Bloemsmond Grid Connection Infrastructure
Near Upington, Northern Cape

Aquatic Specialist Study

for

Bloemsmond Grid (Pty) Ltd

June 2019

by

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DECLARATION OF CONSULTANTS INDEPENDANCE

This report was compiled by Jacqueline (Jackie) Dabrowski, the Director of Confluent Environmental (Pty) Ltd. Jackie holds a Ph.D. in Veterinary Science and her post-graduate studies were in the field of freshwater ecology. She has conducted research and published scientific articles on a range of topics including aquatic food webs, fish health, and trends in water quality, branchiopod diversity, and land-use impacts on water quality. Her consulting work has focussed on a range of environmental assessments of dams, rivers, ephemeral watercourses and wetlands at various locations in South Africa.

At the time of conducting this study, I declare that:

- I am an independent specialist consulting in the field of Aquatic Science;
- I do not have any financial interest in the undertaking of the activity, apart from remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- I do not have any vested interest in the proposed activity proceeding;
- I will not engage in any conflicting interests in the undertakings of the activity;
- I undertake to disclose to the competent authority any relevant information with the potential to influence the decision of the competent authority or the objectivity of the report; and,
- I will provide the competent authority with access to all information at my disposal regarding the application, whether this information is favourable to the applicant or not.

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1 INTRODUCTION

1.1 BACKGROUND

Bloemsmond Grid (Pty) Ltd is proposing the development of the Bloemsmond photovoltaic (PV) facilities which consists of 5 PV developments as well as associated infrastructure on sites to be located within Portion 5 and Portion 14 (two adjacent farm portions) of the farm Bloemsmond 455. The PV developments will connect to the National Grid via the Upington Main Transmission Substation (MTS). Confluent Environmental (Pty) Ltd were appointed to provide aquatic specialist inputs to a Basic Assessment Report (BAR) for the development of the proposed grid connection infrastructure. The inputs of an aquatic specialist are required for the BAR and Water Use Authorisation (WUA) of the target area where the grid connection infrastructure will be located. In addition, a professional opinion is required on surface hydrological issues pertaining to the target area and potential mitigation and measures to aid in future decisions regarding the proposed project and to minimise the significance of identified impacts. Bloemsmond Farm 455 is located approximately 30 km south west of Upington and 16 km north east of Keimoes in the Kai !Garib Local Municipality (ZF Mgcawu District Municipality) in the Northern Cape.

1.2 DEVELOPMENT DESCRIPTION

Technology proposed for the PV developments consists of arrays of photovoltaic (PV) solar panels each with a net generating capacity of 100MW. In order to connect to the National Grid, each of the PV developments will connect via the Bloemsmond Collector Substation (Location: 28°35'16.57"S; 21° 2'33.88"E) to the Upington MTS (Figure 1). Four overhead power lines are required for the Bloemsmond Grid Connection Infrastructure:

- **B3BC**: a single circuit 33kV or 132kV line from Bloemsmond 3 substation/ switching station to the Bloemsmond Collector Substation
- **B4BC**: a single circuit 33kV or 132kV line from Bloemsmond 4 substation/ switching station to the Bloemsmond Collector Substation
- **B5BC**: a single circuit 33kV or 132kV line from Bloemsmond 5 substation to the Bloemsmond Collector Substation
- **COLLECTOR-MTS:** a double circuit 132kV line from the Bloemsmond Collector Substation to the Upington MTS

There are two alternative routes for **B4BC**, **B5BC** and **COLLECTOR-MTS**:

B4BC:

- Eastern alternative (preferred): a single circuit 33kV or 132kV line from Bloemsmond 4 eastern alternative substation running to the eastern boundary of Portion 14 of Bloemsmond 455, and then south along the boundary and west to the Bloemsmond Collector Substation
- Western alternative: a single circuit 33kV or 132kV line from Bloemsmond 4 western alternative substation running along the western boundary to the Bloemsmond Collector Substation

B5BC:

- Eastern alternative (preferred): a single circuit 33kV or 132kV line from Bloemsmond 5 eastern alternative substation running along the eastern boundary to the Bloemsmond Collector Substation
- Western alternative: a single circuit 33kV or 132kV line from Bloemsmond 5 western alternative substation running along the western boundary to the Bloemsmond Collector Substation

Two proposed layouts are being considered for the connection between the **Bloemsmond Collector and the Upington MTS**: Alterative A to the north and Alternative B to the south.

- Alternative A is approximately 10.5 km in length and routes via the approved/ constructed Dyasonsklip Substation and on to the Upington MTS, and
- Alternative B goes southwards from the Bloemsmond Collector along the eastern boundary of Bloemsmond Farm 455 and then runs adjacent to the Eskom Aries-Upington 400kV servitude and is approximately 9.5 km from the Bloemsmond 455 farm boundary to the Upington MTS.

The grid connection infrastructure comprises switching stations / substations, three single circuit 33kV or 132kV lines from on-site facility substations to the Bloemsmond Collector Substation, and one double circuit 132KV power line from the Bloemsmond Collector Substation to the Upington Main Transmission Substation (MTS). There will be an internal network of access roads which will measure up to 8 m width and a maximum of 15 km in length. Two main access roads are proposed along the Eastern Alternative and the Western Alternative boundaries which connect to the N14 national road.

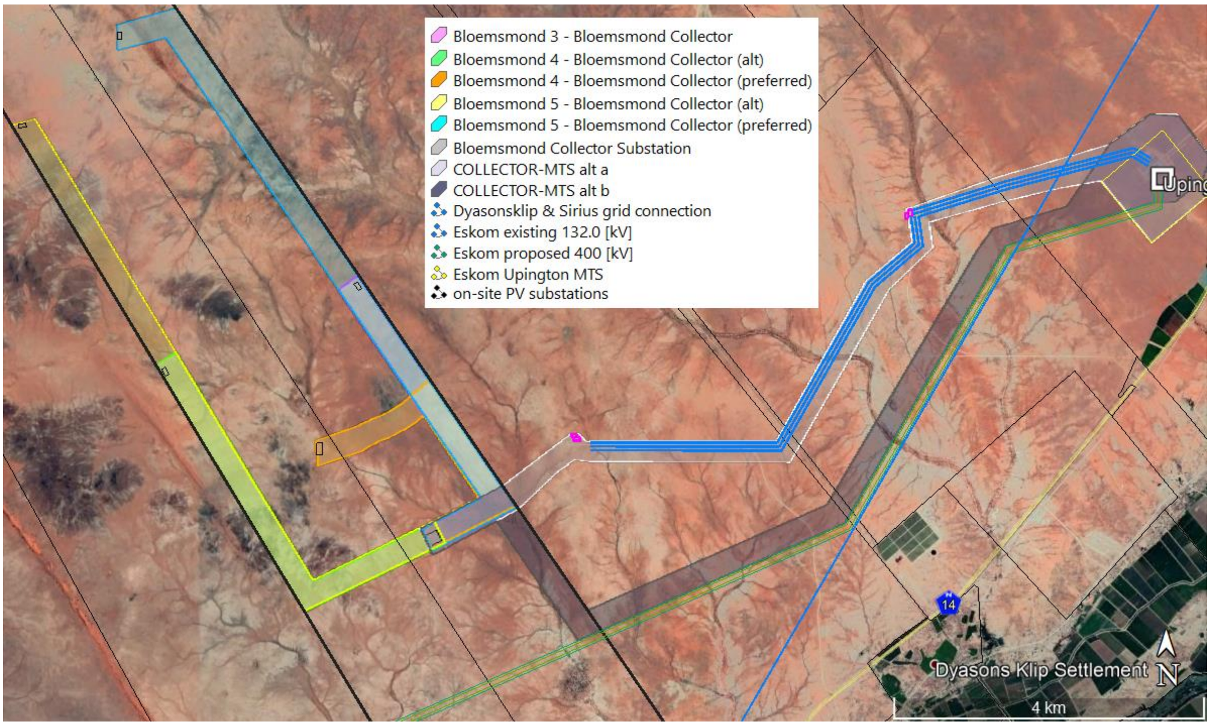

Figure 1. Proposed layout of the Bloemsmond Grid Connection Infrastructure corridor alternatives.

