly clayey soils. It is clear that during rainy downpours that the rain water spreads evenly over the flat surface and flows in a sheet-like manner to the shallow depressions which represents the drainage line.

Most of the terrestrial areas around these drainage systems in the project area are covered with dwarf karroid scrub and tufted grass (Figure 18a) but devoid of trees or shrubs. Due to the fact that this river is an intermittent river, very little trees are present in the riparian zone.

The site information is summarized in Figures 20 to 25:

Transect 1 represents the upper catchment of the Brak River (D62D - 05613) and the Transect runs over 590m (Figure 20). On the right hand side of the transect the main channel (active channel) is visible as a 1.5 m deep channel with reeds and hygrophilous grass (Figure 17a) on the sandy river bed. To the right of the main channel, are two smaller drainage lines (20-30 cm deep) forming part of the extensive alluvial fan and one drainage lines has sedges and rushes growing in the sand bed (Figure 17b). The higher lying areas or “islands” between the drainage lines are covered with dwarf karroid scrub and tufted grass but devoid of trees or shrubs (Figure 18a).

Transect 2 (Figure 21) represents a much narrower system (143m) of the Brak River (D62D - 05613) and consists of two sandy drainage lines that converge just before a medium-sized earthen farm dam. The main drainage line is flanked by a narrow band of sedges and rushes (Figure 17c). The areas between the drainage lines are covered with dwarf karroid scrub and tufted grass (Figure 18a).

Transect 3 (Figure 22) represents the lower part of the Brak River (D62D - 05613) and consists of the main drainage line that converge with a medium-sized drainage. The main drainage line is flanked by a narrow band of sedges and rushes, and the 1.2 m deep channel is covered with sedges and hygrophilous grass (Figure 17b). A small number of tamarisk trees (Figure 17e) are also growing in the main drainage line. The areas between the drainage lines are covered with dwarf karroid scrub and tufted grass (Figure 18a).

Transect 4 represents the upper catchment of the unnamed drainage line (D62D - 05610) which is a tributary to the Brak River (D62D - 05613). This transect reaches over 154m (Figure 23) and the main drainage line is discernible only as slightly shallow depression (Figure 18b) with no clear associated vegetation and slightly clayey soils. Transect 5 are very similar to the upstream transect (Figure 24). Dwarf karroid scrub and tufted grass (Figure 18a) are the only vegetation present on these two transects.

Transect 6 (Figure 25) is not documented by the DWS database due to its small size and low capacity. This transect was surveyed due to the fact that the power line will traverse through this area. The only visible signs of the drainage line are a shallow depression (25 cm deep) and signs of a watermark behind a diversion wall. Dwarf karroid scrub and tufted grass are the only vegetation present on this transect (Figure 18a).

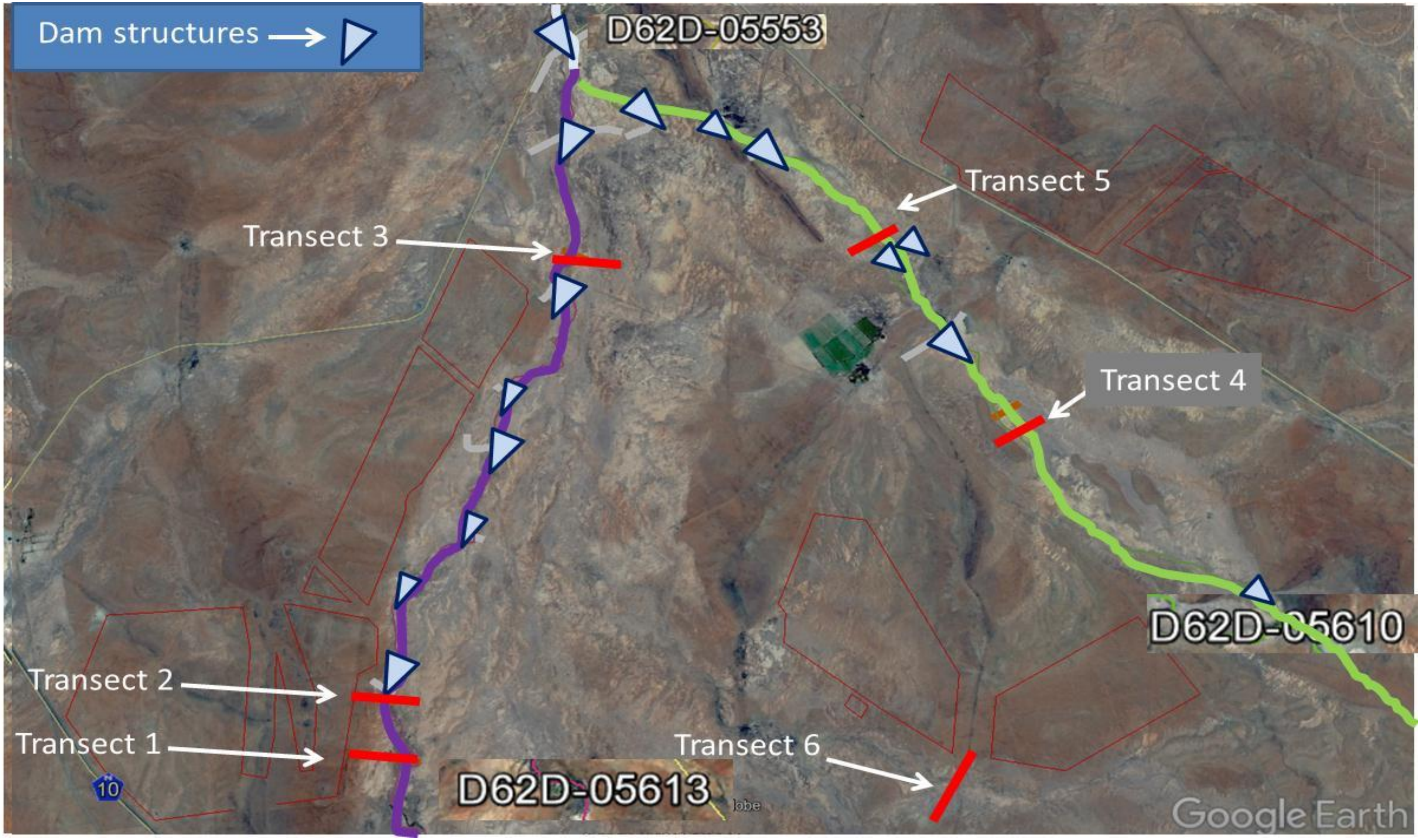


Figure 15: The prominent drainage lines surveyed for the project, indicating the survey transects and also the dam structures on these drainage lines in the project area.

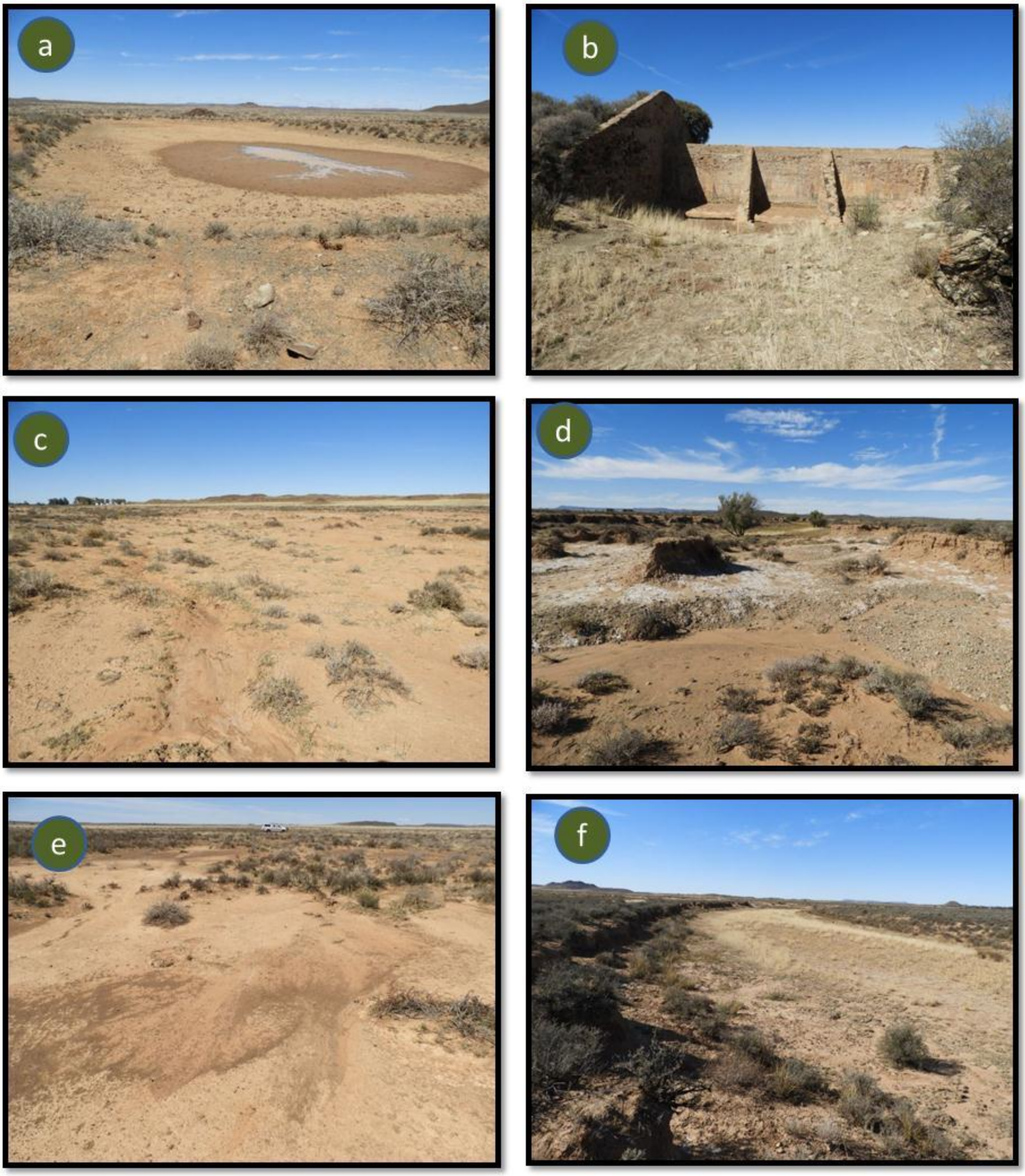


Figure 16a: Small- sized earthen farm dam.

Figure 16b: Medium-sized earthen farm dam

Figure 16c: An alluvial fan.

Figure 16d: An erosion donga.

Figure 16e: Bare soil flats with conduits.

Figure 16f: Very little discernible riparian vegetation on the drainage line banks.

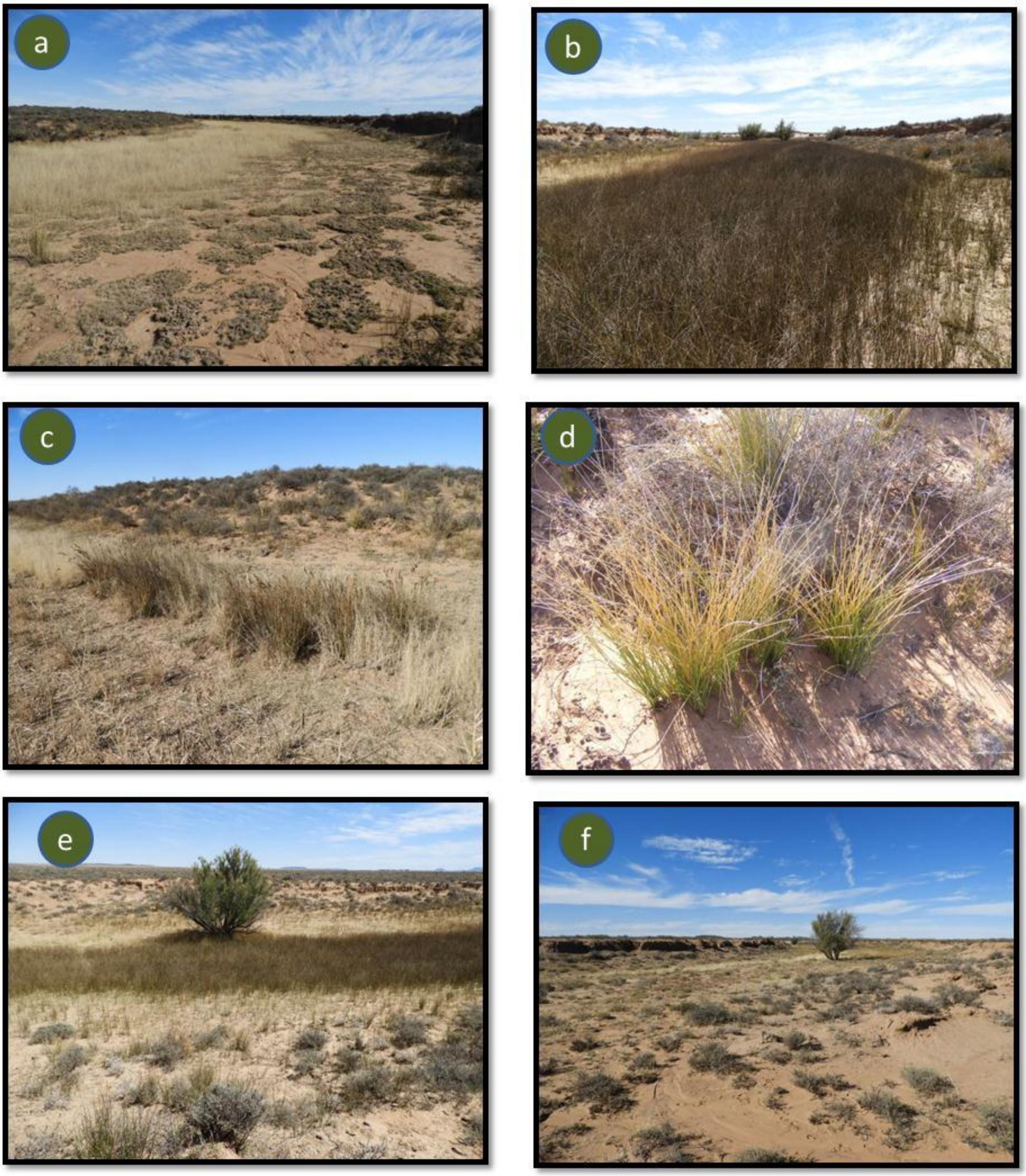


Figure 17a: Reeds and tall hygrophilic grass in the river bed.

Figure 17b: Sedges and rushes the river bed.

Figure 17c: Sedges and rushes in a narrow band in a narrow band along the embankment.

Figure 17d: Sedges and rushes patches further away between drainage lines.

Figure 17e: A tamarisk trees in the river bed.

Figure 17f: The river bed is between 5 and 30 meters wide.

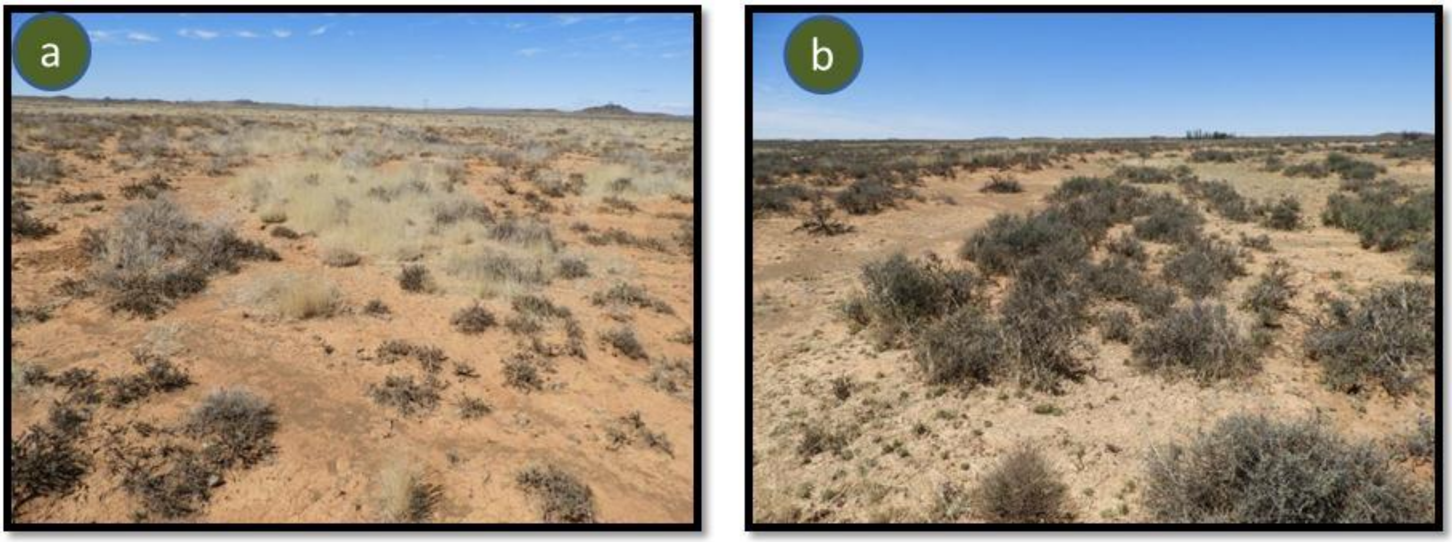
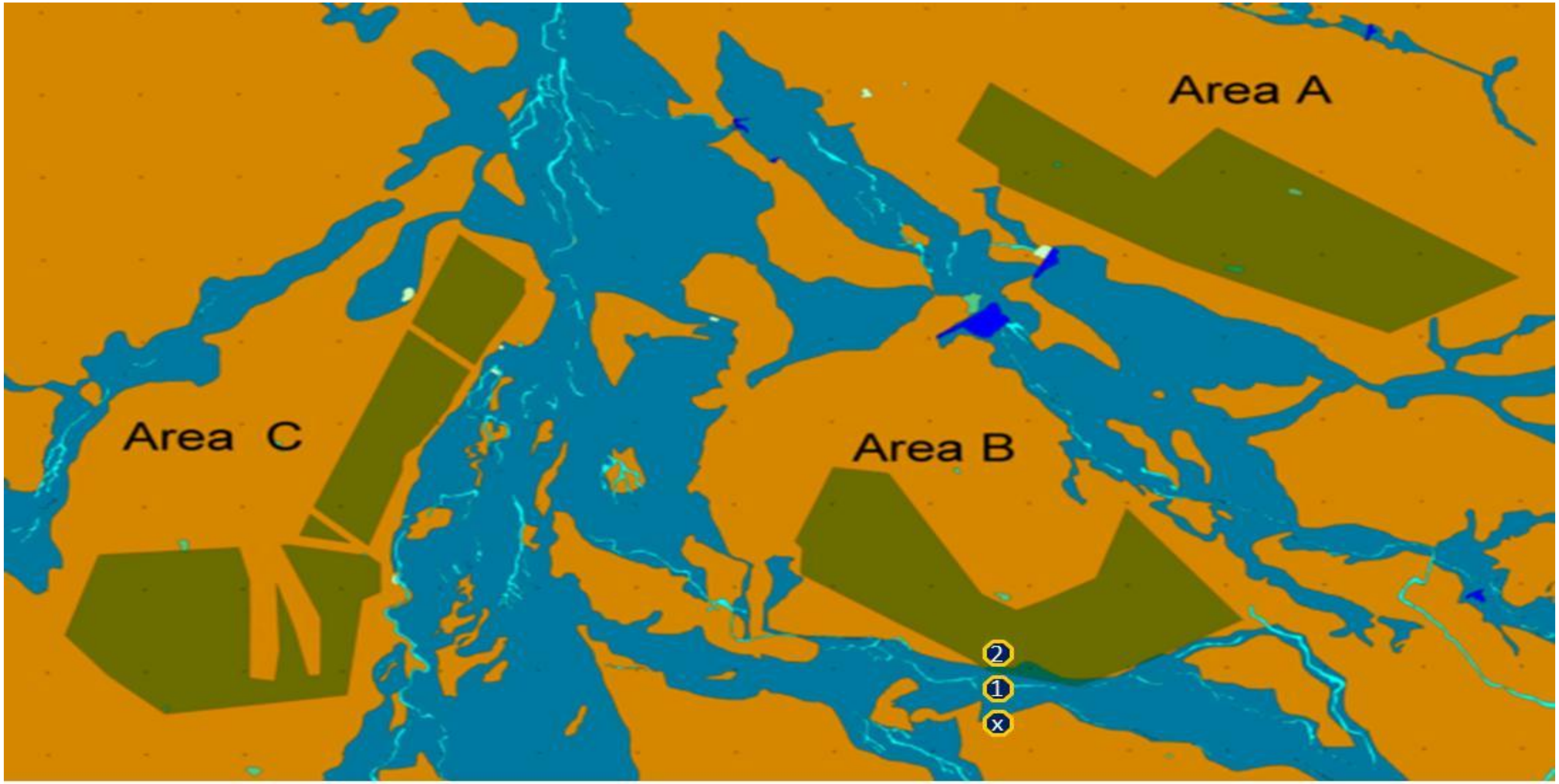


Figure 18a: The areas between the drainage lines are covered with dwarf karroid scrub and tufted grass.