1.3 SCOPE OF WORK

The scope of work covers the following aspects:

- Characterisation of the affected aquatic ecosystem in relation to its current and reference condition using methods recognised by the Department of Water and Sanitation (DWS) to determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS);
- Classify and delineate all watercourses affected by the different alternative layouts at the site;
- Consideration of the development of the grid connection infrastructure within the broader catchment context;
- Identification and assessment of the mitigated and unmitigated environmental impacts resulting from all phases of the development (design & layout, construction, operational etc.);
- Make recommendations for the preferred alternative grid connection corridors; and,
- Provision of recommendations for mitigating and monitoring impacts.

1.4 RELEVANT LEGISLATION

Any reference to a watercourse in this report is based on the definition in the National Water Act (NWA; Act 36 of 1998) which defines a watercourse as:

a) a river or spring;
b) a natural channel in which water flows regularly or intermittently;
c) a wetland, lake or dam into which, or from which, water flows ; and
d) any collection of water which the Minister may, by notice or Gazette, declare to be a watercourse.

Additional legislation relevant to this report includes:

- General Authorizations (GAs): As promulgated under the National Water Act and published under GNR 398 of 26 March 2004;
- South African Constitution Act 108 of 1996;
- National Environmental Management Act 107 of 1998;
- Environment Conservation Act (ECA) (No 73 of 1989) and amendments; and,
- National Environmental Management Act: Biodiversity Act / NEMA:BA (Act No. 10 of 2004) and amendments.

1.5 ASSUMPTIONS AND LIMITATIONS

- This assessment is based on the findings of a visual assessment of the site combined with available desktop resources. This study was not informed by detailed geohydrological or hydrological assessments;
- The assessment was conducted once-off during the late wet season and therefore lacks detailed information on seasonal and inter-annual variation inherent in natural ecosystems.
- The study area is very large, and it was not possible to inspect every individual drainage line. As a result, site-specific variations in sensitivity may have been missed in this report;
- Limited information was available with regard to the construction methods required for the grid connection infrastructure.

2 ATTRIBUTES OF THE AFFECTED AQUATIC ECOSYSTEM

2.1 CATCHMENT CONTEXT

The Farm Bloemsmond 455 and all corridor alternatives for the Bloemsmond Grid Connection Infrastructure are located within Quaternary Catchment D73F which drains into the Orange (alias Gariep) River (Figure 2). The Orange River is the only perennial river in the catchment which is otherwise dominated by non-perennial drainage lines and ephemeral pans and washes. Land-use at the farm is currently livestock and game farming with the dominant impact being grazing. However, the dominant land-use is likely to change as the study area is located within Renewable Energy Development Zone (REDZ) 7 which has been identified for large scale renewable energy facilities.

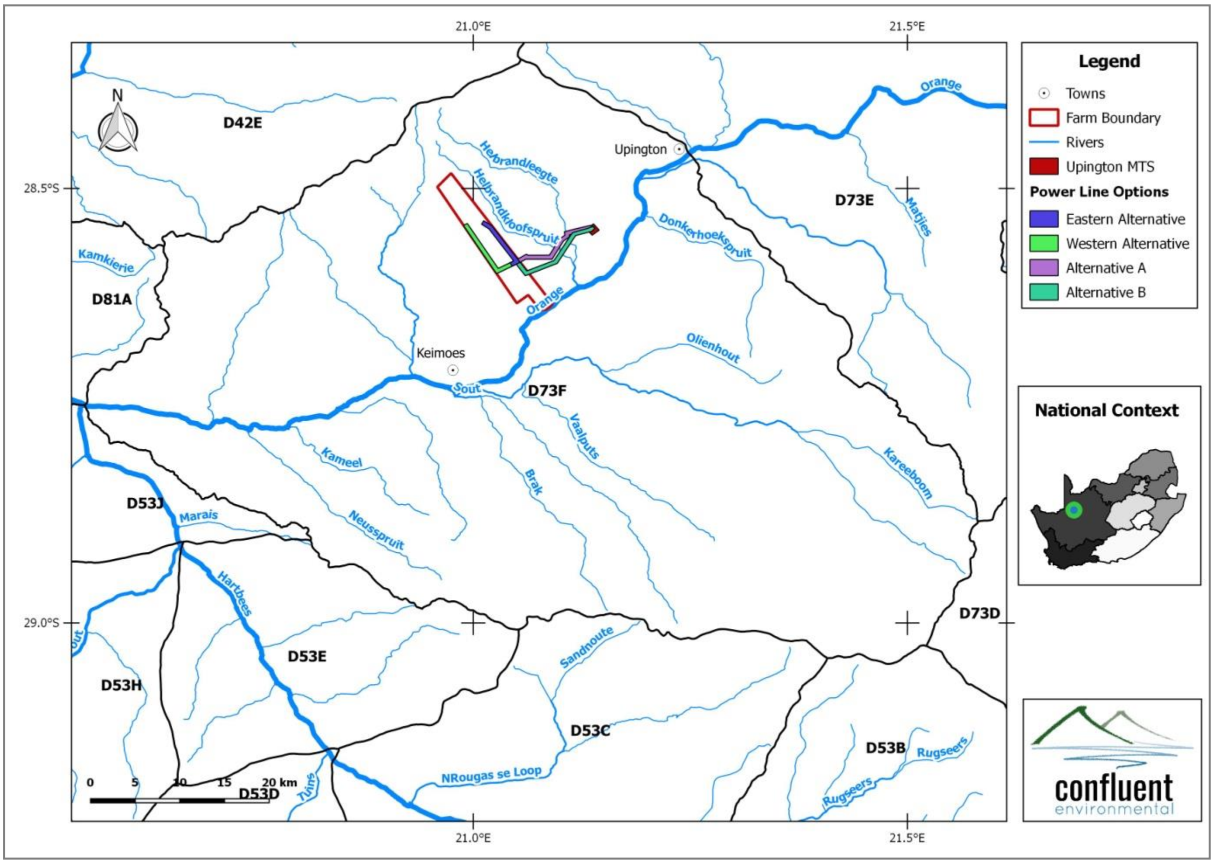

Figure 2. Location of Bloemsmond Farm and grid connection infrastructure corridor alternatives in relation to quaternary catchments.

2.2 ECOREGION AND VEGETATION

Bloemsmond Farm 455 as well as the proposed grid connection infrastructure corridor alternatives are located in Ecoregion 26.05 of the Nama Karoo. Terrain is characterized by Irregular plains, dune hills with parallel crests and lowlands, and slightly irregular plains. The Mean Annual Precipitation is 0 – 300mm with most rainfall occurring in mid to late summer. The vegetation type mapped for Bloemsmond Farm 455 is mostly Kalahari Karroid Shrubland, and the two corridor alternatives from the Bloemsmond Collector to the Upington MTS are mostly mapped as Bushmanland Arid Grassland (Mucina & Rutherford, 2006). The transition zone between these vegetation types occurs within the boundaries of the study area and characteristics of both vegetation types may be present in each area. The conservation status of both vegetation types is Least Threatened.

2.3 WATERCOURSE CLASSIFICATION

Aquatic ecosystem classification was determined according to a range of resources including Ollis *et al*. (2013). Watercourses associated with Bloemsmond Farm 455 and the grid connection infrastructure corridor alternatives are shown in Figure 1. All the aquatic systems in the study area are inland and are located in the Nama Karoo in Ecoregion 26.05. The drainage lines and alluvial washes occur on plains as well as slopes, while the pans occur on plains. The hydrological regime for all drainage lines is non-perennial with intermittent flows. The pans are ephemeral, and largely dependent on rainfall. A more detailed description of watercourses at the site is provided in the following sections.

2.3.1 Drainage Lines

Drainage lines follow flow paths through low points, connecting to form larger drainage lines, and ultimately, rivers. There are no perennial streams or rivers, but during heavy rainfall events surface water runs off, creating channels which support distinctive bands of riparian vegetation. Riparian vegetation provides cover for terrestrial fauna for feeding, breeding and dispersal in the landscape. Drainage lines act as conduits for flood waters, delivering them to main stem rivers. As such, they should be retained in good condition to ensure water quality is not negatively affected downstream. Both of the Bloemsmond Collector-Upington MTS corridor alternatives cross the Helbrandkloofspruit and the Helbrandleegte stream. Both drainage lines are non-perennial tributaries of the Orange River.

2.3.2 Pans

The pans in the study area are shallow depressions, usually oval in shape and measuring 20-50 m in diameter, but this may not be the case when they are associated with washes (see Section 2.3.3). The hydrology of pans at the site is not well understood, but they probably receive water from a combination of rainfall, river (drainage line) flow, and ground water. Some drainage lines are interspersed by pans. Pans that retain water and do not drain to other watercourses are termed endorheic (inward draining). They lose their water through evaporation or infiltration. Exorheic (outward draining) pans may drain a portion of their water into a drainage line or wash which can be via surface flow or interflow. The pans are not vegetated but have a distinct fringe of vegetation around their perimeter. Pans in this region typically host a range of branchiopod crustaceans which are specially adapted to survival in short-lived hydrological regimes. Their eggs survive extended dry periods and they emerge and mature rapidly when stimulated by wet conditions. Branchiopods are an important link in the terrestrial food web as they convert plant material (algae and detritus) into protein which is a valuable food resource, particularly for birds.

2.3.3 Alluvial Washes

Alluvial fans (within the washes) and washes do not fall into any of the HGM units defined by Ollis *et al*., (2013). Washes are characterised by unconsolidated alluvial sediments. Braided washes are common in low gradient arid systems with minimal valley confinement such as at the study area. They may have multiple channels and transient gravel bars. Washes may be cryptic and difficult to follow in the landscape as distinct channels can wash out into unconsolidated alluvium, also referred to as floodout zones. These areas play an important role in ground water recharge from floods as channelled flows are dispersed to shallow sheet flow which readily infiltrates the unconsolidated alluvium.

2.4 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS (NFEPA)

The study area is located within three separate NFEPA sub-quaternary reaches (SQRs). These are SQR 3051 for Helbrandkloofspruit, SQR 2996 for Helbrandleegte stream, and SQR 3193 which includes the Orange River (Figure 3; Nel *et al*., 2011).

SQR 3051 and SQR 2996 are classified as Upstream Management Areas with the following management objectives:
These are sub-quaternary catchments in which human activities need to be managed to prevent the degradation of downstream Protected Areas and Fish Support Areas.

SQR 3193 is classified as a Fish Support Area because it incorporates a large portion of the Orange River which hosts a high diversity of fish species. SQRs in this category have the following management objectives:
Fish sanctuaries are sub-quaternary catchments that are required to meet biodiversity targets for threatened and near threatened fish species indigenous to South Africa. Fish sanctuaries also include SQRs that are important for migration of threatened and near threatened fish species. River reaches in Fish Support Areas need to be maintained in a condition that supports the associated populations of threatened fish species.

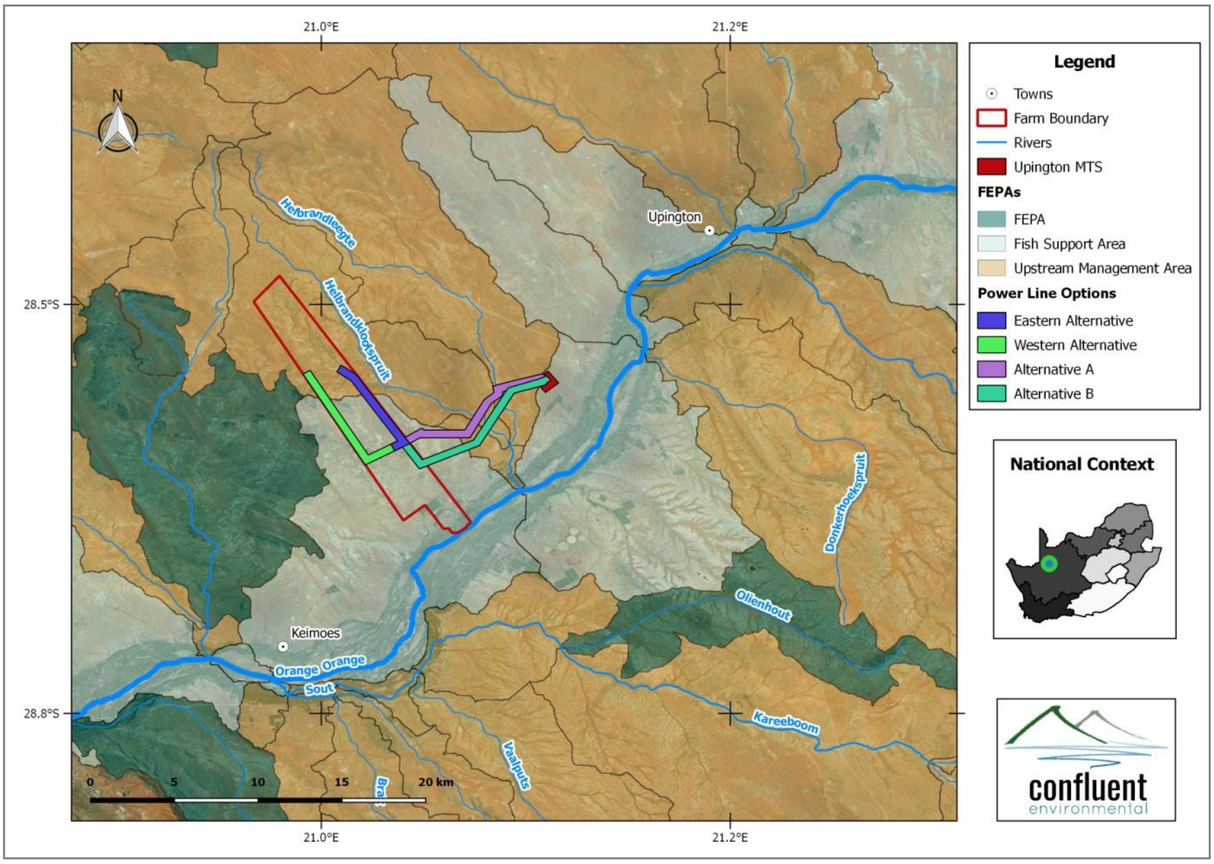

Figure 3. Map of the study area in relation to NFEPA areas.

2.5 CONSERVATION STATUS

The Northern Cape Critical Biodiversity Areas (CBAs; 2016) does not identify any CBAs within Bloemsmond Farm 455, which is classified as Other Natural Area. The Helbrandkloofspruit and Helbrandleegte Stream are classified as an Ecological Support Area (ESA).

2.6 DESKTOP PRESENT ECOLOGICAL STATE & ECOLOGICAL IMPORTANCE AND SENSITIVITY (PESEIS)

Water resources can be defined by their degree of modification or impairment. Resource Quality and Information Services at DWS developed the desktop Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) assessment to achieve this for every sub-quaternary reach (SQR) in South Africa. The EI and ES class categories are rated as an indication of the vulnerability of the river reach to environmental modification. EI refers to biophysical aspects in the SQR that relate to its capacity to function sustainably. ES considers SQR attributes related to the sensitivity of biota to environmental changes such as flow, water quality and geomorphology. The EIS is determined using a combination of expert knowledge and geospatial data to assess the estimated fish and macro-invertebrate species, along with riparian vegetation and vertebrates, and assessments of habitat (DWS, 2014). The PES categories used to describe the current condition of South African rivers are presented in Table 1.

Table 1: Present ecological state categories (DWS, 2014)

Ecological category	Description
A	Unmodified, natural
B	Largely natural
C	Moderately modified
D	Largely modified
E	Seriously modified
F	Critically / extremely modified.

The desktop Present Ecological State (PES; DWS, 2014) for SQR 3051 and 2996 was not determined because both the Helbrandkloofspruit and Helbrandleegte systems are ephemeral. The riparian zone associated with drainage lines in both SQRs was assessed and their EI was classed as Moderate. The methods used by DWS in desktop PESEIS assessments lean heavily toward impacts affecting communities of aquatic taxa including fish and macroinvertebrates, which are mostly absent from ephemeral systems. The PES determined for SQR 3193 does not add much value as it concerns the state of the Orange River in this river reach.

2.7 HISTORICAL CONTEXT

The oldest historical aerial image that could be obtained was from 1964. This shows that the footprint of the study area is very similar in appearance to the present day (Figure 4). The drainage lines and pans appear to be located in much the same position as their current location.