Figure 18b: The main drainage line is discernible only as slightly shallow depression.



Colour	No	Class
	1	Water
	2	Permanent wetland
	3	Seasonal wetland
	4	Floodplain
	5	Streambeds
	6	Non-wetland

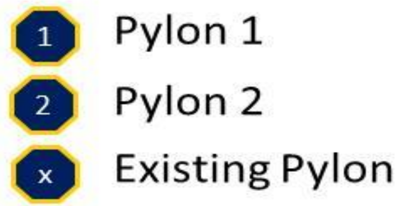


Figure 19: The wetland map compiled for the project area indicates the extent of the alluvial fans (dark blue) and additional draining channels in the erodible and very dry landscape (Van den Berg & De Wet, 2017). The active channel (light blue) is dwarfed by the extensive drainage area (Ecoleges Environmental Consultants, 2017).

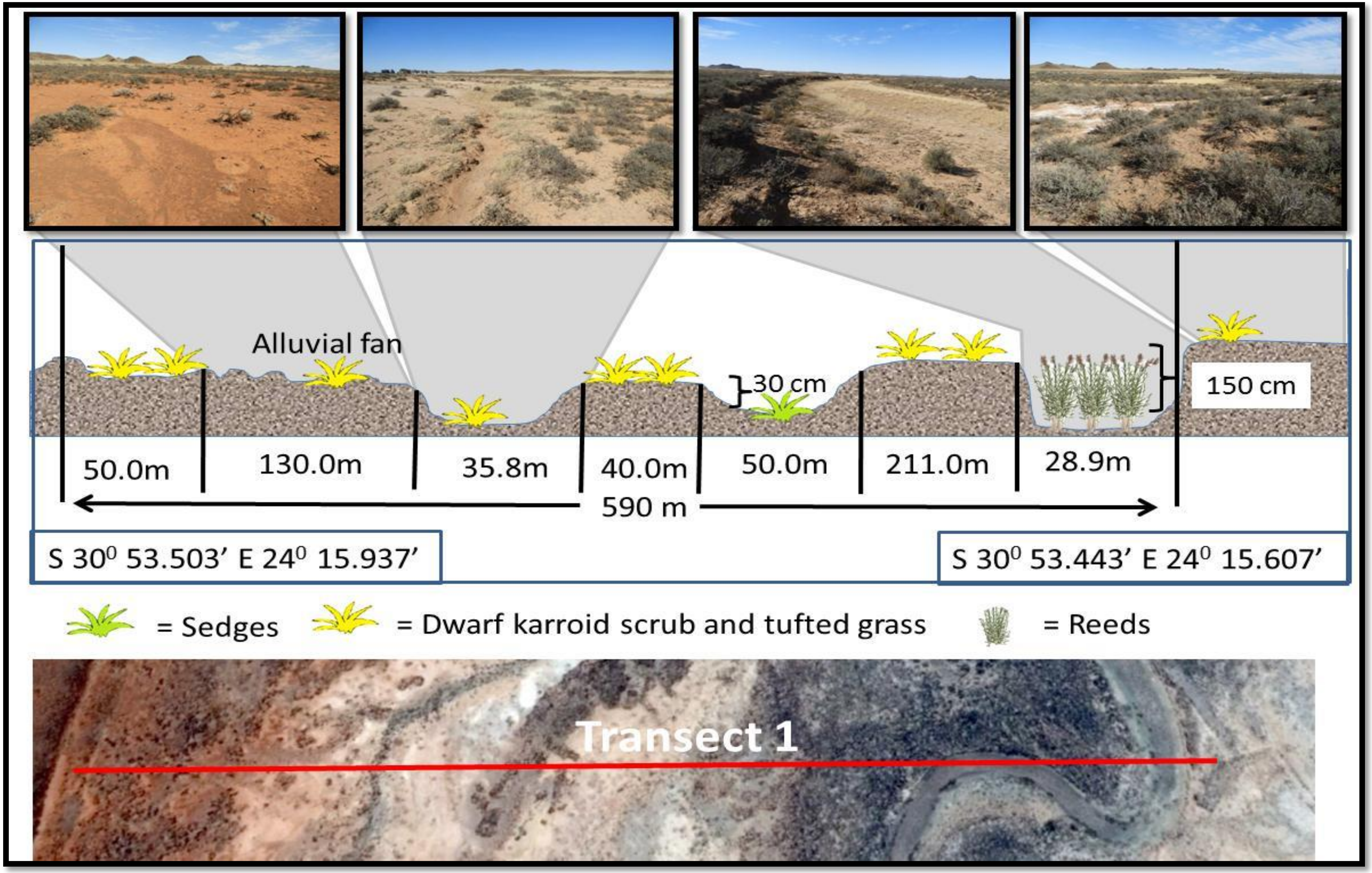


Figure 20: Riparian Transect 1 - Brak River D62D - 05613 (Coordinates: S 30^0 53.503 E 24^0 15.937).

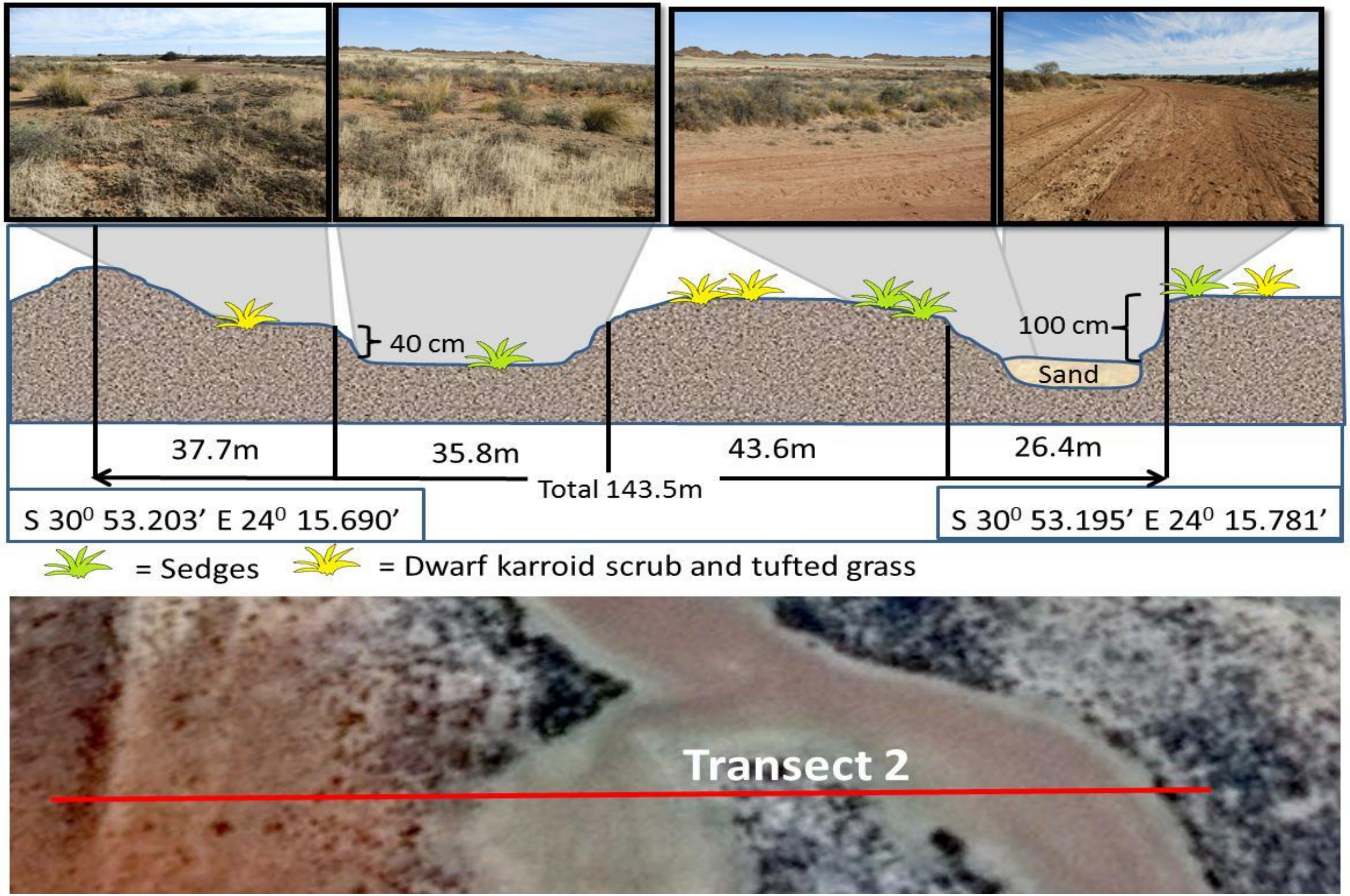


Figure 21: Riparian Transect 2 - Brak River D62D - 05613 (Coordinates: S 30^0 53.203' E 24^0 15.690').

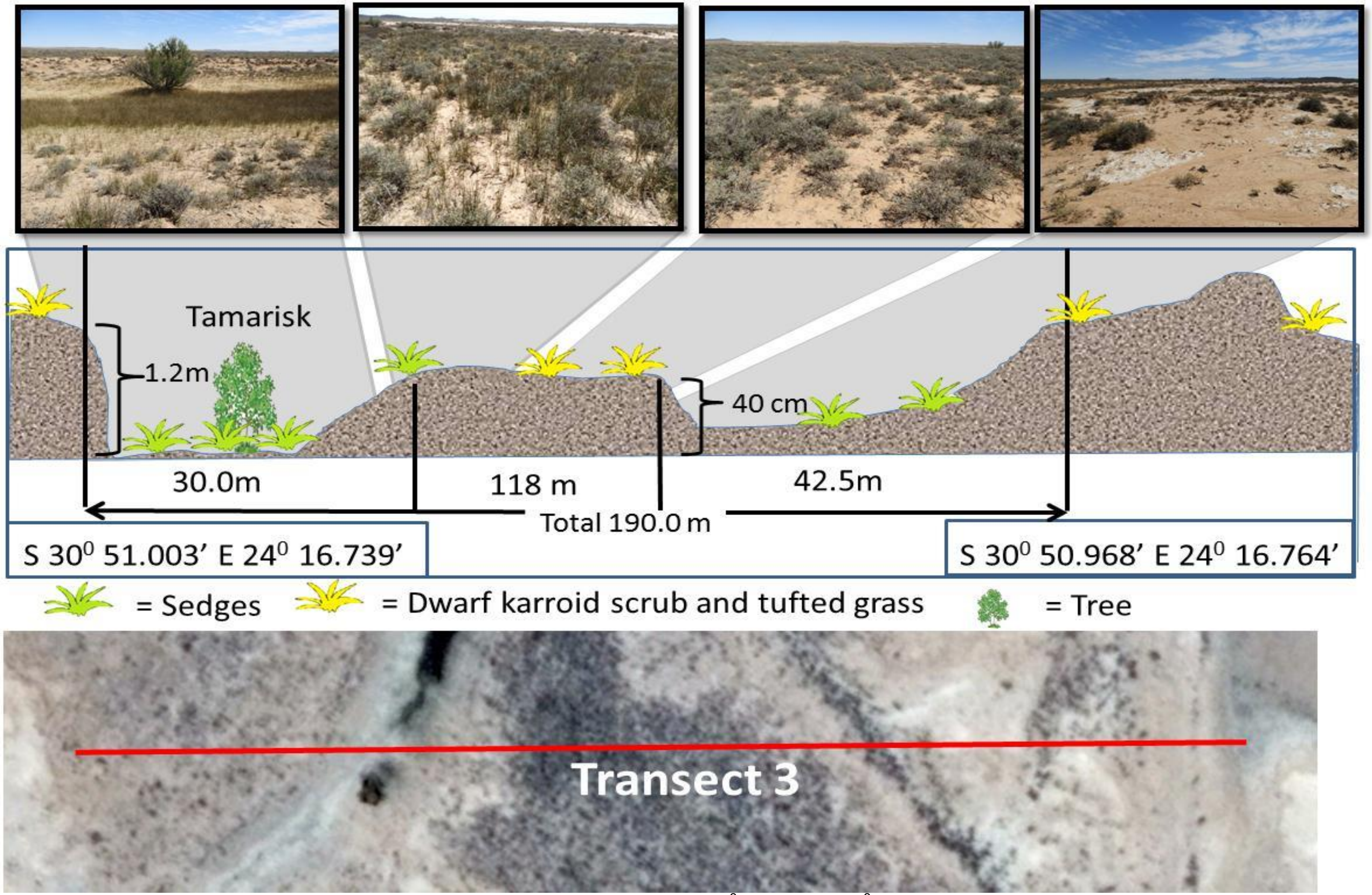


Figure 22: Riparian Transect 3 - Brak River D62D - 05613 (Coordinates: S 30^0 51.003' E 24^0 16.739').

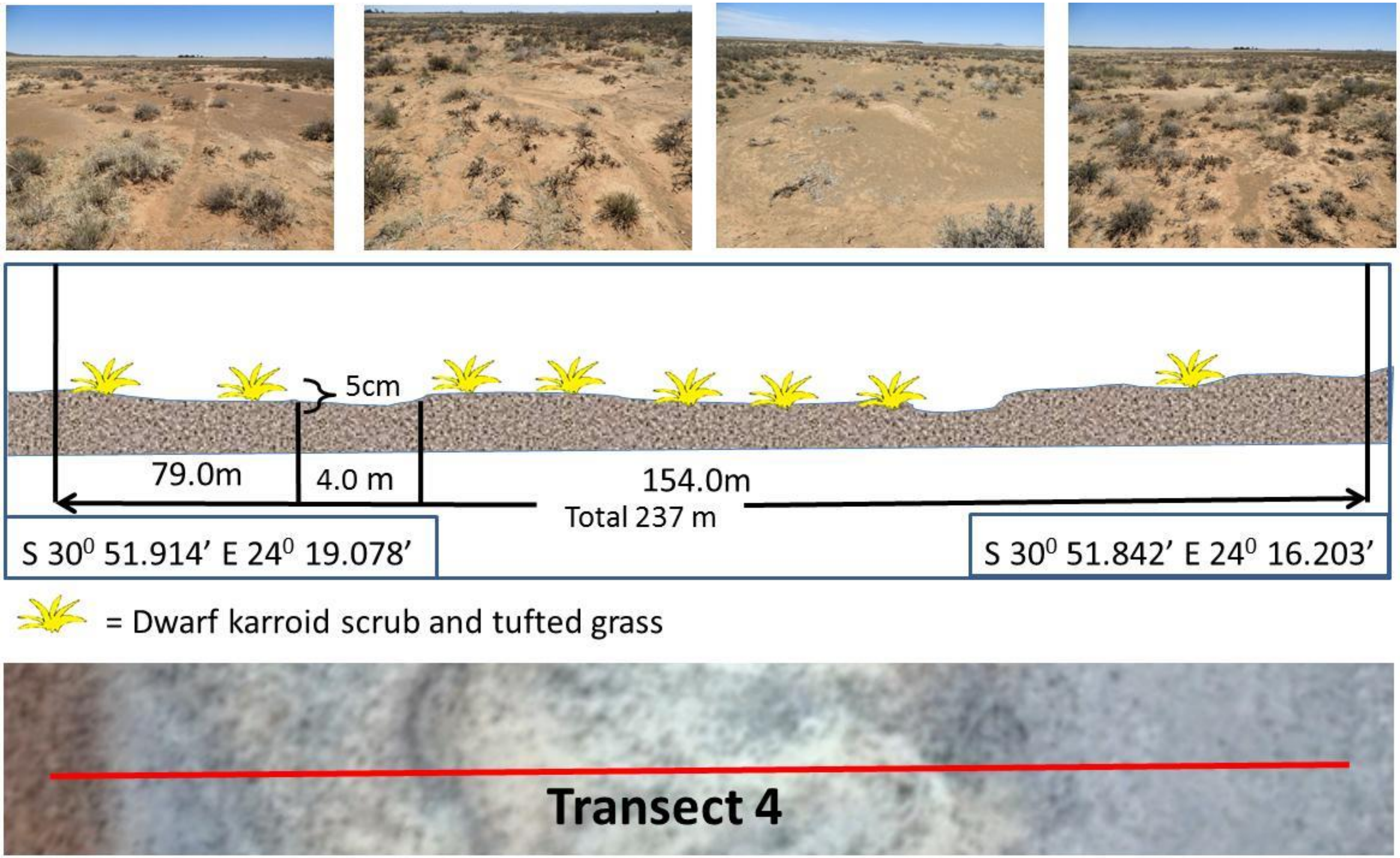


Figure 23: Riparian Transect 4 – Unnamed tributary to the Brak River D62D - 05610 (Coordinates: S 30^0 50.914' E 24^0 19.078').