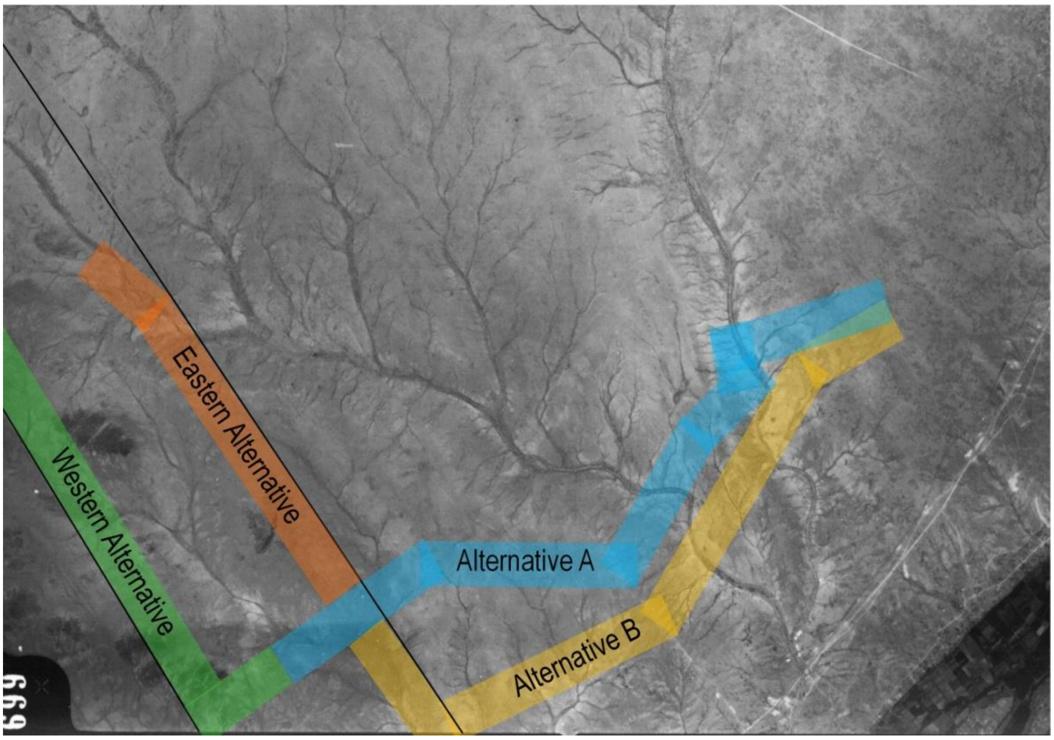

Figure 4. Historical aerial photo (1964) showing the approximate layout of the grid connection infrastructure corridor alternatives on Bloemsmond Farm 455 and to the Upington MTS.

3 METHODS

3.1 SITE VISIT

The site was visited between 23 April and 26 April 2019 (4 days), which is considered to be representative of the late wet season. There was widespread light rainfall in the area on the day and evening before fieldwork commenced (22 April) resulting in small pools of water in rock pools. The rainfall was however insufficient to result in any surface flows or pooling in drainage lines or pans in the area.

3.2 SENSITIVITY MAPPING

Watercourses were delineated following the methods developed by DWAF for the delineation of wetlands and riparian areas (2008). In arid regions such as the Nama Karoo, vegetation is the best indicator for delineation of riparian zones along drainage lines as there is a very distinct change in vegetation structure characterized by robust growth forms compared to adjacent terrestrial areas. For pans (wetlands) in arid areas the conventional methods of wetland delineation are not appropriate. The soils of temporary wetlands in very arid areas are often too shallow, too saline, or too temporarily inundated to exhibit typical wetland features such as gleying and mottling (Day *et al*., 2009). Hydrophytic vegetation indicators are also not reliable indicators of wetlands in arid environments. During infrequent periods of inundation plants may include annual macrophytes and algae, but during long dry conditions, plants are typically terrestrial, often ruderal species that are not adapted to life in saturated soils (Day *et al*., 2009). As a result, the centre of arid pans in the area of inundation may be bare of vegetation. Other indices such as the presence of branchiopod crustaceans hatched from sediments of suspected wetlands can be used to confirm cryptic wetlands in arid environments. Similar to the drainage lines at Bloemsmond Farm 455, terrestrial vegetation surrounding pans had a distinctive, more robust growth form that was utilised for their delineation. Satellite imagery was used for the delineation of all watercourses as vigorous growth associated with watercourses was easily observable. This method could be extended to the presence of alluvial washes associated with drainage lines and pans, because vegetation in these zones also displayed more robust growth forms.

Ephemeral drainage lines and to a lesser extent alluvial washes are a common feature of the landscape at Bloemsmond Farm 455. Therefore a system of grading drainage lines in terms of their ecological and hydrological function was developed in order to indicate drainage lines and washes of more / less importance. The grading system took the following parameters into account:

- Channel width (wider, more developed channels carry more water);
- Extent and structure of the riparian zone (width and presence of large shrubs and trees);
- Presence of vegetated sandbars and braiding along the river bed;
- Connectivity with other drainage lines;

- Evidence of degrading impacts (e.g. rubbish dumping, alien plants, vegetation removal, erosion, instream barriers);

Each system was determined to be of low, moderate or high sensitivity based on observations in the field and using satellite imagery. An example of typical drainage lines allocated these scores is provided in Figure 5. Buffers ranged depending on sensitivity with Low at 10m, Moderate at 20m and High at 30m.

All ephemeral pans are considered High sensitivity sites and are allocated a 50m buffer around the perimeter. They play an important role in providing standing (lentic) water following rainfall which supports drinking and feeding requirements for a wide range of taxa. They support specially adapted crustaceans (branchiopods) which convert detritus and algae into an important source of protein for birds. Very little is known about the taxonomy and distribution of the branchiopods of arid pans. Water infiltration from pans also replenishes ground water (Figure 6).

Figure 5. Example of drainage lines typical of Low (a), Moderate (b) and High (c) sensitivity at Bloemsmond Farm 455

Figure 6. A typical pan located on Bloemsmond Farm 455.

3.3 PRESENT ECOLOGICAL STATE DETERMINATION

3.3.1 Drainage Lines

Drainage lines were assessed collectively because they were determined to be in a very similar state with minimal impacts. The method used to determine the PES was the Index of Habitat integrity (IHI; Kleynhans, 1996) which measures the impact of human disturbance on riparian and instream habitats. The IHI is a rapid assessment of the severity of impacts affecting habitat integrity within a river reach. It can be applied to both perennial and non-perennial watercourses. The instream impacts considered were: water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; and rubbish dumping. The riparian impacts assessed were: vegetation removal; exotic vegetation; bank erosion; channel modification; water abstraction; inundation; flow modification; physico-chemistry. Each of the impacts is given a score based on the degree of modification. An IHI class is then determined based on the resulting score (Table 2).

Table 2. Index of habitat integrity (IHI) classes and descriptions.

Integrity Class	Description	IHI Score (%)
A	Natural	> 90
B	Largely Natural	80 – 90
C	Moderately Modified	60 – 79
D	Largely Modified	40 – 59
E	Seriously Modified	20 – 39
F	Critically Modified	0 – 19

3.3.2 Pans

The RDM-99 protocol for rapid assessment of palustrine wetlands (on depressions or flats) was applied (DWAF, 1999) to determine the PES of pans within the study area. The Wetland Index of Habitat Integrity (IHI) and WET-Health methods (Macfarlane *et al*., 2008) were not used in this case because they were not developed for application to wetland flats or depressions. These methods were developed for floodplain, peat and valley-bottom wetlands The RDM-99 method evaluates a range of impacts potentially affecting the hydrology, water quality, geomorphology and biota of depressions and wetland flats. These impacts are scored from 0 – 5, with 0 being critically modified, and 5 being natural. Each score is allocated a level of confidence ranging from 1 being low confidence up to 4 being very high confidence. The end result is a PES score with the same categories as those presented in Table 2.

3.4 BRANCHIOPOD DIVERSITY

Given the limited understanding of the taxonomy and distribution of branchiopods in arid pans, branchiopods were collected from the site in order to positively identify them and determine whether any rare or new species occur at the site. Nauplii (juveniles) were collected from small standing pools where they had already emerged and were returned to the laboratory where they were raised to sexual maturity for identification. Sediment samples were collected from a number of dry pans at Bloemsmond Farm and were rewet in order to stimulate emergence of branchiopods and raise them to maturity.