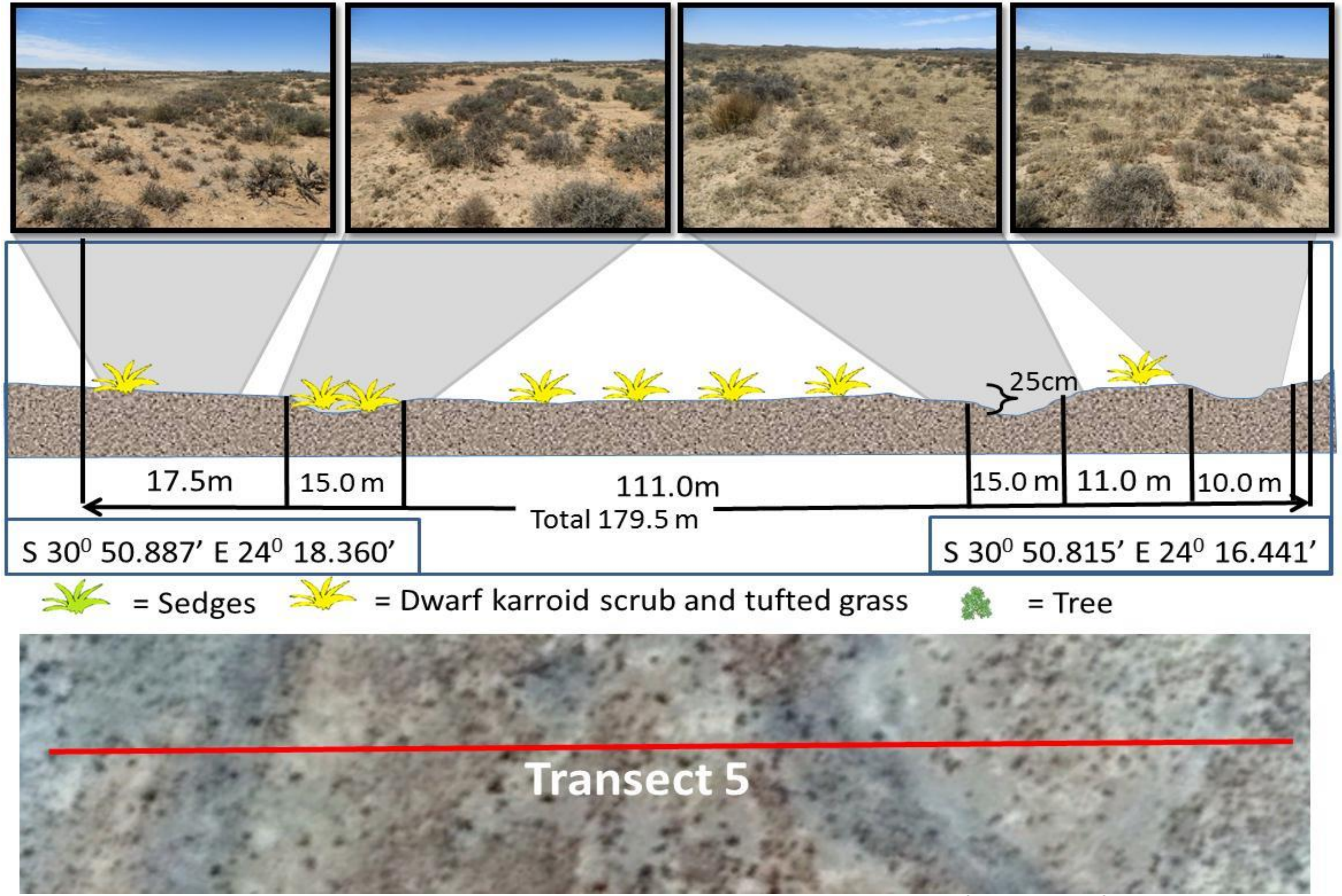


Figure 24: Riparian Transect 5 – Unnamed tributary to the Brak River D62D - 05610 (Coordinates: S 30^0 50.887' E 24^0 18.360').

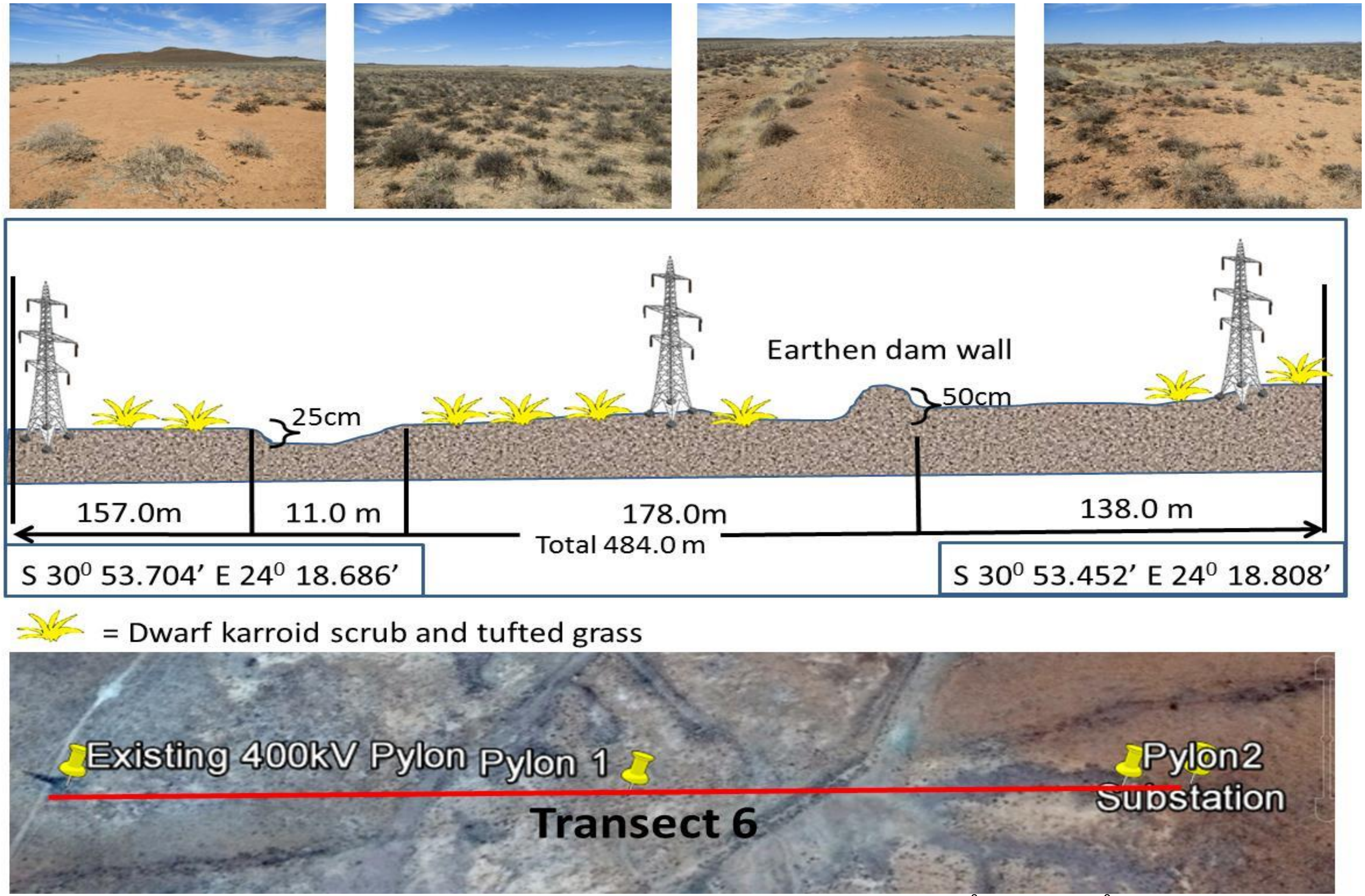


Figure 25: Riparian Transect 6 – Unnamed tributary to the Brak River D62D - 05610 (Coordinates: S 30^0 53.704’ E 24^0 18.80’).

Task 1.2.3 Present Ecological State or PES

Describe within context of the immediate catchment and segment, the historic as well as current state (Present Ecological State or PES) of the affected reach/es of the watercourse with regards to the following characteristics (attributes):

1.2.3.1. Flow and sediment regimes at appropriate flows

1.2.3.2. Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime

1.2.3.3 Riparian and Instream Habitat.

The determination and categorisation of the Present Ecological State (PES) takes place during the process of the Ecological Classification process. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

During the EcoClassification process, the EcoStatus is also determined. EcoStatus represents an ecologically integrated state representing the **drivers** (hydrology, geomorphology, physico-chemical) and **responses** (fish, aquatic invertebrates and riparian vegetation). The EcoStatus refers to the integration of physical changes by the biota and as reflected by biological responses.

The development of methods to achieve the objectives of this study, focussed on a two-step process –

- Devising consistent indices for the assessment of the Ecological Categories of individual biophysical components.
- Devising a consistent process whereby the Ecological Categories of individual components can be integrated at various levels to derive the EcoStatus of the river.

The following index models were developed following a Multi Criteria Decision Making Approach (MCDA):

- Hydrological Driver Assessment Index (HAI)
- Geomorphology Driver Assessment Index (GAI)
- Physico-chemical Driver Assessment Index (PAI)
- Fish Response Assessment Index (FRAI)
- Macro Invertebrate Response Assessment Index (MIRAI)
- Riparian Vegetation Response Assessment Index (VEGRAI)

Due to the complexity of the HAI, GAI and PAI (only used during a Comprehensive Reserve Determination) the EcoStatus Level 3 determination has been used for this study. Each of these models result in an Ecological Category expressed in terms of A to F where A represents the close to natural and F a critically modified condition.

Task 1.2.3.1. Flow and sediment regimes at appropriate flows.

The Brak River of the SQ reach D62D-05613 has a length of 41 km of which the last 10 km runs through the project area.

River classification

In order to assess the condition and ecological importance and sensitivity of the rivers in the study area, it is necessary to understand how the rivers might have appeared under un-impacted conditions. This is achieved through classifying rivers according to their ecological characteristics, in order that it can be compared to ecologically similar rivers.

River typing or classification involves the hierarchical grouping of rivers into ecologically similar units so that inter- and intra-river variation in factors that influence water chemistry, channel type, substratum composition and hydrology are best accounted for (DWA 2005). Any comparative assessment of river condition should only be done between rivers that share similar physical and biological characteristics under natural conditions. Thus, the classification of rivers provides the basis for assessing river condition to allow comparison between similar river types. The primary classification of rivers is a division into Ecoregions. Rivers within an ecoregion are further divided into sub-regions (Belcher, 2013).

Ecoregions are groups of rivers within South Africa, which share similar physiography, climate, geology, soils and potential natural vegetation. For the purposes of this study, the ecoregional classification presented in Department of Water Affairs and Forestry in 1999 (DWAF, 1999), which divides the country's rivers into ecoregions, was used. The river assessed lies within the Nama Karoo Ecoregion, with the characteristics as described in Table 5.

Sub-regions (or geomorphological zones) are groups of rivers, or segments of rivers, within an ecoregion, which share similar geomorphological features, of which gradient is the most important. The use of geomorphological features is based on the assumption that these are a major factor in the determination of the distribution of the biota. Table 5 provides the geomorphological features of the streams assessed.

Table 5. Characteristics of the Nama Karoo Ecoregion (Dominant Types In Bold).

Main Attributes	Description
Terrain Morphology: Broad division	Plains; Low Relief; Plains Moderate Relief; Lowlands; **Hills and Mountains;** **Moderate and High Relief**; Open Hills, Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief
Vegetation types	Eastern Mixed Nama Karoo; Upper Nama Karoo; **Bushmanland Nama Karoo**; Orange River Nama Karoo
Altitude (m a.m.s.l)	300-1700
MAP (mm)	0 to 500
Rainfall seasonality	Late to very late summer to Winter
Mean annual temp. (°C)	12 to 20
Median annual simulated runoff (mm) for quaternary catchment	<5 to 60 mm

River/Site Characterisation

The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic. The Soventix project area has no permanent perennial water source although in favourable seasons the Brak River may flow. There is no water flow data available from DWS for this river reach (DWA Flow data, 2017). All the small tributaries in the area are ephemera or intermittent

The Brak River drains an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017, the river had no water in the system and was not suited to an assessment of aquatic biota present surface. Groundwater interactions are thought to be important for sustaining them.

The peak flow for the area was calculated and evaluated for the node of interest (Jones & Wagener, 2017) and the 1:20, 1:50, 1:100 and Regional Maximum Flood (RMF) are presented in Table 6.

Table 6: Peak flows and catchment area for Node 1

Node	**Peak Flow (m^3/s) for Recurrence Interval**						
	1:2 yr	**1:5 yr**	**1:10 yr**	**1:20 yr**	**1:50 yr**	**1:100 yr**	**RMF**
1	23	38	56	78	117	161	427

The daily simulated runoff volumes averaged to monthly runoff values based on Hydro Zone G, are indicated in Table 7 below.

Table 7: Estimated average seasonal runoff (WR2012) (m^3x10^6).

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Stream flow	0.09	0.26	0.40	0.75	1.96	2.63	1.01	0.20	0.03	0.01	0.05	0.07

Most of the surface water ecosystems in the study area are thus intermittent or ephemeral, being inundated only for brief periods each year, with periods of drought that are predictable in frequency but unpredictable in duration. The low rainfall across the study area means that evaporation is the dominant component of the water balance and while rainfall drives the inundation periodicity of the aquatic ecosystems in the area.

The ephemeral rivers of the Karoo are highly dependent on groundwater discharge, which occurs at springs and when groundwater recharge (through precipitation at higher elevations) allows the water table to intersect with the river channel.

From the Site Characterisation assessments, the geomorphological and physical characteristics of the Brak River tributaries can be classified as shown in Table 8.

Table 8. Geomorphological and Physical features of the Brak River tributaries (Belcher, 2013).

River	Ephemeral tributaries of the Brak River
Geomorphological Zone	Foothill rivers in the Upper Karoo Geomorphic Province
Lateral mobility	Unconfined
Channel form	Complex
Channel pattern	Multiple thread: low sinuosity
Channel type	Silt/clayey with pebbles
Channel modification	Moderate modification (trampling and grazing within river channel, instream impoundments)
Hydrological type	Ephemeral
Ecoregion	Nama Karoo
DWA catchment	D62D
Vegetation type	Northern Upper Karoo shrubland
Rainfall region	Autumn

Task 1.2.3.2. Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime.

DWS has no continuous water quality sampling sites in the Brak River (https://www.dwa.gov.za/iwqs/report.aspx). One sample was collected by DWS on 1987/07/24 in the Brak River and was obtained from the DWS website https://www.dwa.gov.za/iwqs/report.aspx. The results are summarised in Table 9.

Table 9: Median concentrations of water quality parameters at the De Bad sampling site (WMS D62_100917) for the one sample on 1987/07/24 in the Brak River (https://www.dwa.gov.za/iwqs/report.aspx).

Parameter	Brak River
Conductivity	101 mS/m
Ca_Diss_Water	104.3 mg/l
Cl_Diss_Water	80 mg/l
DMS_Tot_Water	749
EC_Phys_Water	101.2 mS/m
F_Diss_Water	1.12 mg/l
K_Diss_Water	3.04 mg/l
Mg_Diss_Water	39.7 mg/l
Na_Diss_Water	59.7 mg/l
NH4_N_Diss_Water	0.04 mg/l
NO3_NO2_N_Diss_Water	5.67 mgN/l
pH_Diss_Water	7.7
PO4_P_Diss_Water	0.014 mgP/l
Si_Diss_Water	13.51 mg/l
SO4_Diss_Water	98 mg/l
TAL_Diss_Water	277.3 mg/l

The Brak River drains an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present.

Ephemeral rivers are particularly vulnerable to changes in hydrology, as they are specifically adapted to brief periods of inundation and flow. Consequently, pollutants and sediments entering these watercourses are not regularly diluted or flushed out of the catchment, leading to a lack of resilience to pollution, erosion and sedimentation.

Task 1.2.3.3 Riparian and In-stream Habitat.

Task 1.2.3.3.1 Morphology (physical structure)

Index of Habitat Integrity (IHI)

The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans 1996).

Habitat integrity assessment is approached from an in-stream and riparian zone perspective. Both of these are formulated according to metric groups, each with a number of metrics that enable the assessment of habitat integrity. The model functions in an integrated way, using the results from the assessment of metric groups, or metrics within a metric group, for the assessment of other metric groups where appropriate.

The Instream Index of Habitat Integrity (IIHI) and the Riparian Index of Habitat Integrity (RIHI) is based on the methods outlined in Kleynhans *et al*., 2008.

Table 10: The in-stream IHI: evaluated for the Brak River in the study area.

	MRU
INSTREAM IHI	
Base Flows	-0.5
Zero Flows	-1.0
Floods	-1.5
HYDROLOGY RATING	**1.0**
pH	0.5
Salts	0.5
Nutrients	0.5
Water Temperature	0.5
Water clarity	0.5
Oxygen	0.5
Toxics	0.5
PC RATING	**0.2**
Sediment	-1.5
Benthic Growth	0.0
BED RATING	**0.6**
Marginal	-2.0
Non-marginal	-1.5
BANK RATING	**1.8**
Longitudinal Connectivity	-2.5
Lateral Connectivity	-2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**78.8**
INSTREAM IHI EC	**B/C**
INSTREAM CONFIDENCE	**3.4**

Table 11: The riparian IHI: evaluated for the Brak River in the study area.

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	-2.0
Moderate Floods	-2.0
Large Floods	-1.5
HYDROLOGY RATING	**1.8**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	0.0
Invasive Alien Vegetation (marginal)	0.0
Invasive Alien Vegetation (non-marginal)	0.0
Erosion (marginal)	0.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	0.5
Physico-Chemical (non-marginal)	0.5
Marginal	1.0
Non-marginal	1.0
BANK STRUCTURE RATING	**1.0**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
RIPARIAN IHI %	**68.8**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.2**

The outcome of the in-stream and riparian IHI evaluated for the Brak River in the study area, resulted in an in-stream IHI of 78.8 (B/C) (Table 10) which classifies as "Largely natural with few modifications" according to the Habitat Integrity Categories in Table 12, or "Good" (Small change) when using the finer detail EC rating table (Appendix). The riparian IHI of 68.8 (C) (Table 11) falls in a "Moderately modified" category (Table 12) or "Fair" (Moderate change) when using the finer detail EC rating table (Appendix 2).

Table 12: The ratings for the Habitat Integrity Categories prescribed to the IHI model (Kleynhans et al, 2008).

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In	0-19

Task 1.2.3.3.2 Vegetation

According to the IHI evaluation (Table 11), the Riparian Zone Habitat Integrity is "Moderately modified" and the C score indicates some impacts at this stage on the riparian habitats:

- Large number of small and medium-sized weirs and dams in the study area;
- Some erosion due to trampling and diversions;
- Small amount of alien vegetation.

Riparian surveys

Riparian delineation

During the process of riparian delineation, 6 transects were surveyed: Three transects were surveyed on the D62D-05613 SQ of the Brak River (Figures 20 to 22), two were surveyed on the D62D-05610 SQ of a Brak River tributary (Figures 23 to 24), and Transect 6 evaluated the drainage area where the proposed power line pylons will be situated (Figure 25). A transect runs from the outer edge of one riparian zone (left bank), through the drainage line to the outer edge of the other riparian zone (right bank). The results of the surveys are depicted in Figures 20 to 25 in Task 1.2.2.1.

Figure 26 depicts the Brak River with the delineated active channel of the river and ephemeral tributaries with the proposed 100m buffer zone around the active channel in the project area. This riparian corridor in the area is usually between 1 and 5 meters wide (on both sides of the drainage) with very little discernible riparian vegetation present (Figure 16f).

According to the Northern Cape CBA map (Figure 27), the riverine zone (active channel and associated drainage) along this reach of the Brak River renders the river reach a CBA river (refer to Task 1.2.6 – Sensitive environments). The areas surrounding the drainage lines in the project area (light yellow in Figure 27), is classified as an Ecological Support Area (ESA). The desired management objective for an ESA is to be maintained in a natural, functional state.

The Brak River SQ D62D-05610 is a Critical Biodiversity Area one, while the area surrounding the ephemeral drainage line, is categorised as a Critical Biodiversity Area two (Figure 27). As part of the management objective for the Northern Cape CBA process, the following is suggested:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

The 100 m buffer around the delineated riparian area should be measured from the top of the active channel bank. Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another.