4 RESULTS

4.1 SENSITIVITY MAPPING

Results for mapping the sensitivity of watercourses within Bloemsmond Collector-Upington MTS Alternatives A and B are presented in Figure 7. Both alternatives cross the Helbrandleegte Stream and Helbrandkloofspruit which are classified as high sensitivity drainage lines. In addition, Alternative B crosses and runs parallel to an unnamed high sensitivity drainage line prior to connecting to the Eastern Alternatives for B3BC, B4BC, and B5BC on Bloemsmond Farm 455. There are no pans located in the footprint of Alternative A, while there are 3 pans within the footprint of Alternative B (two small and one large). Both alternatives have approximately the same number of potential stream crossings, but there are a higher number of low sensitivity crossings for Alternative A (Table 3).

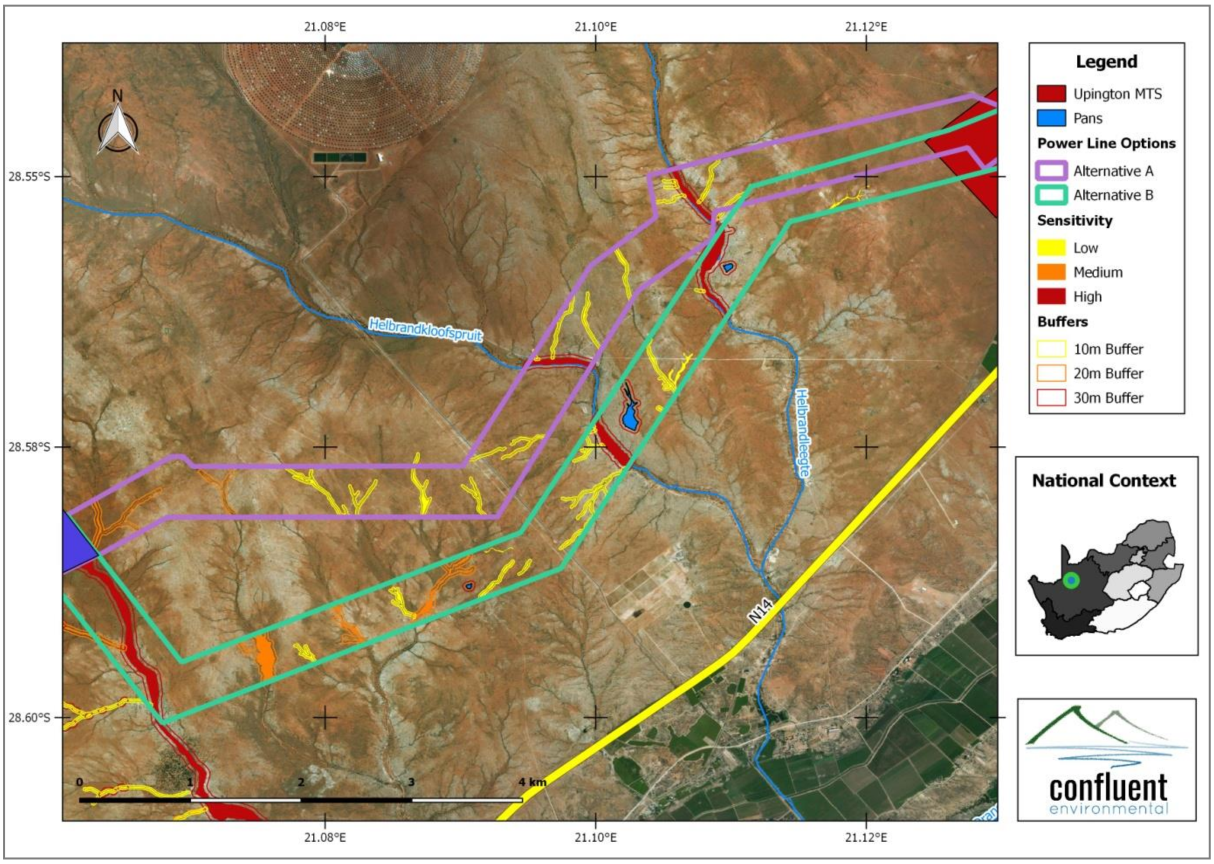

Figure 7. Sensitivity map for watercourses within Bloemsmond Collector-Upington MTS Alternative A and B corridors.

Results for mapping the sensitivity of watercourses within the corridor alternatives from the facility substations to the Bloemsmond Collector are presented in Figure 8. The Eastern alternative corridors have two high sensitivity drainage lines at the northern and southern extent which should be avoidable. However, the power line from Bloemsmond 5 would need to run parallel to the northern drainage line for a short distance. There are no high sensitivity drainage lines in the Western alternative corridors, but there are a higher number of low sensitivity crossings compared to the Eastern alternative corridors (Table 3). The Eastern alternative corridors have two small connected pans, while the Western Alternative corridors have no pans.

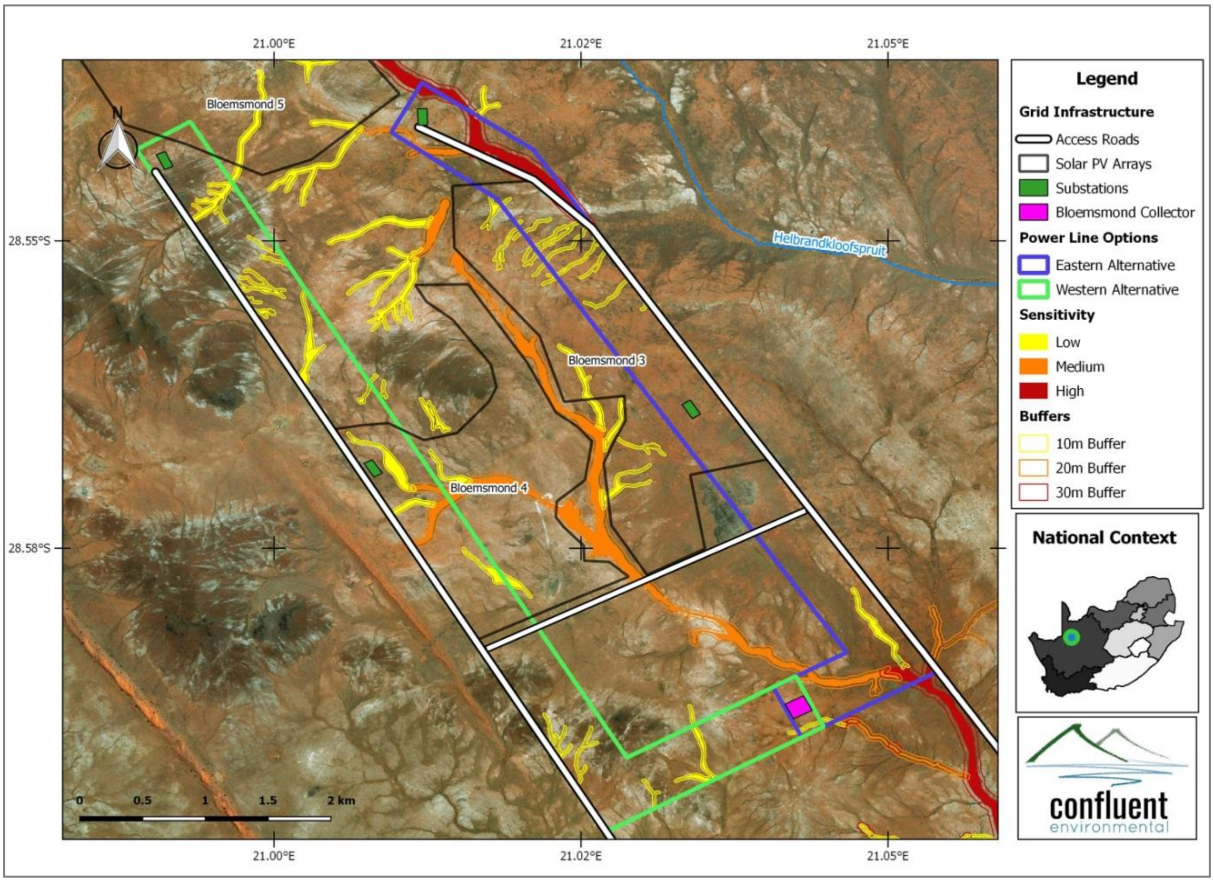

Figure 8. Sensitivity map for watercourses within the corridor alternatives from the facility substations to the Bloemsmond Collector.

The number of unavoidable drainage line crossings per grid connection corridor alternative was tallied. Unavoidable means that the width of the grid connection corridor more-or-less intersects the drainage line and no deviation within the corridor would result in missing the drainage line. Where drainage lines run almost parallel to the inner edge of the grid connection corridor they can easily be avoided, and have not been counted. The total number of crossings was then separated into the low, medium and high sensitivity drainage line crossings. In addition, the number of pans (automatically high sensitivity) per grid connection corridor alternative were presented (Table 3). A similar process was followed for 3 proposed Access Roads: The Western Access Road (referred to as Alternative 1(new) in spatial layers); The Eastern Access Road (referred to as Alternative 2 (unconfirmed / new) in spatial layers); and, Access Road Link 3 & 4 (referred to as 3 & 4 Link Rd in spatial layers). In terms of length, the Western Access Road is 7.1 km, the Eastern Access Road is 10.9 km and the Link Road between Bloemsmond 3 and 4 is 2.9 km.

Table 3. Comparison of drainage line crossings and pans present in the grid connection corridor alternatives and access roads at Bloemsmond Farm 455.

Gridline Alternative	PANS	Total DL	Low Sensitivity DL	Medium Sensitivity DL	High Sensitivity DL
MTS Alternative A	0	13	8	3	2
MTS Alternative B	3	12	5	4	3
	2	8	7	1	0
	0	13	12	1	0
B3BC					
B4BC Eastern Alternative					
B4BC Western Alternative					
B5BC Eastern Alternative					
B5BC Western Alternative					
Access Rd Western[1]	0	11	9	2	0
Access Rd Eastern[2]	0	13	10	3	0
Access Rd Link 3 & 4[3]	0	3	2	1	0

DL = Drainage Lines; [1] This is also referred to Alternative 1 (new) in spatial layers; [2] This is also referred to as Alternative 2 (unconfirmed / new) in spatial layers; [3] This is also referred to as 3 & 4 Link Road in spatial layers

4.2 PREFERRED ALTERNATIVES BASED ON SENSITIVITY MAPPING

On the basis of the least number of crossings of medium and high sensitivity watercourses, the preferred options were selected. For the grid connection between the Bloemsmond Collector and the Upington MTS, the preferred option is Alternative A. Within Bloemsmond Farm 455, the preferred options for the corridor alternatives from the facility substations to the Bloemsmond Collector are the Eastern Alternatives of B4BC and B5BC, provided the high sensitivity drainage lines at the southern and northern extent can be given a wide berth and will not be crossed by the power lines. There is no alternative for B3BC but the corridor is acceptable provided the high sensitivity drainage lines at the southern and northern extent can be given a wide berth and will not be crossed by the power lines. If there is a choice between the Western and Eastern access roads, then the Western Access Road (alias Alternative 1) is the preferred alternative because it is shorter in distance than the Eastern Access Road and crosses fewer drainage lines in its path (Table 3). There is no alternative provided for the Link Road between Bloemsmond 3 and 4 however it is considered acceptable from an aquatic perspective.

4.3 PRESENT ECOLOGICAL STATE

4.3.1 Drainage Lines

The drainage lines located across all the grid connection corridor alternatives are all in a very similar ecological state and have had minimal negative impacts. As a result their PES was collectively assessed and results of the IHI are presented in Table 1. The majority of drainage lines are completely unmodified with some localised areas slightly impacted by dirt track crossings or grazing / browsing impacts by livestock. As a result their PES was collectively classified as **A, natural or closely approaching natural.** Both the Helbrandkloofspruit and the Helbrandleegte stream are important drainage lines with large well developed braided channels. Riparian vegetation is dense and woody with very large trees (for the area) and shrubs (Figure 9).

Table 4. PES determined using the Index of Habitat Integrity for drainage lines crossed by the proposed grid connection corridor alternatives.

Habitat Modification	Score	Comments
INSTREAM HABITAT		
Water abstraction	0	Not observed
Flow modification	0	Not observed
Bed modification	3 (Small)	Few small dirt track crossings
Channel modification	3 (Small)	Few small dirt track crossings
Physico-chemistry	0	Not observed
Inundation	0	Not observed
Alien macrophytes	0	Not observed
Introduced aquatic fauna	0	Not observed
Rubbish dumping	0	Not observed
PES = A,Natural		
RIPARIAN HABITAT		
Vegetation removal	5 (Small)	Minor vegetation disturbance at dirt track crossings and livestock impacts
Exotic vegetation	0	Not observed
Bank erosion	0	Not observed
Channel modification	3 (Small)	Localised disturbance at dirt track crossings
Water abstraction	0	Not observed
Inundation	0	Not observed
Flow modification	0	Not observed
Physico-chemistry	0	Not observed
PES = A, Natural		

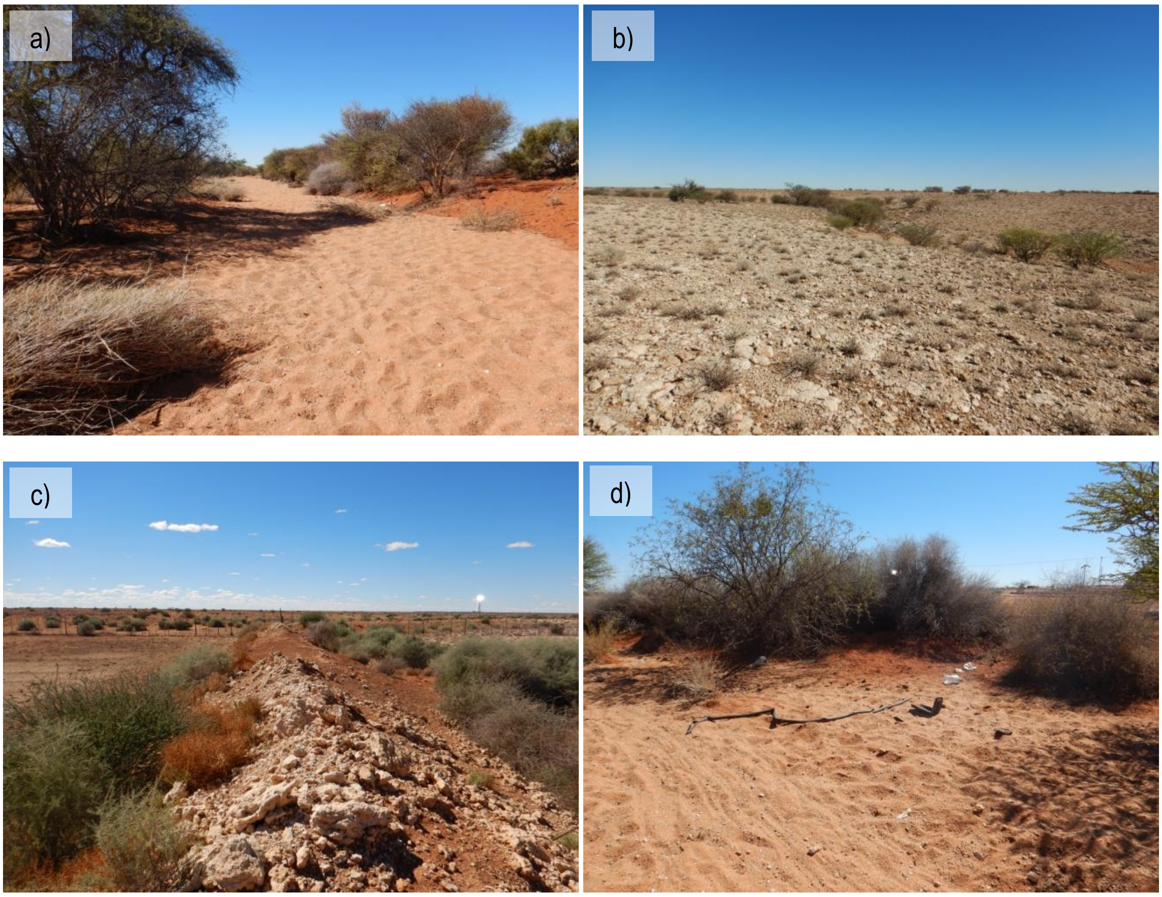

Figure 9. Drainage lines in the study area showing a) distinct bed and banks, and large trees and shrubs in stream and in the riparian zone of Helbrandkloofspruit; b) a typical drainage line evident by large shrubs; c) the instream embankment on the drainage line to the north-east of the B5BC Eastern Alternative; and, d) some minor rubbish dumping in the Helbrandleegte Stream.