Buffer zones associated with water resources have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include:

- Maintaining basic aquatic processes;

- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

Most of the activities proposed for the Soventix Solar PV project will be taking place outside the riverine environment of the Brak River and ephemeral tributaries (Figure 1). The preferred option of Area B is fittingly distant from the two main drainage lines in the study area (SQs D62D-05613 and D62D-05610 SQ), however the indistinct drainage area to the south of this solar array is adjacent to this development and a power line pylon will be erected in the drainage area (Figure 26).

The implementation of a buffer zone will emphasize the importance of the riverine area and this will certainly augment the importance of the ecology in the project area. The area included in the buffer zone, as well as the core areas in the riverine zone should have explicit and very strict biodiversity conservation management measures and the operating teams should be well aware of this.

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality.

While determining the area and distribution of a core habitat is important, it is equally important that appropriate management measures be determined to ensure the core habitat continues to function effectively. Biodiversity conservation management measures that need to be taken into consideration when determining management measures for core habitats and corridors include:

- Habitat and species management;
- Alien and invasive species management;
- Fire management;
- Grazing management; and
- The management of soil erosion and physical disturbances.

Determining the required buffer width is largely an exercise of assessing the situation and linking it to an acceptable level of risk. Determining appropriate management measures for aquatic impact buffer zones is largely dependent on the threats associated with the proposed activity adjacent to the water resource. These threats include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

A buffer zone of 100m from the delineated riparian zone is therefore suggested. Figure 26 depicts the Brak River delineation in the in the project area with the proposed buffer zone included.

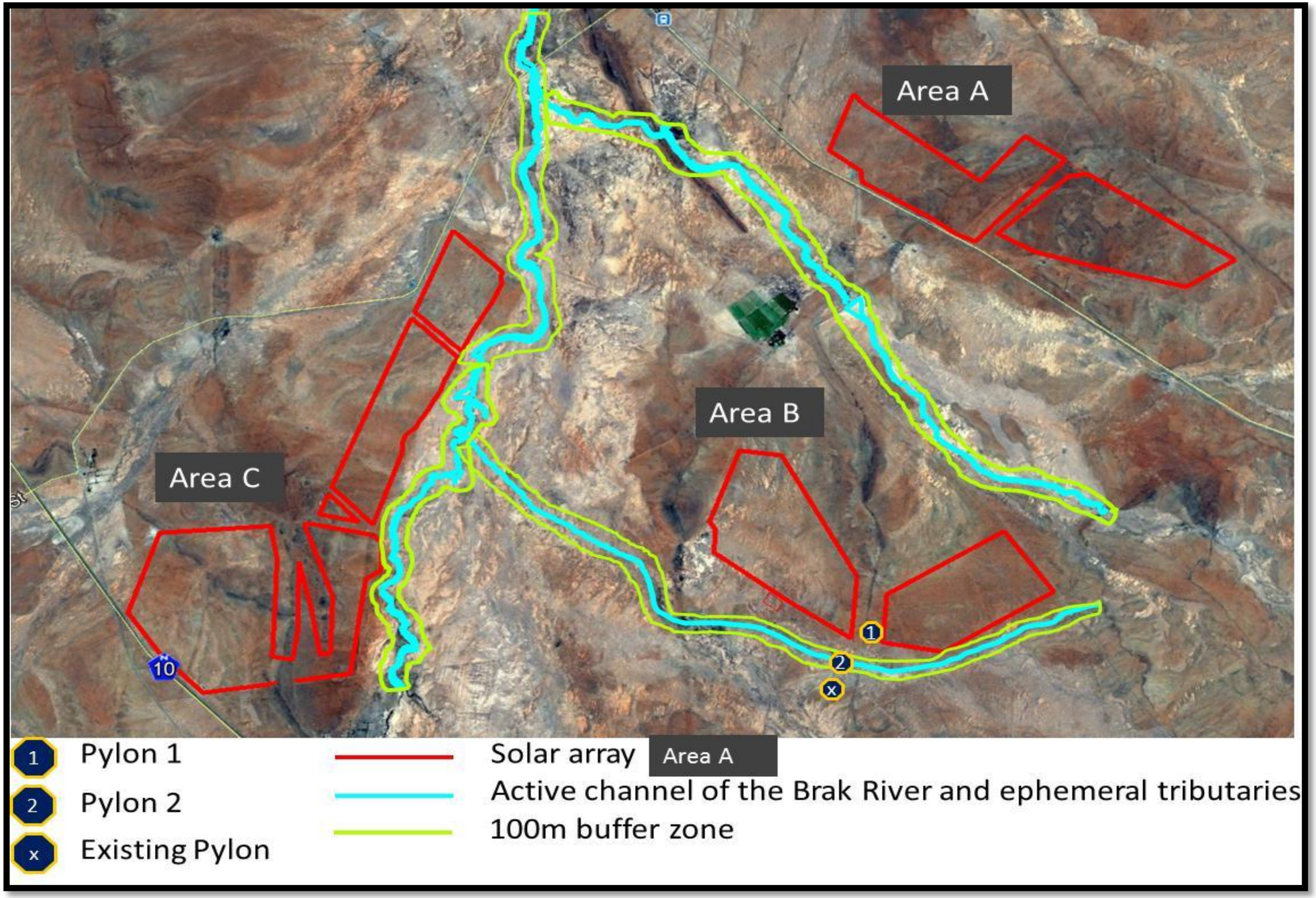


Figure 26: The delineated active channel of the Brak River and ephemeral tributaries (blue lines) with the estimated 100m buffer (yellow-green lines) around the active channel in the project area.

Riparian habitat surveys (Riparian Vegetation Index — VEGRAI)

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

VEGRAI model

VEGRAI has a spread sheet model component that is composed of a series of metrics and metric groups each of which is rated in the field with the guidance of data collection sheets (referred to as field forms).

The metrics in VEGRAI first describe the status of riparian vegetation in both its current and reference states and second, compare differences between the two states as a measure of vegetation response to an impact regime.

The riparian vegetation zones (Marginal, Lower and Upper) are used as the metric groups. For the simplified Level 3 version, the Lower and Upper zones were combined to form the Non-Marginal metric group (zone).

A range of metrics for each metric group is selected of which some are essential for both Levels 3 and 4 (Abundance and Cover) and the others are optional (Species Composition, Population Structure and Recruitment). The metrics are then rated and weighted and an Ecological Category (A-F) determined which represents the Ecological Category for the riparian vegetation state.

Impact evaluation on riparian zone and interpretation

The purpose is to evaluate and interpret the observed impacts at a site in terms of its relative influence on the riparian vegetation according to vegetation removal, alien vegetation invasion, water quantity and quality. The approach followed is that each of these four broad causes of modification relates to and is associated with particular human-related activities that would change the riparian vegetation characteristics directly or indirectly. Some of these changes may occur rapidly while others will occur gradually and only become evident through time.

This approach relates to the National Water Act which aims to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource. The protection of water resource quality is essential to achieve this:

``Resource quality'' means the quality of all the aspects of a water resource including,

- the quantity, pattern, timing, water level and assurance of in-stream flow;
- the water quality, including the physical, chemical and biological characteristics of the water;
- the character and condition of the in-stream and riparian habitat; and
- the characteristics, condition and distribution of the aquatic biota
- considering the functions of the riparian vegetation, these have been summarized as:

- Sediment trapping,
- Nutrient trapping
- Bank stabilization and bank maintenance,
- Contributes to water storage,
- Aquifer recharge,
- Flow energy dissipation,
- Maintenance of biotic diversity,
- Primary production.

Most of these functions relate to in-stream habitat conditions and it follows the basic consideration when assessing the condition of the riparian vegetation, and thus impacts should be interpreted in terms of the influence on the in-stream habitat.

Table 13: A comparative description related to reference and present state of the riparian zone in the project area.

Zones	Impacts	Response Metrics	Description of PRESENT STATE	Description of REFERENCE STATE
Marginal	Vegetation Removal Exotic Vegetation Water Quantity Water Quality	Cover Abundance Species Composition	The “riparian zone” of the Brak River is between 1 and 5 meters wide and the river bed is between 5 and 30 meters wide. Along the active channel (1.0 -1.5 m deep) reeds and tall hygrophilic grass dominates the instream habitat, while there is very little discernible riparian vegetation in the marginal area. Some drainage line tributaries have sedges and rushes growing in the sandy river bed which indicates areas of extended surface water accumulation, or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) can be observed in a narrow band along the embankment. The other ephemeral tributaries have no visible wetland vegetation present. Due to the fact that this river is an intermittent river, very little trees are present along the river banks. There are many impoundments on these drainage lines and they are small- to medium-sized earthen farm dams.	The outline of the river bed of the Brak River was more distinct and much less alluvial fans and additional draining channels in the erodible and very dry landscape than today. The “riparian zone” of the Brak River was between 1 and 5 meters wide and the river bed between 5 and 30 meters wide. Along the active channel (1.0 -1.5 m deep) reeds and tall hygrophilic grass dominated the instream habitat, while very little discernible riparian vegetation was present in the marginal area. Some drainage line tributaries had sedges and rushes growing in the sandy river bed which indicated areas of extended surface water accumulation (much more than today), or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) could be observed in a narrow band along the embankment. The other ephemeral tributaries have no visible wetland vegetation present. Due to the fact that this river is an intermittent river, very little trees was present along the river banks.
Non-marginal	Vegetation Removal Exotic Vegetation Water Quantity Water Quality	Cover Abundance Species Composition	The floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present. All the smaller tributaries in the area	A dominant feature of the Karoo landscape was the alluvial floodplains, washes and fans, however there were less of these features. All the smaller tributaries in the area were ephemeral or intermittent and most were

	are ephemeral or intermittent and most are discernible only as slightly shallow depressions with no clear associated vegetation. The higher lying areas or “islands” between the drainage lines are covered with dwarf karroid scrub and tufted grass but devoid of trees or shrubs. A small number of alien tamarisk trees are growing in the main drainage line. Sedges (*Scirpoides*) and rushes (*Juncus*) are found in some wet patches further away between drainage lines.	discernible only as slightly shallow depressions with no clear associated vegetation. The higher lying areas between the drainage lines were covered with dwarf karroid scrub and tufted grass but devoid of trees or shrubs. Sedges (*Scirpoides*) and rushes (*Juncus*) were found in some wet patches further away between drainage lines.

Table 14: Evaluation of the marginal zone integrity (VEGRAI model) in the project area**.**

	MODIFICATION RATINGS						
CAUSES OF MODIFICATION	**INTENSITY**	**EXTENT**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**			
REMOVAL	1.5	0.5	4.0	Erosion and inundation removed habitat.			
EXOTIC INVASION	0.5		4.0	Only few *Tamarix* trees.			
WATER QUANTITY	3.5	3.5	3.0	Weirs and dams impede subsurface flows.			
WATER QUALITY	2.0	2.0	4.0	Impoundments and evaporation.			
AVERAGE			3.8				
		RESPONSE METRIC RATINGS					
VEGETATION COMPONENTS	**RESPONSE METRIC**	**CONSIDER? (Y/N)**	**RATING**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**		
WOODY	COVER	Y	0.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	0.5	4.0	Maybe some removal by people and erosion.		
	SPECIES COMPOSITION	Y	0.5	4.0	Similar to original.		
			0.5	4.0			
NON-WOODY	COVER	Y	1.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	1.5	3.0	Erosion removed some.		
	SPECIES COMPOSITION	Y	0.0	4.0	Similar to original.		
			1.0	2.3			
VEGETATION COMPONENTS	**CONSIDER? (Y/N)**	**RANK**	**WEIGHT**	**RATING**	**WEIGHTED RATING**	**MEAN CONFIDENCE**	**NOTES: (give reasons for each assessment)**
WOODY	Y	2.0	10.0	0.5	0.05	4.0	Not many natural occurring woody plants in the system.
NON-WOODY	Y	1.0	100.0	1.0	1.00	2.3	More influential in the marginal zone.
					1.05	3.2	

CHANGE (%) IN MARGINAL ZONE CONDITION	**19.1**

Table 15: Evaluation of the non-marginal zone integrity (VEGRAI model) in the project area.

	MODIFICATION RATINGS						
CAUSES OF MODIFICATION	**INTENSITY**	**EXTENT**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**			
REMOVAL	2.0	0.0	3.0	Erosion and inundation removed habitat.			
EXOTIC INVASION	0.5		3.0	Only few *Tamarix* trees.			
WATER QUANTITY	3.5	4.0	3.0	Weirs and dams inundate non-marginal.			
WATER QUALITY	2.0	2.0	4.0	Sedimentation due to erosion and diversion walls.			
AVERAGE			3.3				
		RESPONSE METRIC RATINGS					
VEGETATION COMPONENTS	**RESPONSE METRIC**	**CONSIDER? (Y/N)**	**RATING**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**		
WOODY	COVER	Y	0.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	0.5	4.0	Maybe some removal by people and erosion.		
	SPECIES COMPOSITION	Y	0.5	4.0	Similar to original.		
			0.5	4.0			
NON-WOODY	COVER	Y	2.0	4.0	Erosion and inundation removed habitat.		
	ABUNDANCE	Y	1.5	3.0	Erosion and inundation removed habitat.		
	SPECIES COMPOSITION	Y	0.0	4.0	Similar to original.		
			1.2	2.3			
VEGETATION COMPONENTS	**CONSIDER? (Y/N)**	**RANK**	**WEIGHT**	**RATING**	**WEIGHTED RATING**	**MEAN CONFIDENCE**	**NOTES: (give reasons for each assessment)**
WOODY	Y	2.0	10.0	0.5	0.05	4.0	Not many natural occurring woody plants in the system.
NON-WOODY	Y	1.0	100.0	1.2	1.17	2.3	All that remains of riparian zone.
					1.22	3.2	

CHANGE (%) IN MARGINAL ZONE CONDITION	**22.1**

Table 16: The vegetation integrity evaluation of the riparian zone in the project area.

LEVEL 3 ASSESSMENT						
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**	**NOTES: (give reasons for each assessment)**
MARGINAL	80.9	62.2	3.2	1.0	100.0	Only wetland plants present.
NON MARGINAL	77.9	18.0	3.2	2.0	30.0	Very little wetland plants.
	2.0				130.0	
LEVEL 3 VEGRAI (%)				80.2		
VEGRAI EC				**B/C**		
AVERAGE CONFIDENCE				3.2		

According to the VEGRAI assessment (Table 16) for the Brak River, the Ecological Class is a B/C (80.2%).

The final scores of the VEGRAI assessment regarding the riparian and marginal zone integrity of the Brak River in the project area are presented in Table 17.

Table 17: A summary of the VEGRAI scores of the Brak River in the project area.

Drainage lines	Non-marginal zone condition	Marginal zone condition	Level 3 VEGRAI	VEGRAI EC
% change	19.1%	22.1%	80.2%	B/C

The vegetation integrity score for the Brak River is 80.2%, which represents an Ecological Class B/C (>77.4 and <82.01). This score reflects a "Largely natural with few modifications." status (Table 18), or a "Good – Small change" in the finer detail EC rating table (Appendix 2).

Table 18: Generic ecological categories for EcoStatus components (modified from Kleynhans 1996 & Kleynhans 1999).

ECOLOGICAL CATEGORY	**DESCRIPTION**	**SCORE (% OF TOTAL)**
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.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

Task 1.2.3.4 Biota – Aquatic invertebrates and Fish

Aquatic habitat assessment

Aquatic surveys and bio-monitoring are components of ecological risk assessment and aims to measure present biological conditions and trends in the aquatic ecosystem. It attempts to relate the observed variation to changes in available habitat, as dictated by physical system drivers of the system such as water quality, geomorphology, and hydrology (Kleynhans et al, 2008).

Task 1.2.3.4.1 Aquatic invertebrate assessment

Very little is known of the invertebrate fauna of the watercourses and wetlands of the Karoo region. Given the constant shift from aquatic to dry phases, ephemeral ecosystems support unique, well-adapted biotic communities with species that show rapid hatching, fast development, high fecundity, and short life spans. Organisms that inhabit these ecosystems rely on the production of desiccation-resistant or dormant propagules (such as eggs, cysts, seeds, spores) to survive the dry period, and then become active again when the wetland is inundated. The eggs of these organisms can survive in the sediments for many years, and rapidly hatch when sufficient rain falls. Many taxa will reproduce asexually several times during the wet season.

It is evident that marginal vegetation and pools are important biotopes in non-perennial rivers for invertebrates. Marginal vegetation is sometimes still available in pools and deeper sections even after the stones-in-current and stones-out-of-current biotopes have dried up. The gravel/mud and sand habitat would also be available for longer than some of the other habitat types.

The presence of refugia near to the river – either tributaries or other streams in the vicinity is vital to survival of some species. Many of the invertebrates present in non-perennial rivers are the same as those found in temporary pools and pans in the area and these pans/pools also serve as refugia.

The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

Important to remember is that when pools are threatened by silting due to erosion or mismanagement of the catchment upstream it would mean that refugia for instream biota is removed and this could lead to the destruction of instream biota in other non-perennial rivers in the vicinity as well.

The recharging of the surface water by groundwater is also an important factor in these rivers as some invertebrates are found in this subsurface water and recolonise the surface water from there.

In the arid and semi-arid Southern African Rivers the environmental stressors are extreme and organisms surviving in these systems are not stressed by the high flows as such but rather by competition for dwindling resources as the systems dry out.

Unfortunately, at the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS 2014) will be used to establish some background for the PES determination.

According to the DWS PESEIS database, macro-invertebrate aspects of the Brak River (D62D-05613) read as follow:

Macro-invertebrate taxa per SQ: 11 taxa
Invertebrate representivity per secondary: Very high
Invertebrate rarity per secondary class: High
Invertebrate physical-chemical description: Moderate
Invertebrate velocity sensitivity: High
Invertebrate taxa estimated:

- Baetidae 1sp
- Gerridae
- Naucoridae
- Vellidae
- Dytiscidae
- Gyrinidae
- Ceratopogonidae
- Chironomidae
- Culicidae
- Muscidae

By using these parameters, the PESEIS assessors establish a Category D for the instream biota aspect, which equates to “Largely modified” (Table 19). However, by evaluating the changes in the system and the diversity of these ephemeral systems, it is rather a lack of diversity then a case of modification when the instream biota is evaluated (“Low diversity”).

Table 19: Ratings for the macro-invertebrate integrity classes.

	MIRAI ASSESSMENT CLASSES	
Class rating	Description of generally expected conditions for integrity classes	Relative FRAI score (% of expected)
A	Unmodified, or approximate natural conditions closely	90 to 100
B	Largely natural with few modifications.	80 to 89
C	Moderately modified.	60 to 79
D	Largely modified.	40 to 59
E	Seriously modified.	20 to 39
F	Critically modified.	0 to 19

Task 1.2.3.4.2 Fish Response Assessment Index (FRAI)

The purpose of the Fish Response Assessment Index (FRAI) is to provide a habitat-based cause-and-effect interpretation underpinning the deviation of the fish assemblage from the reference condition.

Unfortunately, at the time of the field visit in October 2017, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS, 2014) will be used to establish some background for the PES determination.