Only a few of the drainage lines assessed had different or more significant impacts than this. The Helbrandkloofspruit on the Bloemsmond Collector – Upington MTS Alternative A has some minor rubbish dumping and an embankment has been built along the outer edge of the riparian zone (Figure 9). These modifications appear to be associated with an incomplete abandoned lodge/entertainment venue. Nearby the MTS on Alternative A there are approximately 3 drainage line crossings by a large tar road. The north-eastern edge of the B5BC Eastern Alternative corridor has one section of drainage line excavated and dammed by an embankment in order to increase instream capacity and store water when it rains. The PES for this drainage line was classified as **B, largely natural** with few modifications. This drainage line was the only one in the study area to be classified with a PES lower than A. There were no drainage lines with more than minimal impacts in the Western Alternative corridors or Alternative B from the Bloemsmond Collector to the MTS. Riparian vegetation is mostly dominated by large indigenous shrubs and trees and the instream habitat consists of unconsolidated sand and gravel. The riparian vegetation is conspicuous because it consists of the largest trees and shrubs in the landscape, providing habitat for a range of biota.

4.3.2 Pans

There were no pans within the footprint for Alternative A from the Bloemsmond Collector to the Upington MTS or the Western Alternative corridors within Bloemsmond Farm 455. There were two small (20-30 m diameter) connected pans located within the B4BC and B5BC Eastern Alternative corridors and three separate pans within the Bloemsmond Collector – Upington MTS Alternative B.

There were no major impacts observed for the two small pans identified in the B4BC and B5BC Eastern Alternative corridors. The only impact affecting their PES was the possibility of over-utilisation of vegetation due to grazing pressure by livestock farming over the years. The resulting PES determined using the RDM-99 was classified as **A, Natural** (Table 5). These two pans are unlikely to be strictly endorheic because they are located along a drainage line. This suggests that they are connected via surface and/or sub-surface flows.

The two smaller pans located within the Bloemsmond Collector – Upington MTS Alternative B were similar in size and condition to the two pans located within the B4BC and B5BC Eastern Alternative corridors (Figure 10 d). However, they are not part of a larger drainage system and are therefore likely to be endorheic, predominantly receiving water from rainfall. The PES of these two pans was also classified as **A, Natural**.

Table 5. Combined PES assessment of two connected pans in the B4BC and B5BC Eastern Alternative corridors and the smaller pan in the Bloemsmond Collector – Upington MTS Alternative B using the RDM-99 method

Criteria	Comments	Score	Confidence
Hydrological			
Flow modification	No modification	5	4
Permanent Inundation	No modification	5	4
Water Quality			
Water quality modification	None observed	5	4
Sediment load modification	None observed	5	4
Geomorphology			
Canalisation	None	5	4
Topographic alteration	No modifications	5	4
Biota			
Terrestrial encroachment	Not observed	5	4
Indigenous vegetation removal	None observed	5	4
Invasive plant encroachment	None observed	5	4
Alien fauna	Goats and other livestock	4	4
Overutilisation of biota	Possible grazing / browsing pressure from livestock	3	3
Overall PES Category		**A**	**3.9**

The only pan with different and more serious impacts was the larger of the two pans within the Bloemsmond Collector – Upington MTS Alternative B (Table 6). This pan measures about 80m in diameter and is located nearby the Helbrandkloofspruit (Figure 10 a). The surrounding area is heavily grazed, and troughs provide drinking water for a range of free-roaming game and livestock. The perimeter of the entire pan has had holes excavated every few meters for no apparent reason (Figure 10 b). This may have been for fence poles, but the holes appear to be too large. Given these modifications, the PES of the pan was classified as **B, Largely Natural**. Although the pan has been modified, the modifications are relatively minor and the hydrology and geomorphology of the pan are not likely to have been significantly affected.

Table 6. PES assessment of the larger pan in the Bloemsmond Collector – Upington MTS Alternative B using the RDM-99 method

Criteria	Comments	Score	Confidence
Hydrological			
Flow modification	No modification	4	3
Permanent Inundation	No modification	5	4
Water Quality			
Water quality modification	None observed	4	3
Sediment load modification	None observed	4	3
Geomorphology			
Canalisation	None	5	4
Topographic alteration	No modifications	3	4
Biota			
Terrestrial encroachment	Not observed	5	4
Indigenous vegetation removal	None observed	3	3
Invasive plant encroachment	None observed	5	3
Alien fauna	Goats and other livestock	3	4
Overutilisation of biota	Possible grazing / browsing pressure from livestock	3	3
Overall PES Category		**B**	**3.5**

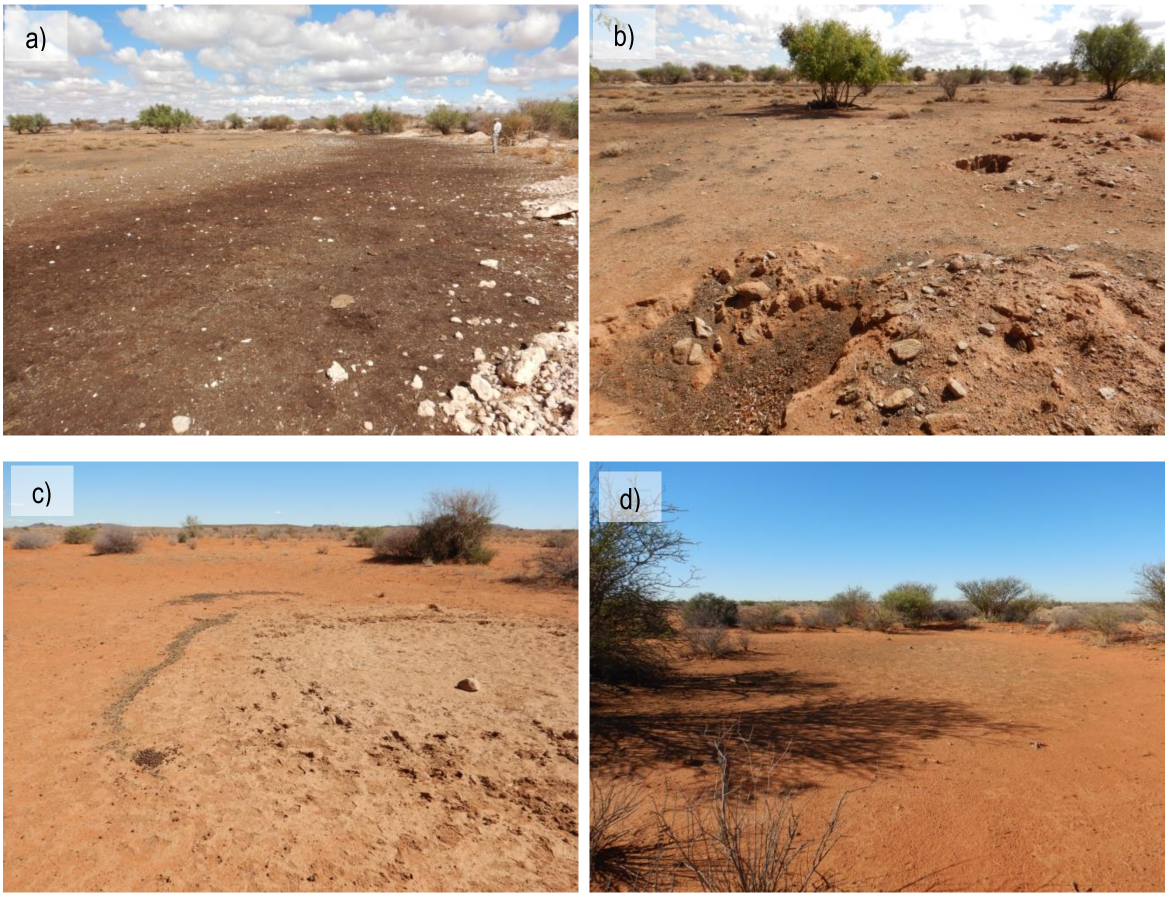

Figure 10. Photos showing the larger pan within the Bloemsmond Collector – Upington MTS Alternative B (a), and the holes that have been dug around the perimeter (b), one of the small connected pans from the B4BC and B5BC Eastern Alternative corridors (c), and one of the smaller pans within the Bloemsmond Collector – Upington MTS Alternative B (d).