According to the DWS PESEIS database, the freshwater fish aspects of the Brak River (D62D-05613) read as follow:

Fish species per SQ: 2 species
Fish representivity per secondary: Moderate
Fish rarity per secondary class: Moderate
Fish species estimated:
Barbus anoplus
Labeo umbratus
Fish physical-chemical description: Moderate
Fish no-flow sensitivity description: Moderate

By using these parameters, the PESEIS assessors establish a PES of a Category D for the instream biota aspect, which equates to "Largely modified" (Table 20). However, by evaluating the changes in the system and the diversity of these ephemeral systems, it is rather a lack of diversity then a case of modification when the instream biota is evaluated ("Low diversity").

Table 20: Ratings for the fish integrity classes

	FRAI ASSESSMENT CLASSES	
Class rating	Description of generally expected conditions for integrity classes	Relative FRAI score (% of expected)
A	Unmodified, or approximate natural conditions closely	90 to 100
B	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification.	80 to 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at lower limits of this class.	60 to 79
D	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderate intolerant species. Impairment of health may become more evident at the lower limit of this class.	40 to 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.	20 to 39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a loss of species at the lower limit of the class. Impairment of health generally very evident.	0 to 19

Task 1.2.4 Describe the ecological importance and sensitivity (EIS) as well as the Socio-cultural Importance (SI) of the affected reach/es of the watercourse including the functions.

Ecological importance and sensitivity (EIS)

The PESEIS data from the Department of Water and Sanitation Desktop PESEIS assessment (DWS, 2014), supplies most of the current status information of the relevant sub-quaternary river reaches (SQRs) for South Africa. The objective of the PESEIS is to provide desktop level information on ecological issues as it relates to the protection and management of SQRs. For management purposes this refers specifically to the consideration of ecological reserve issues, water use licensing issues and EWRM (including the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) activities) and the determination of priorities for monitoring.

The data analysis for the PESEIS of the Brak River catchment was evaluated during 2011 (Table 21).

Table 21: A summary of the Ecological Importance of the Brak River obtained from the DWS PES-EIS model (DWS, 2014).

Ecological Importance	
Fish spp/sq	2
Fish representivity per secondary: class	Moderate
Fish rarity per secondary: class	Moderate
Riparian-wetland natural veg rating based on % natural veg in 500m (100%=5)	Very high
Riparian-wetland natural veg importance based on expert rating	Moderate
Invertebrate taxa/SQ	11
Invertebrate representivity per secondary, class	Very high
Invertebrate rarity per secondary: class	High
Ecological importance: riparian-wetland-instream vertebrates (excluding fish) rating	Low
Ecological importance: riparian-wetland-instream vertebrates (excluding fish) comments	Total number of species in SQ: 15; number of special species: 0 ; main habitats: Seasonal/Ephemeral, riparian trees, pools; main adverse conditions: Agriculture, instream dams, lack of surface flows.
Habitat diversity class	Low
Habitat size (length) class	High
Instream migration link class	Moderate
Riparian-wetland zone migration link	Moderate
Riparian-wetland zone habitat integrity class	Moderate
Instream habitat integrity class	High
Mean EI Class	**Moderate**

The mean Ecological Importance Class of the Brak River in the SQ reach D62D-05613 is “Moderate” (DWS, 2014).

Table 22: A summary of the Ecological Sensitivity (ES) of the riparian-wetland vertebrates (non-fish) in the Nhlaralumi River obtained from the DWS PES-EIS model (DWS, 2014).

Metrics: riparian-wetland vertebrates (non-fish)	Ratings & comments
Fish physical-chemical description:	Moderate
Fish no-flow sensitivity description:	Moderate
Invertebrate representivity per secondary	Very high
Invertebrate rarity per secondary class	High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Very low
Ecological sensitivity: riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes, comments	High dependance species: 0; Main habitats: Seasonal/Ephemeral, pools; Main adverse conditions: Instream dams, lack of surface flows.
Stream size sensitivity to modified flow/water level changes description	Low
Riparian-wetland vegetation intolerance to water level changes description	Moderate
Riparian-wetland vegetation intolerance to water level changes comments	Moderate
Mean ES Class	**Moderate**

The mean Ecological Sensitivity Class of the Brak River in the SQ reach D62D-05613 is “Moderate” (DWS, 2014).

Socio-cultural Importance (SI)

De Aar is situated in the Northern Cape Province, with an approximate population of 35 539 people (census 2001). De Aar situated within the Emthanjeni Municipality, is renowned for its central location on the main railway line between Johannesburg, Cape Town, Port Elizabeth and Namibia. The Municipality is further situated in the Pixley ka Seme District Municipality with an approximate population of 164 607 people (census 2001), this represents 16, 92% of the Northern Cape population. The Municipality is also approximately 300km south west of Kimberley, 440 km south east of Upington, 300 km north east of Beaufort West and 300 km south west of Bloemfontein.

Hanover lies approximately 65 km east of De Aar on N1 main north to south route. Britstown is situated about 55 km west of De Aar on the N12 route. Both these main routes link Johannesburg and Cape Town. The towns of Emthanjeni lie in an extensive stock farming area with the emphasis on sheep, mutton and wool farming, especially Merino’s. The climatic restrictions (namely very low rainfall) means that this part of the Northern Cape is best suited for grazing, although the grazing capacity is low (approximately 20-25 ha/large stock unit). The only means of cultivation would be by irrigation. The region is subject to periodic droughts which have a serious impact on the surrounding farming areas and on the economy of the towns. The area has a low prevailing agricultural potential.

Less than 1% of the Karoo is cultivated under dryland or irrigated conditions, and in the eastern Karoo intensive agriculture is largely restricted to small fields of irrigated lucerne, as well as prickly pear *Opuntia ficus-indica* orchards. *Opuntia* has fortunately not invaded the natural rangelands of this specific area, but the exotic mesquite *Prosopis glandulosa* has become a serious problem in some areas, particularly in drainage lines in the west

Emthanjeni Municipality, specifically De Aar, is the seat of Pixley ka Seme District Municipality; the Municipality further hosts all Government Departments. Emthanjeni Municipality covers an area of approximately 11390km². Emthanjeni comprises 11% of the district land area and 3% of the province. We further represent approximately 23% of the district's population. (Emthanjeni Local Municipality, Integrated Development Plan 2011 – 2016).

The study area of Ward 6 almost half of the population belongs to the Coloured population group, with just over two fifths of the population belonging to the Black population group. About two fifths of the people in Ward 6 aged 20 years or older have no schooling or only some primary education. This is higher than on local, district or provincial level.

Ward 6 has the highest proportion of people aged between 15 – 65 years that are employed. Just over half of the people who are employed in Ward 6, are employed in the formal sector. This is much lower than on local or district level. About a quarter of the employed work in the informal sector, which is proportionately higher than on local or district level.

Agriculture forms the backbone of the economy of the Emthanjeni LM (Emthanjeni LM IDP, 2016/2021) with mutton and wool being the main produce. Besides sheep farming, cattle, goat, pig and game are also being farmed. Current commercial livestock farming in the Karoo revolves mostly around sheep and extensive wool (Merinos) and mutton (Dorpers) production. Approximately 50% of the commercial farming enterprises in the Karoo are found on properties smaller than 3000 ha and less than 25% on properties larger than 6000 ha.

Although game ranching has a relatively short history in the Karoo, there are many roperties that stock a few of the plains game indigenous to South Africa.

The manufacturing sector shows potential for growth through the introduction of renewable energy projects in De Aar and the surrounding areas. There are also stone crushers in the area that specialise in the manufacturing of sand, bricks cement and rocks. Other economic activities include services, retail, transport and tourism.

De Aar is the main town of Pixley ka Seme and is a potential industrial growth point with ample industrial sites, reasonable prices and tariffs, affordable labour and the necessary infrastructure. De Aar is therefore the ideal place to establish industries, a fact which can be borne out by various major industries which have already established themselves here. The central location and excellent rail and road links have resulted in several chain stores opening branches.

Hanover is also well endowed with qualified construction industry artisans. Like the other towns in this region, wool is exported to Port Elizabeth without being processed.

Task 1.2.5 Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse.

According to the IHI evaluation (Table 11), the Riparian Zone Habitat Integrity is "Moderately modified", and the C score indicates some impacts at this stage on the riparian habitats:

- Large number of small and medium-sized weirs and dams in the study area;

- Some erosion due to trampling and diversions;
- Small amount of alien vegetation.

Large number of small and medium-sized weirs and dams in the study area

The many impoundments on this ephemeral system consist of small- to medium-sized earthen farm dams, and about 15 of these are found on the project farm alone.

By storing or diverting water weirs alter the natural distribution and timing of stream flow. Impacts on in-stream flow (quantity, pattern, timing, water level and assurance):

- Disruption of longitudinal and lateral connectivity;
- Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
- Reduction in flows, sometimes no flow or flow during the wrong season;
- Implicates flow, bed, channel and water quality characteristics.
- Downstream riparian vegetation may be influenced by a decrease in the supply of water and dramatically altered;
- Bursting of dams usually has a high environmental impact, increasing flood peaks, sediment loads, stream-bank erosion
- Reduction in downstream annual flooding in particular affects the natural productivity of floodplains and delta.

The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

Water quality threats to the system which could accumulate in the dams include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

Ephemeral rivers are particularly vulnerable to changes in hydrology, as they are specifically adapted to brief periods of inundation and flow. Consequently, pollutants and sediments entering these watercourses are not regularly diluted or flushed out of the catchment, leading to a lack of resilience to pollution, erosion and sedimentation.

Erosion due to trampling and diversions

About 4% of the Nama-Karoo has been cleared for cultivation or irreversibly transformed by building of dams. Erosion is moderate (46.2%), very low (32%) and low (20%) in in the area. In the project area, the floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present. Moderate modification to the system are trampling and grazing within river channel by stock

It is important to remember is that when pools are threatened by silting due to erosion or mismanagement of the catchment upstream it would mean that refugia for instream biota is removed and this could lead to the destruction of instream biota in other non-perennial rivers in the vicinity as well.

Alien vegetation

A small number of alien tamarisk trees are growing in the main drainage line. *Prosopis glandulosa, is* regarded as one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type, however none has been observed in the project area.

Task 1.2.6 List and map sensitive environments in proximity of the project locality-sensitive environments include wetlands, nature reserves, protected areas, etc.

Northern Upper Karoo has not been significantly affected by transformation and is still approximately 96% intact. It is classified as Least Threatened (Mucina & Rutherford 2006). The Soventix Project Site falls within the planning domain of the Northern Cape Provincial Biodiversity Plan, developed by the Department of Environment and Nature Conservation, Northern Cape. The potential impact of the development on Critical Biodiversity Areas should be considered in detail as these areas have been identified through systematic conservation planning exercises and represent biodiversity priority areas which should be maintained in a natural to near natural state in order to safeguard biodiversity pattern and ecological processes. The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to meet national biodiversity objectives.

Importance of the site

To establish how important the site is for meeting biodiversity targets, the Land-Use Decision Support Tool (LUDS) was used to compile the LUDS Report (BGIS, 2016). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level. Its primary objective is to serve as a guide for biodiversity planning but should not replace specialist ecological assessments.

Critical Biodiversity Areas (CBAs) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. If these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.

Before the field study, the team will establish how important the site is for meeting biodiversity targets. To do this, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g. is it in a CBA or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the Department of Environment and Nature Conservation, Northern Cape's requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

The key results of the BGIS Maps are illustrated in Figure 27 and the LUDS Report are summarized in Table 23. The information is extracted for the area from national datasets available on the Biodiversity Geographic Information System (BGIS).

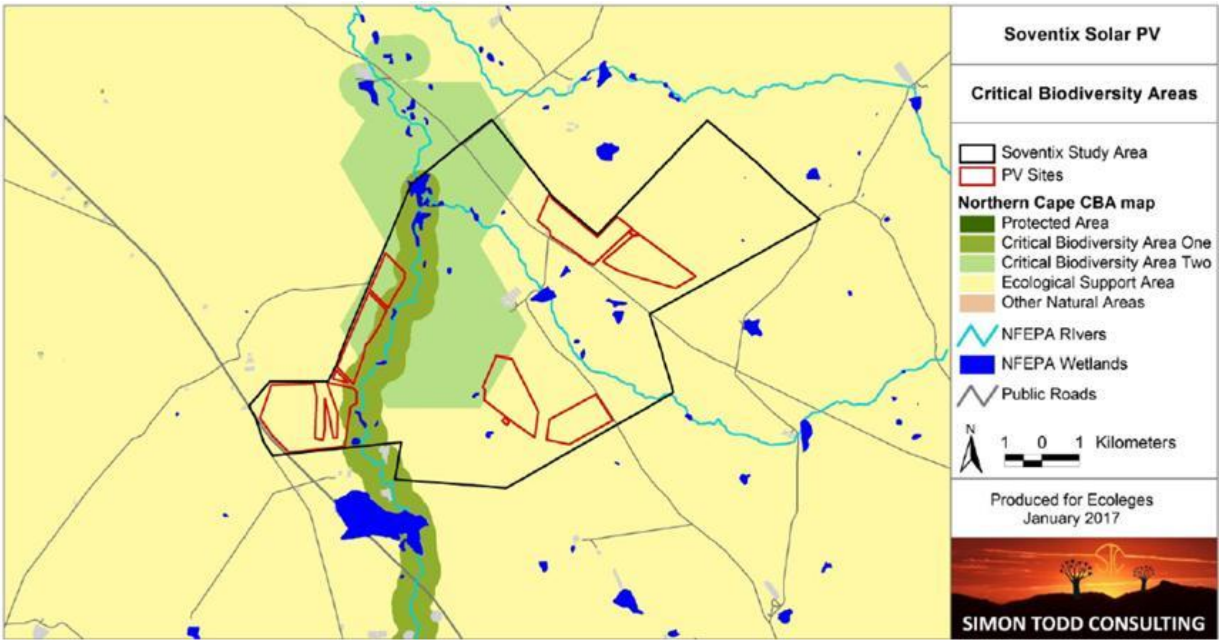


Figure 27: Critical Biodiversity Areas map of the proposed Soventix PV project and the surrounding area.

Critical Biodiversity Areas (CBAs)

Ecological Support Areas (ESAs): Those areas that play a significant role in supporting ecological functioning of Critical Biodiversity Areas (CBAs) and/or delivering ecosystem services, as determined in a systematic biodiversity plan. A *Critical Biodiversity Area map* is a map of Critical Biodiversity Areas and Ecological Support Areas based on a systematic biodiversity plan. Critical Biodiversity Areas and Ecological Support Areas are areas that require safeguarding to ensure the continued existence of biodiversity, ecological processes and ecosystem services. A Critical Biodiversity Area map, often developed at provincial level, provides the basis for a biodiversity sector plan.

Freshwater Ecosystem Priority Areas (FEPAs)

Freshwater Ecosystem Priority Areas (FEPAs) were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas. NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs.

Table 23: The key results of the LUDS Report as extracted for the Soventix project area from national datasets available from BGIS.

National Data Set	Aspect	Presence
National terrestrial information: Northern Cape		
South African municipal boundaries	**Municipality name:** Local - Emthanjeni (NC073) District – Pixley ka Seme	NC073
Informal land-based protected areas		
Protected area	An area of land or sea that is formally protected in terms of the Protected Areas Act and managed mainly for biodiversity conservation. Includes state-owned protected areas and contract protected areas.	None
Critical Biodiversity Areas		
Critical Biodiversity Area 1	Riverine system	Brak River
Critical Biodiversity Area 2	Drainage area	Brak River
Ecological support Area	Nama Karoo	Ephemeral - - Lower foothill
National aquatic information: Lower Orange, Orange tributaries		
Brak River	Largely natural, not threatened	D62D-05613 & D62D – 05610
NFEPA sub-quat. catchment river FEPAs (Wetland Cluster)	D62D	WetCluster FEPA
FEPA River ecosystem type	D62D-05613	Ephemeral - Nama Karoo - Lower foothill Ephemeral - Nama Karoo - Upper foothill
1. FEPA River ecosystem type	D62D-05613	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Seep Karoo_Unchannelled valley-bottom wetland
2. FEPA River ecosystem type	D62D – 05610	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Unchannelled valley-bottom wetland

In the study area, the Brak River has been identified as having conservation importance. Figure 27 represents the Freshwater Ecosystem Protected Areas (FEPA) map for the area. For river FEPAs the whole sub-quaternary catchment is shown in dark green (Figure 27), although FEPA status applies to the actual river reach within such a sub-quaternary catchment. The shading of the whole sub-quaternary catchment indicates that the surrounding land and smaller stream network need to be managed in a way that maintains the good condition (A or B ecological category) of the river reach.

Wetland clusters (Table 23) are groups of wetlands embedded in a relatively natural landscape. This allows for important ecological processes such as migration of frogs and insects between wetlands. In many areas of the country, wetland clusters no longer exist because the surrounding land has become too fragmented by human impacts.

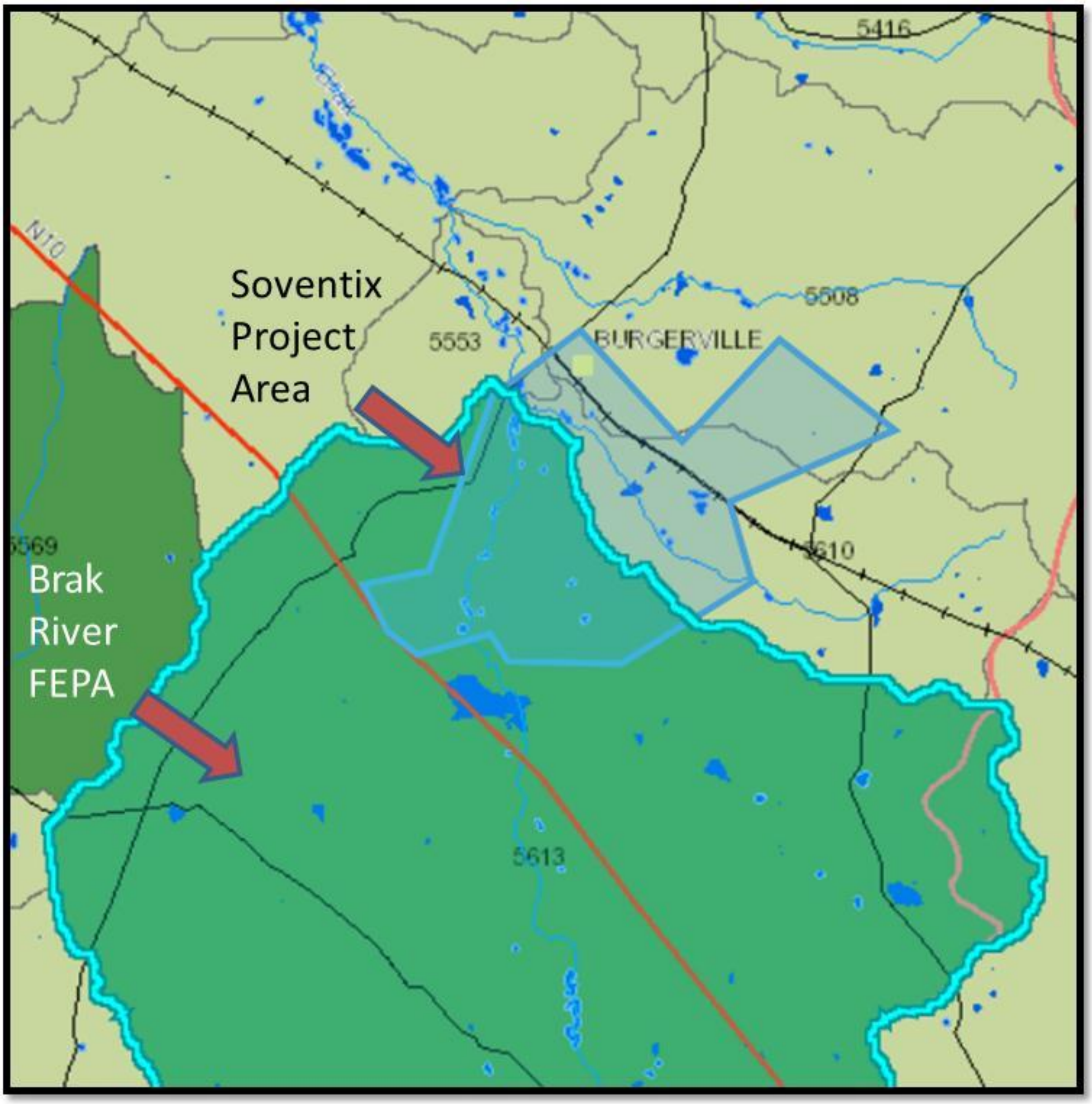


Figure 28: The position of the project site in relation to the Brak River FEPA.

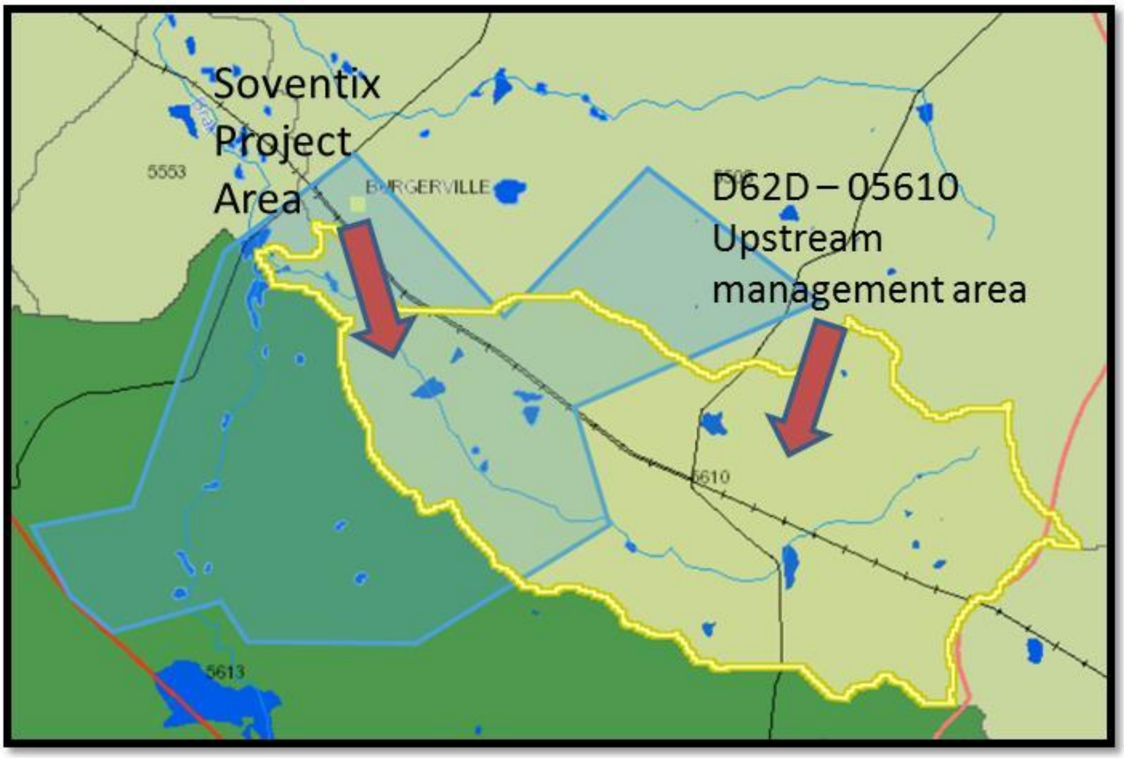


Figure 29: The position of the D62D-05610 FEPA Upstream Management Area in relation to the project site.

Upstream Management Areas (Figure 29) are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas. Upstream Management Areas do not include management areas for wetland FEPAs, which need to be determined at a finer scale.

The areas surrounding the drainage lines in the project area (light yellow in Figure 27), is classified as an Ecological Support Area (ESA). The desired management objective for an ESA is to be maintained in a natural, functional state. Limited loss of ecosystems or functionality is acceptable, as long as the present ecological state is not lowered.

- All wetlands are protected under the National Water Act (Act 36 of 1998).
- In terms of the National Water Act, freshwater ecosystems (all wetlands included) should not be allowed to degrade to an unacceptably modified condition (E or F ecological category).
- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland (Task 1.2.3.3.2).

The following four-step process should be followed for taking FEPAs into account in EIAs and will supply information on the Brak River as part of the Department of Environment and Nature Conservation, Northern Cape systematic biodiversity plans:

FEPA Step 1: Consult the FEPA map

- Make an initial desktop assessment of whether the proposed activity is likely to impact on the FEPA as mapped.

Probable impacts to mitigate.

Water flow patterns

The land use is currently agriculture, and will retain in part its agricultural use for livestock grazing, but will convert significant sections for commercial Solar PV for a fixed-term. The size of the proposed development footprint is approximately 520ha.

Altered surface water flow patterns, e.g. changing sheet flow (natural open system) to concentrated flows (large areas of solar panels directing rainwater), which leads to erosion, altered flow regimes and changes in water availability.

Storm water run-off from vehicle service tracks between the panel arrays, un-surfaced roads, buildings, borrow pits and excavation sites may cause erosion and channelling of flow, changes in flow patterns, head-cut and gully erosion, and sedimentation in wetlands and watercourses.

Inadequate storm water management and soil stabilisation measures in cleared areas could lead to erosion that could cause the loss of riparian vegetation and which would lead to siltation of nearby watercourses.

Off-road driving (even once-off) can cause long-term structural change in habitat. Driving of heavy vehicles even once over flat clay flood plain areas will have major impact, these areas are highly sensitive to change and the whole ecology of the system is dependent on spreading out of water over vast flat areas during rainfall events.

Indentations caused from vehicles driving over the soil surface will cause significant changes in water run off patterns and will remain in the landscape for hundreds of years.

Erosion

Erosion and sedimentation are important ecological processes in the Karoo. Loss and fragmentation of habitat disrupt these processes. Erosion is a particularly high risk on steep slopes, and in drainage lines that lack channel features and are naturally adapted to lower energy runoff with dispersed surface flows (such as unchannelled valley-bottom wetlands), and naturally less turbid freshwater systems.

Damming or diverting water

No additional or new damming of water or diverting water as part of the project construction or long term operations is envisaged.

Extraction of groundwater

Any extraction of water (surface or groundwater) in the arid Karoo environment will result in impacts on inundation/saturation regimes in wetlands, and flow regimes in watercourses. Extraction of groundwater will also result in drawdown of the water table.

Ephemeral and seasonal pools lower down in catchments are more vulnerable as they are more dependent on groundwater.

Extraction of water will cause a decline on species dependent on water availability, including amphibians and fish, and may impact availability of breeding habitats for aquatic species. Riparian plant species and communities dependant on perched water tables (such as *Valchelia karroo, Searsia lancea, Phragmites australis*) will be impacted.

Roads and stream crossings

Driving on wet clay forms ruts that later develop into dongas or holes too deep for vegetation establishment. The disruption of surface drainage patterns where roads are raised above the base level of natural drainage channels or wetlands can cause fragmentation of aquatic ecosystems, and loss of connectivity, and can hamper the movement of aquatic or semi-aquatic fauna along riverine corridors or within and between wetlands.

Once permanent roads are built and regularly maintained and graded, there will be erosion that results from the formation of rills. This will change hydrological flows and have a detrimental effect on vegetation surrounding the roads.

Pollution of the water sources

Construction and maintenance of roads and other infrastructure can be associated with spills of fuel and other chemicals. Water pollution/contamination from accidental releases associated with natural flood events; leaking infrastructure (e.g. ponds, closed water treatment units); and spills of waste water.

In addition to pollution effects, any release of waste water into surface water ecosystems will impact on flow and temperature regimes. This is especially disruptive for the ephemeral and seasonal ecosystems of the arid Karoo environment, including affecting hatching/mating cues and growth of freshwater species.

The uncontrolled interaction of construction workers with watercourses that could lead to the pollution of these watercourses, e.g. dumping of construction material into the drainage system, washing of equipment The lack of provision of adequate sanitary facilities and ablutions on the servitude may lead to direct or indirect faecal pollution of surface water resources.

Invasive alien plant species

Construction can introduce invasive alien species, and lead to the spread of those that are already present. This will negatively compete with indigenous species and disrupt ecological processes.

Overhead power lines

Power lines can be associated with impacts on surface water resources if the towers are placed within a river or watercourse, or if the riparian vegetation within the power line servitude is felled. The process of constructing the power lines can also cause impacts on surface water resources, especially if certain mitigation measures and procedures are not followed.

Apart from habitat loss within the development footprint, another major potential source of impact of the development on birds would be from any power lines needed for the grid connection which could cause mortalities through electrocution and collisions of susceptible wetland bird species such as cranes and flamingos. Given the proximity of the Eskom lines to the site, any required overhead lines would be short, which would be important in mitigating this impact to a low level. Bird flappers could be incorporated in areas of increased bird activity.

FEPA Step 2: Site assessment

- Visit the site. Verify that the river/wetland ecosystem types for which the FEPA has been selected exist on the ground. Check that the FEPA is not heavily modified.

The site visit to the Soventix project area took place in October 2017. At the time of the field visit the river had no surface water available, not even in the earthen dams. There are a large number of small and medium-sized weirs and dams in the study area, and about 15 of these are found on the project farm alone. The floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present. It is concluded that this FEPA is moderately modified.

Most of the demarcated FEPA wetlands in the project area are in fact these small and medium-sized weirs and dams. The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

- Ground-truth the location of the FEPA (e.g. the river, the associated sub-quaternary catchment, and any wetland FEPAs that fall within the sub-quaternary catchment);

The location of the FEPAs were verified and indicated in the maps of Task 1.2.6.

- Type the FEPA according to the river and wetland ecosystem types used by NFEPA (see Table 24);

Table 24: The Brak River FEPA according to the river and wetland ecosystem types used by NFEPA (Nel et al, 2011).

1. FEPA River ecosystem type	D62D-05613	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Seep Karoo_Unchannelled valley-bottom wetland

- Examine the surrounding sub-quaternary catchment, looking at the condition and location of other FEPAs (see Table 25), and other freshwater ecosystems in good condition, and/or of apparent ecological importance and/or sensitivity;

Table 25: The unnamed FEPA according to the river and wetland ecosystem types used by NFEPA (Nel et al, 2011).

2. FEPA River ecosystem type	D62D – 05610	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Unchannelled valley-bottom wetland

The unnamed drainage line (D62D - 05610), which is a tributary to the Brak River (D62D - 05613), is discernible only as a slightly shallow depression with no clear associated vegetation and slightly clayey soils. Dwarf karroid scrub and tufted grass are the only vegetation present in this drainage area. It is in a good condition despite some weirs and diversion walls in die catchment.

- Determine current condition (present ecological state) and compare with modelled condition: EcoStatus (Present Ecological State) for rivers – *primary data should be collected wherever possible*.

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): "Largely modified", mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B "Largely natural with few modifications" and thus the increasing the overall EcoStatus to a C (72.5%): "Moderately modified".

FEPA Step 3: Delineate the ecosystem

- Map the extent of the FEPA accurately, using the DWA protocol for delineation of wetlands and riparian areas (DWAF, 2005);

The Brak River SQ D62D-05610 is a Critical Biodiversity Area one, while the area surrounding the ephemeral drainage line, is categorised as a Critical Biodiversity Area two. As part of the management objective for the Northern Cape CBA process, the following is suggested:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

- Determine the appropriate buffer width, using accepted national protocols.

The 100 m buffer around the delineated riparian area should be measured from the top of the active channel bank. Most of the development is positioned further than 100 from the edge of the drainage wetland by the EIA team, thus a 100m buffer is acceptable in this dry environment.

FEPA Step 4: Assess the significance of the impact of the proposed development

- Determine ecological importance and sensitivity (EIS) using DWA protocol, and compare with FEPA status – examine the reasons why ecosystem has achieved FEPA status, and check whether these are correct and complete, if so, these should be used in the determination of EIS – *primary data should be collected wherever possible*;

The PESEIS data from the Department of Water and Sanitation Desktop PESEIS assessment (DWS, 2014), supplies most of the current status information of the relevant sub-quaternary river reaches (SQRs) for South Africa. The objective of the PESEIS is to provide desktop level information on ecological issues as it relates to the protection and management of SQRs. For management purposes this refers specifically to the consideration of ecological reserve issues, water use licensing issues and EWRM (including the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) activities) and the determination of priorities for monitoring.

The mean Ecological Importance Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014). The mean Ecological Sensitivity Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014).

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): "Largely modified", mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B "Largely natural with few modifications" and thus the increasing the overall EcoStatus to a C (72.5%): "Moderately modified".

- Assess the significance of impacts. The degree of significance will depend on the degree of deterioration in ecological condition that would result from the proposed development as well as its reversibility (e.g. whether the impact is short-term, medium-term or long-term).

This will be discussed in the following task (Task 3.2) Risk Assessment

- Deterioration of a FEPA from a B ecological condition to a C condition might be considered an impact of medium significance but should never be considered of low significance.

This level of deterioration is not envisaged.

FEPA Step 5: Make recommendations ((This will be discussed in the following task (Task 3.2) Risk Assessment))

- Consult the NFEPA ecosystem management guidelines, and apply these to the development application;

- Develop suitable and realistic mitigation measures;

- Determine rehabilitation requirements, in order to meet management objectives for FEPAs;

Design a monitoring programme that aims to track the impacts associated with the development and how these affect the condition of the affected FEPAs.

Task 3.2 Provide an assessment of the risks associated with the water use/s and related activities.

The Risk Assessment was done in accordance with the Risk Matrix (Based on DWS 2015 publication: Section 21 (c) and (I) water use Risk Assessment Protocol and as contained as Appendix A in GN509 of 26 August 2016) and it was carried out considering the risk rating of the proposed project activities after implementing mitigation measures (Appendix 4). Following is an abstract from the completed Risk Matrix (Table 26) to indicate the significance of the project activities on the Sabie River:

Table 26: An abstract from the completed Risk Matrix, indicating the significance of the project activities on the Brak River.

No.	P*	Activity	Aspect	Potential Impact	Significance	Risk Rating	Control Measures
1	Construction	Impacts on water quality: Erosion and Sedimentation that leads to increased turbidity and siltation of aquatic habitats. Chemical pollution of the water resources.	Altered surface water flow patterns, e.g. changing sheet flow (natural open system) to concentrated flows (large areas of solar panels directing rainwater). Inadequate storm water management and soil stabilisation measures.	Leads to erosion, altered flow regimes and changes in water availability. Loss of vegetation. Sedimentation in wetlands and watercourses.	**34**	(L) Low Risk	The objective of a Storm Water Management Plan (SWMP) is to control storm water runoff from the site. It should be designed to improve the storm water quality (i.e. sediment removal) and control runoff directly being discharged from the designated site. Disturbance of the natural topography and vegetation cover should be minimised. The natural contours should be preserved as far as is practical in order to preserve the existing site drainage patterns as far as possible. Natural, dispersed, drainage should be encouraged, by maintaining the natural drainage characteristics of the land as far as possible, thereby minimising the concentration of flows and consequently the risk of erosion. Diversion of upslope surface runoff around the solar PV area should be considered. Berms and/or open drains can be provided for this purpose. The size and lining of the drain would be dependent on the peak flow rates and velocities, which should be determined through hydrological modelling. Domestic livestock should be excluded from areas under rehabilitation for at least the first year of recovery.
			Run-off from vehicle service tracks between the panel arrays, un-surfaced roads, buildings, borrow pits and excavation sites. Driving of heavy vehicles even once over flat clay flood plain areas will have a major impact.	Cause erosion and channelling of flow, changes in flow patterns, head-cut and gully erosion, and sedimentation in wetlands and watercourses.	**38.25**	(L) Low Risk	A storm water drain should be provided along all access roads. The size and lining of the drain would be dependent on the peak flow rates and velocities, which should be determined through hydrological modelling. Storm water crossings at access roads should be provided in the form of drifts, rather than pipes or culverts. No off-road driving in wet conditions, and for two weeks afterwards. In particular, no driving in veld should take place on clay or fine-textured soils following rain.

			Construction and maintenance of roads and other infrastructure - associated with spills of fuel and other chemicals. Water pollution/contamination from accidental releases associated with natural flood events; leaking infrastructure (e.g. ponds, closed water treatment units); and spills of waste water.	Chemical pollution of surface water resources.	**26**	(L) Low Risk	Sites of oiling and refuelling points to be located away from rivers, surface water sewers or other watercourses. Mitigated by controlled re-fuelling points, use of bio-degradable hydraulic oils, spill kits, etc. No fuel storage, refuelling, vehicle maintenance / washing or vehicle depots should be allowed within 50 m of the edge of any wetlands or watercourses. Refuelling and fuel storage areas, and areas used for the servicing, washing or parking of vehicles and machinery, should be located on impervious bases and should have bunds around them. Bunds should be sufficiently high to ensure that all the fuel kept in the area will be captured in the event of a major spillage. If construction areas are to be pumped of water (e.g. after rains), this water should be pumped into an appropriate settlement area, and not allowed to flow straight into any watercourses or wetland areas. An emergency protocol must be developed that deals with accidents and spills. This must include methods for absorbing chemicals / oils / fuel, and the transport and disposal of all contaminated material in a suitable hazardous waste site.
			The uncontrolled interaction of construction workers with watercourses that could lead to the pollution of these watercourses, e.g. dumping of construction material into the drainage system, washing of equipment. The lack of provision of adequate sanitary facilities and ablutions on the servitude may lead to direct or indirect faecal pollution of surface water resources. It is envisaged that a maximum of 2 kl of sewage and wastewater would be generated per day.	Pollution by workers: dumping, washing and faecal pollution.	**18**	(L) Low Risk	Effluent will be generated from the on-site sanitation facilities and treated by way of a BiorockTM waste water treatment package plant. The BiorockTM Waste Water Treatment Package Plant (WWTPP) will treat the water to the requisite standard before the water is disposed of via a seep-away. However, the proponent may choose in the future to further treat the water for reuse, in which case the storage (also in a JoJo tank) will not exceed 5m3, as the daily anticipated operational usage that will generate effluent, will not exceed 2m3. The quality of the treated effluent will be of such a standard that it will not impact any groundwater resource detrimentally. The potential storage of treated effluent will be well short of the minimum threshold. The BiorockTM and potential future storage unit will be outside of any watercourses, as the full development footprint has been excluded from watercourses, including a 100-metre buffer zone.

2	Construction	Impacts on water quanity (surface flows and groundwater):	Any extraction of water (surface or groundwater) in the arid Karoo environment. The mean expected water usage will be higher during construction, for building & foundational purposes as well as periodic dust suppression along haul roads.	Will result in impacts on inundation/saturation regimes in wetlands, and flow regimes in watercourses; will also result in drawdown of the water table.	**26.25**	(L) Low Risk	The existing borehole and windmill facility is located on the north-central portion of Area B outside of the delineated watercourse. The project will require 3000m3 per year for the 18-month construction period and thereafter 850m3 per year for the operational phase. These volumes fall well within the permissible limits. The five (5) storage vessels totalling 100m3 storage capacity, are all off-channel and above-ground.
3	Construction	Changes in riverine habitat structure and function.	Power lines can be associated with impacts on surface water resources if the towers are placed within a river or watercourse.	The process of constructing the power lines can also cause impacts on surface water resources, especially if certain mitigation measures and procedures are not followed.	**33.75**	(L) Low Risk	Disturbance of the natural topography and vegetation cover should be minimised. The natural contours should be preserved as far as is practical in order to preserve the existing site drainage patterns as far as possible. The results of the analysis indicate that the water level in the watercourse is not expected to reach the pylon of concern, at its currently indicated location. The impact on water quality of the construction and operation of the power line between the solar PV array and the existing Eskom 400 kV power line is expected to be LOW prior to mitigation, reducing to VERY LOW with the implementation of the proposed mitigation measures.
			Impacts of permanent roads and stream crossings.	Alterations to local flow patterns cause induced or accelerated bed and bank erosion, or sediment deposition or increased flood risk. Risks of bank erosion during high flow events and rainfall run-off causing silt/sediment pollution. Alterations to local flow patterns cause induced or accelerated bed and bank erosion, or sediment deposition or increased flood risk. Damming and flooding upstream; impact on normal hydraulic regime.	**46.75**	(L) Low Risk	Roads should preferably not be raised above the natural base level, allowing surface runoff to flow uninterrupted. Crossings over water-courses and wetlands should rather be built as stabilised drifts than using culverts or pipes. Roads should preferably not be raised above the natural base level, allowing surface runoff to flow uninterrupted. Crossings over water-courses and wetlands should rather be built as stabilised drifts than using culverts or pipes.

4	Construction	Introduction of invasive alien biota.	Construction can introduce invasive alien species.	This will lead to the spread of invasive alien species that are already present in the system. This will negatively compete with indigenous species and disrupt ecological processes.	**45**	(L) Low Risk	Control exotics and invasive plants to be eradicated . Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion. Any materials brought in to construction sites should be from sources free of invasive alien species. Clearing of invasive alien plants must take place coupled with the sowing of seeds of indigenous species to stabilise disturbed habitats. Compacted bare ground should be loosened and pitted, and covered with branches or stones. This will improve the ability of the surfaces to trap seeds and to absorb rainwater, thereby hastening vegetation recovery.
5	Operational	Impacts on water quantity (surface flows and groundwater):	Borehole: The operational facilities will require water for the on-site office facilities and canteen, including shower and hanging facilities. Additionally, water will be used for washing the solar panels on a quarterly basis and providing water for sheep farming, which is and will remain a functional agricultural practice on the property.	Will result in impacts on inundation/saturation regimes in wetlands, and flow regimes in watercourses; will also result in drawdown of the water table.	**45**	(L) Low Risk	General Authorisation (GA) GN 665 dated 6 September 2013 allows for the section 21 (g) water uses as long as the relevant conditions in the GA are complied with.

6	Operational	Impacts on water quality: Erosion and Sedimentation that leads to increased turbidity and siltation of aquatic habitats.	Once permanent roads are built and regularly maintained and graded, there will be erosion that results from the formation of rills.	This will change hydrological flows and have a detrimental effect on vegetation surrounding the roads.	**37.5**	(L) Low Risk	Drifts should be constructed from concrete or grouted stone pitching. Drifts should be provided at frequent spacings (recommendation is 300 m, again to minimise the concentration of flows. All storm water drainage discharge points should be provided with outlet structures, designed with adequate erosion protection, to ensure that storm water is discharged from formal structures onto the natural ground at a safe and acceptable velocity. Use existing bridges for watercourse or wetland crossings wherever possible. Minimise new crossings over wetlands and watercourses. If wetlands or watercourses cannot be avoided, ensure that road crossings are constructed using riprap, gabion mattresses, and/or other permeable material to minimise the alteration of surface and sub-surface flow. Flow of water under roads must be allowed to occur without leading to concentration of surface flow. This can be achieved through designing bridges that span the entire width of aquatic ecosystems where possible, or laying down pipes or culverts to ensure connectivity and avoid fragmentation of surface aquatic ecosystems. Bank stabilisation measures (gabions, eco logs, geofabric, sediment fences) are required when wetland or watercourse banks steeper than 1:5 are denuded during construction. Ensure erosion control along roads. Put in culverts at drainage lines. Build water diversion structures at 20 to 50 m intervals (depending on the steepness of the slope) along veld tracks. Soil should be dug out across veld tracks and used to create berms downslope of the ditch. Berms must be at least three times the width of the road, to prevent water running around the berm and back onto the tracks. Berm ends should be extended on the downslope side of the road with rocks to prevent diverted water eroding the soil. These will prevent veld roads acting as water channels, causing donga erosion. It will also facilitate vegetation recovery on closed roads. Storm water runoff off all roads must be spread as much as possible, to avoid concentration of flows off compacted or hardened surfaces.

*Phases

5. Discussion

a. EcoClassification

EcoClassification - the term used for the Ecological Classification process - refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The steps followed in the EcoClassification process are as follows:

- Determine reference conditions for each component.
- Determine the Present Ecological State for each component as well as for the EcoStatus. The EcoStatus refers to the integration of physical changes by the biota and as reflected by biological responses.
- Determine the trend (i.e. moving towards or away from the reference condition) for each component as well as for the EcoStatus.
- Determine causes for the PES and whether these are flow or non-flow related.
- Determine the Ecological Importance and Sensitivity (EIS) of the biota and habitat.

Present Ecological State or PES

The purpose of EcoClassification is to gain insight into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

The state of the river is expressed in terms of biophysical components:

- Drivers (physico-chemical, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (fish, riparian vegetation, riverine fauna (other than fish) and aquatic invertebrates).

The Brak River of the SQ reach D62D-05613 were evaluated as “Largely modified” with a PES category “D” (Table 27), based on the median of the metrics (DWS, 2014).

Table 27: A summary of the PES of the Brak River obtained from the DWS PES-EIS model (DWS, 2014).

Parameters	Potential modification (see list below)
Instream habitat continuity modification	3
Riparian/Wetland zone continuity modification	3
Potential instream habitat modification	2
Riparian/Wetland zone modification	3
Potential flow modification	2
Potential physico-chemical modification	1
PES Overall	**D**
	Largely modified

<u>Interpretation of Impact Ratings (referred by in Table 27):</u>

None. Reference. No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability. Rating = 0

Small. The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small. Rating = 1

Moderate. The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited. Rating = 2

Large. The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced. Rating= 3

Serious. The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced. Rating = 4

Critical. The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. Rating = 5

Ecological Category (EC)

EcoStatus Definition: "totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services". This ability relates directly to the capacity of the system to provide a variety of goods and services.

The driver components are assessed separately (i.e. an EC for each driver) and not integrated at a driver level to provide a driver-based indication of the EcoStatus. However, the individual metrics of all the driver components are assessed in a combined fashion that allows some comparison between metrics of all drivers. This facilitates deriving the cause-and-effect relationship that is required in the interpretation and assessment of particular biological responses.

The biological responses are assessed separately, but the resulting fish and macro-invertebrate ECs are integrated to provide an indication of the in-stream EC (Table 28). Logically, the integration of the riparian vegetation EC and the in-stream EC would provide the EcoStatus. The influence of the riparian vegetation on the in-stream habitat is used to interpret the biological responses and endpoints. This means that in some cases, the integrated in-stream biological responses are deemed to provide a reasonable indication of the EcoStatus.

Table 28: Assessing the Ecostatus and Ecoclassification of the Brak River.

INSTREAM BIOTA	Importance Score	Weight	EC %	EC
FISH				
1.What is the natural diversity of **fish** species with different flow requirements	2	70		
2.What is the natural diversity of **fish** species with a preference for different cover types	3	50		
3.What is the natural diversity of **fish** species with a preference for different flow depth classes	1	100		
4. What is the natural diversity of **fish** species with various tolerances to modified water quality	5	10		
FISH ECOLOGICAL CATEGORY	11	230	**50.0**	**D**
AQUATIC INVERTEBRATES				
1. What is the natural diversity of **invertebrate** biotopes	3	30		
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements	1	100		
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality	2	40		
AQUATIC INVERTEBRATE ECOLOGICAL CATEGORY	**6**	170	**50.0**	**D**
INSTREAM ECOLOGICAL CATEGORY (No confidence)		400	**50.0**	**D**

INSTREAM ECOLOGICAL CATEGORY WITH CONFIDENCE	Confidence rating	Proportions	Modified weights
Confidence rating for **fish** information	1	0.50	25.00
Confidence rating for **macro-invertebrate** information	1	0.50	25.00
	2	1.00	50.00
INSTREAM ECOLOGICAL CATEOGORY	**EC**		**D**

RIPARIAN VEGETATION	EC %	EC
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	**80.0**	**B**

ECOSTATUS	Confidence rating	Proportions	Modified weights
Confidence rating for instream biological information	1	0.25	12.50

Confidence rating for riparian vegetation zone information	3	0.75	60.00
	4	1.00	72.50
ECOSTATUS	**EC**		**C**

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): “Largely modified”, mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B “Largely natural with few modifications” and thus the increasing the overall EcoStatus to a C (72.5%): “Moderately modified” (Table 29).

Table 29: Generic ecological categories for EcoStatus.

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
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.	80-89
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 have occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Critical/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

6. Conclusion and summary

The table below (Table 30) provides the available parameters that were instrumental to establish the PES of the Project Area:

Table 30: Available parameters that was instrumental to establish the PES of the Project Area.

Parameter	Score %	Category	Description
In-stream IHI	78.8	B/C	Largely natural with few modifications
Riparian IHI	68.8	C	Moderate change
VEGRAI (Vegetation)	80.2	B/C	Largely natural with few modifications
MIRAI (Macro-invertebrates)		D	Low diversity
FRAI (Fish)		D	Low diversity
Mean Ecological Importance Class			Moderate
mean Ecological Sensitivity Class			Moderate
EcoStatus	72.5	C	Moderately modified
PES		D	Largely modified

Mitigation (Control measures)

Apart of the mitigation prescribed in the Risk Assessment Matrix, the following should be noted:

1. Rehabilitation (DWS, 2016)

(1) Rehabilitation as contemplated in paragraph 6(1)(v) above must be conducted in terms of a rehabilitation plan and the implementation of the plan must be overseen by a suitably qualified SACNASP professional member.

(2) Upon completion of the construction activities related to the water use –

(a) a systematic rehabilitation programme must be undertaken to restore the watercourse to its condition prior to the commencement of the water use;
(b) all disturbed areas must be re-vegetated with indigenous vegetation suitable to the area; and
(c) active alien invasive plant control measures must be implemented to prevent invasion by exotic and alien vegetation within the disturbed area.

(3) Following the completion of any works, and during any annual inspection to determine the need for maintenance at any impeding or diverting structure, the water user must ensure that all disturbed areas are:
(i) cleared of construction debris and other blockages;
(ii) cleared of alien invasive vegetation;

(iii) reshaped to free -draining and non -erosive contours, and
(iv) re-vegetated with indigenous and endemic vegetation suitable to the area.

(4) Upon completion of any works, the water user must ensure that the hydrological functionality and integrity of the watercourse, including its bed, banks, riparian habitat and aquatic biota is equivalent to or exceeds that what existed before commencing with the works.

For most of the anticipated impacts on the environment during the construction phase of the dam, there are very sound mitigation measures (DWAF, 2005: Environmental Best Practice Specifications), and when implemented the process should be overseen by an Environmental Control Officer (ECO).

2. Buffer zones

The areas surrounding the drainage lines in the project area (Brak River and tributaries), is classified as an Ecological Support Area (ESA) and according to the Department of Environment and Nature Conservation, Northern Cape, a 100 m buffer is suggested around the delineated riparian area or 100m measured from the top of bank. Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another.

Suggestion by the Department of Environment and Nature Conservation, Northern Cape:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

Buffer zones associated with water resources have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

Should a buffer zone be proposed, all the planned activities will be incorporated into this zone and the purpose of the buffer zone will be futile. However, the implementation of a buffer zone to emphasize the importance of the riparian zone and adjacent dry land will certainly augment the importance of the ecology in the project area. The area included in the buffer zone, as well as the core areas in the riverine zone should have explicit and very strict biodiversity conservation management measures and the operating teams should be well aware of this.

Therefore, a buffer zone for the project is suggested on both sides of the river in order to impose a level of best practices when the proposed construction gets under way.

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality.

While determining the area and distribution of a core habitat is important, it is equally important that appropriate management measures be determined to ensure the core habitat continues to function effectively. Biodiversity conservation management measures that need to be taken into consideration when determining management measures for core habitats and corridors include:

- Habitat and species management;
- Alien and invasive species management;
- Fire management;
- Grazing management; and
- The management of soil erosion and physical disturbances.

Determining the required buffer width is largely an exercise of assessing the situation and linking it to an acceptable level of risk. Determining appropriate management measures for aquatic impact buffer zones is largely dependent on the threats associated with the proposed activity adjacent to the water resource. These threats include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

3. Placing of Solar PV Plant

The project team took great care to position the location and construction footprint in such a way that all the identified sensitive areas were avoided (Figure 30). This realignment of the original project footprint (preferred option Area B) incorporated the 100m buffer zone and most suitable placement of the power line pylons.

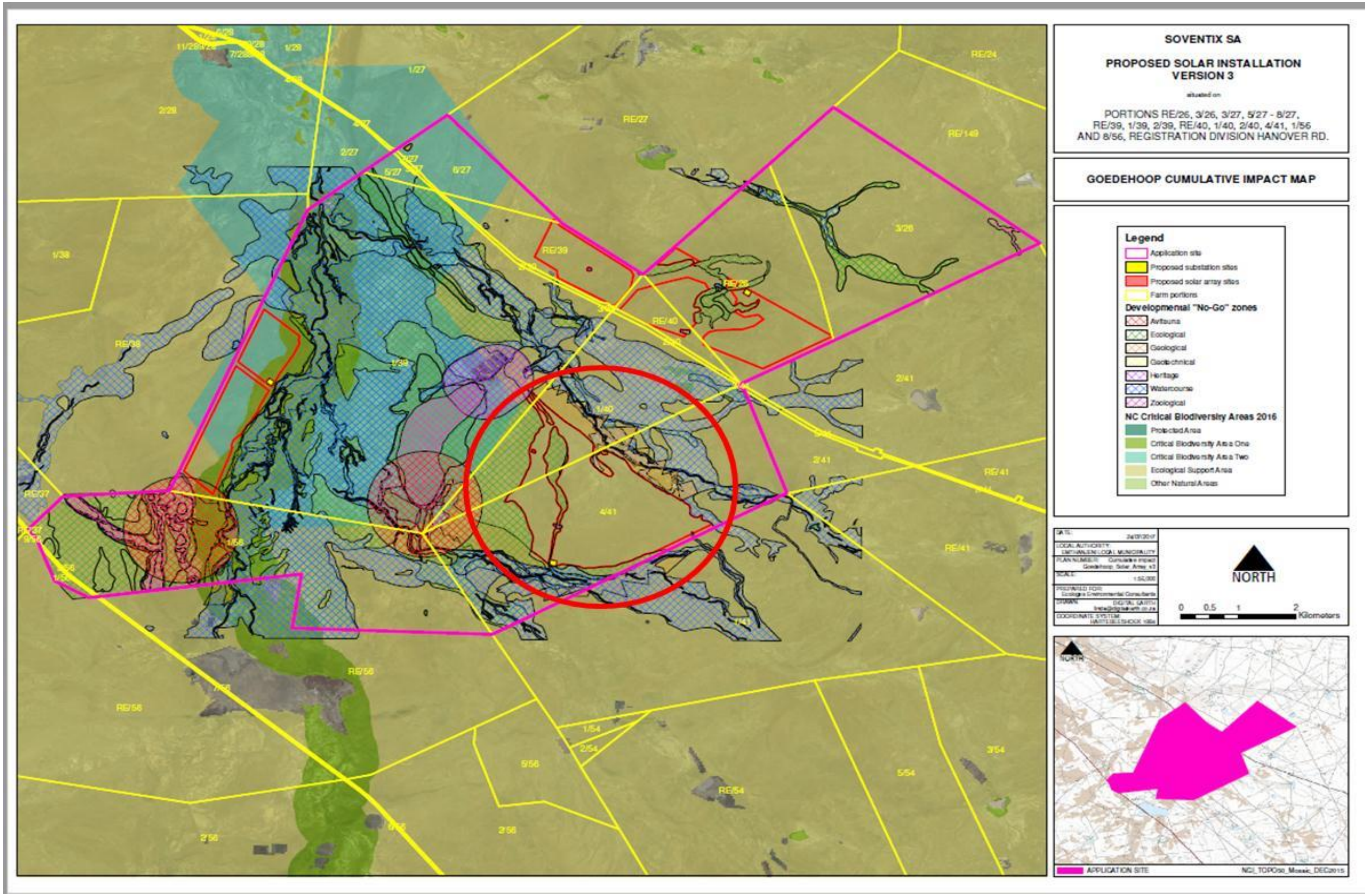


Figure 30: The position the location and construction footprint (inside red circle) in relation to all the identified sensitive areas.

REFERENCES

Belcher, T. 2013. Freshwater assessment for the proposed photovoltaic (solar) energy facilities on Du Plessis dam farm near De Aar, Northern Cape.

BGIS. 2016. BGIS Land Use Decision Support Report. Generated on the BGIS website: 05/01/2016.SANBI Biodiversity for Life.

Department of Water Affairs and Forestry, 1999. Ecoregional typing. Version 1.0: M:/f_rdm_october/rivers/version 1.0/riv_appR1_version1.0.doc.

Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWA&F, Pretoria. Republic of South Africa.

DWAF (2008). *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas,* prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs, South Africa, September 2013. The determination of water resource classes and associated resource quality objectives in the Inkomati Water Management Area: Status Quo assessment, Integrated Unit of Analysis delineation and biophysical node identification. Prepared by: IWR Water Resources. Authored by: Mallory S, Louw D, Deacon A, Holland, M, Huggins G, Kotze P, Mackenzie J, Scherman P, Van Jaarsveld P,. DWA Report, RDM/WMA05/00/CON/CLA/0213.

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

Department of Water and Sanitation (DWS). 2014. Risk-based water use authorisation approach and delegation protocol for Section 21(c) and (i) water uses: Edition 02, final October 2015.

Department of Water and Sanitation, March 2014. Guideline to regulate activities/developments affecting wetlands. First Edition. Pretoria.

Driver, A., JL Nel, K Snaddon, K Murray, DJ Roux, L Hill, ER Swartz, J Manuel & N Funke. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. (WRC Report No. 1801/1/11).

DWA Flow data - http://www.dwa.gov.za/Hydrology/Unverified/UnverifiedDataFlowInfo.aspx - DWA Home Page. Water is life, sanitation is dignity.

DWS WQ data - https://www.dwa.gov.za/iwqs/report.aspx - Resource Quality Information Services Data and Reports.

Ecoleges Environmental Consultants. 2017. Environmental Impact Assessment rReport (EIARr): Proposed Development of a 225MW Solar PV Plant on Several Portions of Farms in the Hanover District, Emthanieni Local Municiplaity, Pixley Ka Seme District Municipality, Northern Cape (File Reference Number: 14/12/16/3/3/998).

Jones & Wagener, 2017. Goedehoop solar power project: Hydrological Assessment. Report No.: JW201/17/G468-Rev 0.

Kleynhans, C. J., 1999. (draft) A procedure for the determination of the ecological management classes for the National Water Balance Planning Estimate for South African Rivers. Institute for Water Quality Studies.

Kleynhans, C.J., Louw, M.D., Thirion, C., Rossouw, N.J. & Rowntree, K. 2005. River EcoClassification: Manual for EcoStatus determination (Version 1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05.

Kleynhans CJ, Louw MD, Graham M, 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08

Kleynhans, C.J., Louw, M.D., Graham, M. 2009. Module G: EcoClassification and Ecostatus determination in River Ecoclassification: Index of Habitat Integrity (Section 1, Technical manual). Joint WRC and DWAF. WRC Report No. TT377/09.

Macfarlane, D.M., A. Teixeira-Leite, P. Goodman, G. Bate and C. Colvin. 2010. Buffer zones. Deliverable 5: Draft method & model. The Institute of Natural Resources and its Associates.

MacKenzie and Rountree, 2007. *Draft riparian delineation methods prepared for the Department of Water Affairs and Forestry, Version 1.0* (unpublished field notes).

Mucina, L. & Rutherford, M.C. (eds.) 2006. Vegetation of South Africa, Lesotho & Swaziland, Sterlizia 19. South African National Biodiversity Institute, Pretoria.

National Environmental Management: Biodiversity Act (Act No. 10 of 2004; RSA, 2004).

National Water Act (Act 36 of 1998), Republic of South Africa.

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

SANBI (2009). Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Van den Berg, H., De Wet, F. 2017. Soventix solar PV project in the Hanover district, Northern Cape. Soil and wetland assessment. Iris International.

APPENDICES

Appendix 1:

Supplementary Water Use Information (Section 21 (c) and (i) Water Uses; Section 21(c) - impeding of diverting the flow of water in a watercourse; Section 21 (i) - altering the bed, banks, course or characteristics of a watercourse)."

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

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SUPPLEMENTARY WATER USE INFORMATION
Section 21 (c) and (i) Water Uses
Section 21(c) ~ impeding of diverting the flow of water in a watercourse
Section 21 (i) ~ altering the bed, banks, course or characteristics of a watercourse

Please read:

(1) The requirements of this form should be discussed with the relevant Regional Office and Primary Responsible Official for these water uses during a pre-application consultation meeting and documented agreement reached in terms of:

(a) Assistance and information to be supplied by the Department (e.g. procedures (refer items 1.2.3 and 1.2.4), management objectives etc.) - this is of particular reference to emerging water users that are not in a position to provide the information as required in this form; and

(b) The scale and level of detail required.

(2) Should any of the supporting documentation to the licence application (e.g. Technical Report, Environmental Impact Assessment Report, Environmental Management Plan or Programme) already contain the requested information below, the applicant is not required to duplicate the information. In such instances, a comprehensive list of these documents must be compiled and this form must be completed by referring to the relevant sections in the supporting documentation.

(3) All maps, Google images, drawings and plans must be at an appropriate detailed scale and have sufficient annotations (North arrow, line scale, legend, co-ordinates, etc.).

(4) Information requirements in respect of Section 27 of the National Water Act, 1998 (Act No. 36 of 1998)[NWA] that have to be considered in the issuing of a licence, are appropriately incorporated and indicated in this form (e.g. item 2.2.3 <Provide information to support efficient and beneficial use of water in the public interest [refer Section 27(1)(c)]>).

(5) This form may be updated from time to time as required to comply with best practice and legal requirements. When completing this form, clearly date it since it will be evaluated against the information requirements related to the edition of the form at that time.

1. Watercourse Attributes	
1.1Locality	*1.1.1 < Provide a description of the location of the watercourse at which the water use/s is to take place>*
	1.1.2 <Provide a locality map/s indicating the relevant catchment[1], surrounding land use, towns, infrastructure etc.>
	1.1.3 <Provide the catchment reference number>
1.2 Description	*1.2.1 <Provide the name and/or description of the affected watercourse>*
	1.2.2 < Provide a map indicating the segment and affected reach/es of the watercourse in which the water use/s is to take place and which indicates/delineates the regulated area including: *1.2.2.1. The extent of the riparian habitat* *1.2.2.2. The 1:100 year flood line[2]>>*
	1.2.3 <Describe within context of the immediate catchment and segment, the historic as well as current state (Present Ecological State or PES) of the affected reach/es of the watercourse with regards to the following characteristics (attributes)[3]:

1 The order of the catchment is to be verified with the relevant Regional Office and Primary Responsible Official

2 The applicant will require a water use authorisation from the Department for any activity within the *regulated area* which is the outer edge of the riparian habitat or 1:100 year flood line, whichever is the greatest distance from the watercourse. The outer edge of the watercourse must be delineated using the Departmental guideline, *A Practical Field Procedure for Identification and Delineation of Wetlands and Riparian Areas* or *Field method for the delineation of Riparian Zones for South African Rivers*

3 Refer to the WRC Reports on Ecoclassification, specifically Report no TT 329/08 on determining EcoStatus

4 The EIS of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. Both biotic and abiotic components of the system are taken into account.

5 SI reflects the dependency of people on a healthy functioning watercourse and also to its cultural and tourism potential.

6 Refer to the RDM procedure for determining Ecological Importance and Sensitivity

7 Refer to the DWAF *Broad-Based Black Economic Empowerment (BBBEE) Guidelines For Water Allocation, Final Draft, June 2007* and the Department of Trade and Industry's requirements relating to compliance with the BBBEE Act, 2003 (Act No. 53 of 2003)

8 The applicant must provide information on how he/she implements the seven elements of BBBEE (i.e. Ownership, Management, Employment equity, Skills development, Procurement, Enterprise development, Socio-economic development) and how this complies with the relevant Sector Charter and score card (e.g. Construction, Agriculture, Mining, Tourism etc). A BBBEE certificate or external verification must accompany the application (refer list of Verification Agents on the Department of Trade and Industry's website)

9 Consult the relevant Regional Office and Primary Responsible Official

10 Assess the potential impacts with regard to their nature, extent, magnitude, duration, probability and significance – each impact must be described in terms of source of impact, pathway (propagation of impact) and receptor (target that experience the risk or impact)

	1.2.3.1. Flow and sediment regimes at appropriate flows *1.2.3.2. Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime* *1.2.3.3 Riparian and Instream Habitat.*
	1.2.3.3.1 Morphology (physical structure) *1.2.3.3.2 Vegetation* *1.2.3.4 Biota>*
	1.2.4 <Describe the ecological importance and sensitivity (EIS)as well as the Socio-cultural Importance (SI) of the affected reach/es of the watercourse including the functions[6]>
	1.2.5 <Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse>
	1.2.6 <List and map sensitive environments in proximity of the project locality-sensitive environments include wetlands, nature reserves, protected areas, etc.>
2. Water Use Information	
2.1 Description and Methodology	*2.1.1 <Describe the activities associated with the water use/s>*
	2.1.2 < Describe the project phases for each activity (i.e. planning, construction, operation and maintenance, decommissioning) including, but not limited to, the programme for and duration of the various phases
	2.1.3 < Provide a basic lay-out plan/s (master plan) indicating the various activities and existing and proposed infrastructure in relation to the 1:100 flood line and edge of the watercourse, etc>.
	2.1.4 < Provide work method statements for the various water use activities>
	2.1.5 < Provide engineer design drawing(s) for construction activities within the watercourse>
	2.1.6 < Provide a description and a map/s indicating any Storm Water Management Practices (SWMPs) specifically addressing 'end of pipe' practices>
	2.1.7 <Provide information on all existing lawful water uses (referSection 21 (1) (a)]>
	2.1.8 <Provide information on investments already made and to be made by the water user in respect of the proposed water use/s (ReferSection 27 (1) (h)]>
	2.1.9 <Indicate and motivate the probable duration of any undertaking for which the water use/s should be authorised (refer Section 27 (1)(k)]>
2.2 Motivation	*2.2.1 < Provide information on the need/intention/objective of the water use/s>*
	2.2.2 < Provide information on contributions to rectify the results of past racial and gender discrimination[7](refer Section 27 (1)(b)[8]]
	2.2.3 <Provide information to support efficient and beneficial use of water in the public interest (refer Section 27(1)(c)]
	2.2.4 < Provide information on relevant catchment strategies[9] and local government planning frameworks that support the proposed water uses (refer Section 21(1)(e)]
	2.2.5 < Provide information on the strategic importance of the water use to be authorised (refer Section 27(1)(i)]
3. Impact Assessment and Management	

3.1 Impact Prediction and Assessment	3.1.1 < Provide a prediction and assessment of the likely environmental and socio-economic impacts or effects[10] associated with the water use/s for different phases: 3.1.1.1 On the watercourse and its characteristics as set out in 1.2.3 above (refer Section 27(1)(f)] 3.1.1.2 On other water users (refer Section 27(1)(f)] 3.1.1.3 On the broader public and property 3.1.1.4 If the water use/s is not authorised (refer Section 27(1)(d)] 3.1.2 < Provide a description of the methodologies employed to undertake impact prediction and assessment as well as a motivation for these>
3.2 Risk Assessment	3.2.1 < Provide an assessment of the risks associated with the water use/s and related activities>
3.3 Alternatives	3.3.1 < Describe the alternatives considered to prevent negative impacts on the watercourse with regard to locality, procedures, materials etc.>
3.4 Mitigation and Management Measures	3.4.1 < Provide mitigation measures[4] to prevent, reduce, remediate or compensate the pre-determined impacts; also provide emergency response>
	3.4.2 < Provide a site map/s that marks the limits of disturbance to the watercourse and in particular indicates erosion and sediment controls> 3.4.3<If the developer (and applicant) of water use related infrastructure is not the end user/beneficiary and will not be responsible for long term maintenance of the infrastructure, provide a programme for hand over to the successor-in-title[12] including a brief management/maintenance plan for the infrastructure along with allocation of responsibilities>
3.5 Changes to the Watercourse	3.5.1 < Assess to what extent the impacts after mitigation will bring about changes in respect of the PES (and recommended ecological category, if this information is available at the stage of study) and functionality of the watercourse; as well as the socio-economic environment (including redress considerations as well impacts on other water users)>
3.6 Monitoring and Compliance	3.6.1 < Provide a detailed monitoring programme and describe the auditing, compliance and reporting mechanisms to ensure execution of the mitigation measures and for informing DWA&F of incidents – ensure that these measures are appropriate in relation to the impacts, mitigation measures, status of the watercourse, etc.>

4The mitigation measures should be collated in an Environmental Management Plan (EMP) – refer to the Department of Environmental Affairs and Tourism's regulations, Government Notice No R 385 in Government Gazette No 28753 of 21 April 2006 for minimum standards

Appendix 2: Finer detail EC rating table.

Rating	Deviation from reference conditions	A- F Categories	Natural – Poor categories	Score
0	No change	A	Natural	≥ 92.01
		A/B		>87.4 and <92.01
1	Small change	B	Good	82.01 – 87.4
		B/C		>77.4 and <82.01
2	Moderate change	C	Fair	62.01 – 77.4
		C/D		>57.4 and <62.01
3	Large change	D		42.01 – 57.4
		D/E		>37.4 and <42.01
4	Serious change	E	Poor	22.01 – 37.4
		E/F		>17.4 and <22.01
5	Extreme change	F		0 - 17.4

Appendix 3: Aquatic invertebrates and Fish assessments

<u>Task 1.2.3.4 Biota – Aquatic invertebrates and Fish</u>

Aquatic surveys

<u>1.2.3.4.1 Aquatic invertebrate assessment</u>

Benthic macro-invertebrate communities of the selected sites will be investigated according to the SASS5 approach. An invertebrate net (30 x 30cm square with 0.5mm mesh netting) will be used for the collection of the organisms. The available biotopes at each site will be identified on arrival. Each of the biotopes will then be sampled separately and by different methods. Sampling of the biotopes will be done as follow:

Stones in current (SIC): Movable stones of at least cobble size (3 cm diameter) to approximately 20 cm in diameter, within the fast and slow flowing sections of the river. Kick-sampling is used to collect organisms in this biotope. This is done by placing the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick-sampling) for ± 2 minutes.

Stones out of current (SOOC): *Where the river is calm, such as behind a sandbank or ridge of stones or in backwaters.* Collection is again done by method of kick-sampling, but in this case the net is swept across the area sampled to catch the dislodged biota. Approximately 1 m^2 is sampled in this way.

Sand: These include sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river where flow was slow or no flow was recorded. This biotope is sampled by stirring the substrate, shuffling or scraping of the feet is done for half a minute, whilst the net is continuously swept over the disturbed area.

Gravel: Gravel typically consists of smaller stones (2-3 mm up to 3 cm). Sampling is similar to that of sand.

Mud: *It consists of very fine particles, usually as dark-coloured sediment.* Mud usually settles to the bottom in still or slow flowing areas of the river. Sampling is similar to that of sand.

Marginal vegetation (MV): *This is the overhanging grasses, bushes, twigs and reeds from the riverbank.* Sampling is done by holding the net perpendicular to the vegetation (half in and half out of the water) and sweeping back and forth in the vegetation (± 2m of vegetation).

Aquatic vegetation (AQV): *Rooted, submerged or floating waterweeds such as Potamogeton, Aponogeton and Nymphaea.* Sampling is done by pushing the net (under the water) against and amongst the vegetation in an area of approximately one square meter.

The organisms sampled in each biotope will be identified and their relative abundance is also noted on the SASS5 datasheet. Habitat assessments, according to the habitats sampled, will be performed due to the fact that changes in habitat can be responsible for changes in SASS5 scores. This will be done by the application of SASS orientated habitat assessment indices. The indices to be used are the IHAS score sheet and the HQI.

The SASS5 method will be used to establish the macro-invertebrate integrity and it will be attempted to sample all three of the main habitat assemblages: stones, vegetation and sand/mud/gravel. The associated habitats were determined with the IHAS and the HQI.

Although the SASS5 method will be used as prescribed by the DWS, it must be kept in mind that this method was designed for water quality purposes. Therefore the macro-invertebrate integrity scores may vary throughout the year as water quality changes, due to flow variation, as should be the case in the pre- and post-construction phases of the proposed development.

1.2.3.4.2 Fish communities - Fish Response Assessment Index (FRAI)

The biotic assessment method uses a series of fish community attributes related to species composition and ecological structure to evaluate the quality of an aquatic biota. Data on distribution, richness, length frequency and abundance will be collected. The sampling methods available are fish traps, seine nets, mosquito nets and electro-fishing.

Fish segment identification, species tolerance ratings, abundance ratings, frequency of occurrence and health status techniques will be applied during this survey to determine the integrity of the fish communities.

On arrival at the site a basic on site visual appraisal is made of the habitats available on that particular day at that particular flow. A site diagram is sketched indicating the different habitats and the various components thereof. Sampling takes place in each of the different habitats. These different habitats are sampled separately using different methods.

a) Electro-shocking

Electro-shocking commences in the downstream component of the habitat. One person uses a backpack electro-shocker for shocking, using a scoop net to catch the stunned fish. The researcher progresses upstream, keeping the fish caught in a bucket until that particular habitat is finished. Each habitat shocked is timed. It is necessary to take care (as far as possible) when shocking so as not to disturb the rest of the habitat still to be worked. As each habitat is completed the fish species caught, are identified, recorded and released back into their respective habitats.

Any fish species that cannot be identified at the time is preserved in 10% formalin (in a sample bottle with label inside) for later identification by experts. The data sheet is completed for that particular habitat – recording every fish, its age class (adult, sub-adult, juvenile) and whether any fish is diseased (e.g. visible ecto-parasites). Each habitat type is recorded (e.g. shoot, riffle or pool etc.), as well as the width, depth, substrate, the extent sampled, the percentage of algae on substrate, whether there was any vegetation, and the turbidity. The flow of that particular habitat is classified into one of five flow classes (no flow, slow flow, medium flow, fast and very fast flow).

The electro shocking device is used to sample certain habitats: shoots, riffles, rapids, shallow- medium depth pools in stream and off stream, runs and back waters.

b) Cast net

A cast net (a weighted circular net that is thrown into the water) is used in pool type or slower flow and deeper habitats. As with method (a) all aspects of the habitat type are recorded as well as the fish species, numbers, age class and health. The number of throws / efforts per a habitat is also recorded.

Appendix 4: RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

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 considered and listed in RED font.

					Severity								
No.	**Phases**	**Activity**	**Aspect**	**Impact**	**Flow Regime**		**Physico & Chemical (Water Quality)**		**Habitat (Geomorph + Vegetation)**		**Biota**		**Severity**
1		**EXAMPLE:** Clearing of vegetation in close proximity to or in a watercourse	Creating Access roads for infrastructure										

Risk being posed to "resource quality" as defined in the Act must be scored according to the Risk Rating Table for Severity. A Severity score is then generated.

Severity	**Spatial scale**	**Duration**		**Consequence**		**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**		**Likelihood**	**Significance**	**Risk Rating**

Consequence, Likelihood and finally Significance scores are automatically calculated with the rest of parameters according to respective Risk Rating Tables.

Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE

RISK = CONSEQUENCE x LIKELIHOOD
CONSEQUENCE= SEVERITY + SPATIAL SCALE + DURATION
LIKELIHOOD = FREQUENCY OF THE ACTIVITY+ FREQUENCY OF THE IMPACT + LEGAL ISSUES + DETECTION

ONLY LOW RISK ACTIVITIES located within the regulated area of the watercourse will qualify for a GA according to this Notice. Medium and High risk activities will require a Section 21 (c) and (i) water use licence.

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

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

Negative Rating

TABLE 1- SEVERITY

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

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

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

TABLE 2 – SPATIAL SCALE

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

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

TABLE 3 – DURATION

How long does the aspect impact on the resource quality?

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

TABLE 4 – FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4

Daily	5

TABLE 5 – FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the resource quality?

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

TABLE 6 – LEGAL ISSUES

How is the activity governed by legislation?

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

TABLE 7 – DETECTION

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

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

TABLE 8: RATING CLASSES

RATING	CLASS	MANAGEMENT DESCRIPTION

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

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

TABLE 9: CALCULATIONS

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

RISK ASSESSMENT MUST BE CONDUCTED BY A SACNASP REGISTERED PROFESSIONAL MEMBER AND THE ASSESSOR MUST:

1) CONSIDER BOTH CONSTRUCTION AND OPERATIONAL PHASES OF PROPOSED ACTIVITIES;

2) CONSIDER RISKS TO RESOURCE QUALITY POST MITIGATION CONSIDERING MITIGATION MEASURES LISTED IN TABLES PROVIDED;

3) CONSIDER THE SENSITIVITY (ECOLOGICAL IMPORTANCE AND SENSITIVITY – EIS) AND STATUS (PRESENT ECOLOGICAL STATUS - PES) OF THE WATERCOURSE AS RECEPTOR OF RISKS POSED;

4) CONSIDER POSITIVE IMPACTS/RISKS REDUCTION AS A VERY LOW RISK IN THIS ASSESSMENT;

5) INDICATE CONFIDENCE LEVEL OF SCORES PROVIDED IN THE LAST COLUMN AS A PERCENTAGE FROM 0 - 100%.

ON THE EXCELL SPREADSHEET POP-UP COMMENTS ARE AVAILABLE FOR ALL COLUMNS IN THE HEADINGS WHICH EXPLAINS THE PURPOSE OF EACH COLUMN!