5 BRANCHIOPOD DIVERSITY

Branchiopods were collected from rock pools and mud sediments from pans within the Bloemsmond 5 development area. The fairy shrimps and clam shrimps identified in this study were collected from the shallow rock pool shown in Table 7. The species identified are likely to be found elsewhere on Bloemsmond Farm 455 and surrounding areas in any suitable habitat such as pans, or on rocky substrates where water pools after rainfall.

The biodiversity of ephemeral pools at Bloemsmond Farm 455 is typical of the community of crustaceans reported in arid areas of southern Africa. The species of fairy shrimps, tadpole shrimps and clam shrimps identified are widespread in the Northern Cape.

A range of crustaceans adapted to extended periods of desiccation (drying out) were identified. These are presented in Table 7 with associated images in Figure 11.

Table 7. Crustaceans found at Bloemsmond Farm 455

Class	Order	Species (if identified)
Ostracoda (seed shrimps)		
Copepoda		
Branchiopoda	Anostraca (fairy shrimps)	*Branchipodopsis tridens*
	Conchostraca (clam shrimps)	*Leptestheriellla inermis*
	Notostraca (tadpole shrimps)	*Triops granarius*
	Cladocera (water fleas)	

The 0.2mm diameter eggs produced by these crustaceans rest in the sediment of pans and pools for extended periods (> 20 years) until they are stimulated to emerge following rewetting (Figure 11b). Development occurs rapidly so that reproduction occurs 4 – 7 days following rewetting, before the pool has a chance to dry out. If the sediments of these pools are disturbed or excavated, the egg bank could be lost. If the hydrological regime is altered from ephemeral to permanent inundation (e.g. through pumping in borehole water) the loss of desiccation phase interrupts the life cycle and these crustaceans can no longer persist.

Figure 11. Images of a copepod (a), anostracan (fairy shrimp) egg circled in sediment (b), an adult fairy shrimp (*Branchipodopsis tridens*) (c), and male and female clam shrimps (*Leptestheriella* sp.; (d).

6 IMPACT ASSESSMENT

The impact assessment considers direct, indirect and cumulative impacts to the aquatic ecosystem that may arise during the design, layout, construction and operational phases of the proposed grid connection corridor alternatives and access road alternatives at Bloemsmond Farm 455. Individual impacts are rated according to criteria which include their intensity, duration and extent. The ratings are then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence = type x (intensity + duration + extent)

Where type is either negative or positive. The significance of the impact is then calculated by applying the probability of occurrence to the consequence as follows:

Significance = consequence x probability

The criteria and their associated ratings are shown in Table 8.

Table 8. Categorical descriptions for impacts and their associated ratings

Category	Description	Rating
Intensity	Negligible	1
	Very low	2
	Low	3
	Moderate	4
	High	5
	Very high	6
	Extremely high	7
Duration	Immediate	1
	Brief	2
	Short term	3
	Medium term	4
	Long term	5
	Ongoing	6
	Permanent	7
Extent	Very limited	1
	Limited	2
	Local	3
	Municipal area	4
	Regional	5
	National	6
	International	7
Probability	Highly unlikely	1
	Rare	2

	Unlikely	3
	Probably	4
	Likely	5
	Almost certain	6
	Certain	7

Categories assigned to the calculated significance ratings are presented in Table 9.

Table 9. Value ranges for significance ratings.

Significance rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact is considered from the perspective of whether losses / gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence is also determined and rated as low, medium or high (Table 10).

Table 10. Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage, but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage, and is not represented elsewhere.	Substantial data supports the assessment

6.1 LAYOUT AND DESIGN PHASE IMPACTS

A summary of the impacts associated with the layout and design phase with and without mitigation is presented in Table 11. The current grid connection corridor alternatives and access road alternatives provides alternative options for consideration by specialists who can then further inform the layout and design phase. From an aquatic ecosystem perspective the optimal layout is the one that impacts least on sensitive watercourses. Based on the sensitivity maps produced for all the grid connection corridor alternatives, it is possible to identify common impacts that require mitigation in every alternative. Where there are alternative specific mitigation measures required these are highlighted. As discussed in the sensitivity mapping section, the preferred alternative for the grid connection from the Bloemsmond Collector to the Upington MTS is Alternative A, and within Bloemsmond Farm the B3BC, B4BC and B5BC Eastern Alternative corridors are preferred. Considering the latter, it is fortunate that the Eastern Access Road is also the preferred road access alternative.

At Bloemsmond Farm 455, drainage lines and alluvial washes are so numerous in the landscape that it is not realistic to expect that the power lines or access roads would be able to avoid every single one. However, situations where power lines cross drainage lines, or run parallel to them in close proximity should be avoided. This is to protect infrastructure from the effects of flooding, and to reduce the risk of impacts affecting fauna making use of drainage lines. The layout should consider routing power lines away from high sensitivity watercourses (including pans) as far as possible.

Mitigation Measures

- Apart from road crossings where necessary, no infrastructure (e.g. pylons) should be planned in any watercourse to avoid erosion and disturbance of the watercourse (bed, banks and riparian zone), as well as potential damage to infrastructure during surface flooding. Infrastructure may span low sensitivity drainage lines provided supports are placed outside of buffered areas;
- Where it is necessary for power lines and roads to cross drainage lines, these crossings should be perpendicular to the drainage line in order to reduce impacts;
- Where sensitive areas such as pans occur ensure that access roads and / or power lines are diverted at least 50m around them (the width of the buffer zone).
- The layout of power lines and access roads should aim as far as possible not to surround watercourses with infrastructure (e.g. a pan sandwiched between a road and a fence);
- Limited development may be planned in buffer zones of low sensitivity watercourses;
- Buffer zones for pans and the pans themselves are no-go zones.

6.1.1 Access Roads

When planning the layout of access roads in the study area, there are additional mitigation measures that may be taken to reduce negative impacts.

Mitigation Measures

- Road crossings should ensure the continuity of substrate and flows in the watercourse;
- Construct road crossings on straight channel segments, avoiding meanders;
- As with gridline crossings, road crossings should be perpendicular to the stream;
- As far as possible, road layouts should follow the paths of existing roads to minimize cumulative impacts unless an alternative route is identified that has significantly fewer drainage line crossings;
- Review the layout of roads in relation to sensitive areas and ensure the minimum number of road crossings is achieved, in low sensitivity drainage lines only (if possible). For instance, the current route for the preferred B4BC and B5BC Eastern Alternative corridors appears to have one or two

unnecessary road crossings of a high sensitivity drainage line to the north which could quite easily be reduced;

6.1.2 Stormwater Management

The region is naturally arid and has low annual rainfall, but in the event of significant rainfall events stormwater from impervious surfaces will need to be effectively managed to limit erosion and conserve water. Impervious surfaces in this case mainly refer to tarred roads and buildings such as the substations and visitor centre etc. The impacts of stormwater management have been assessed collectively because the mitigation measures would apply to any of the alternative options selected for development.

Mitigation Measures

- Minimise alteration to existing drainage networks as far as possible avoiding levelling or infilling as this will alter flow paths causing flooding and erosion;
- Rainwater collection tanks should be installed on building roofs in order to reduce the risk of channelled flows from gutters, and store water for a variety of uses (e.g. dust suppression);
- Consider the use of alternative materials for paved and parking areas that allow greater water infiltration rates such as gravel;
- Considering the beneficial effects of vegetation in terms of intercepting rainwater and reducing erosion, plan to minimize the disturbance of vegetation as much as possible;
- Should stormwater need to be discharged into a drainage line from any surface, methods of energy dissipation such as stilling basins should be employed to reduce flow velocities entering the watercourse. Where this type of modification to flows as well as the bed and banks of the watercourse are concerned, the plan should be reviewed by an aquatic specialist to ensure the risk of degradation is not too great.
- Stormwater should be diverted away from roads early and often so as to disperse flows widely;

Table 11. Summarised impact rating table for the layout and design phase for the corridor alternatives from the facility substations to the Bloemsmond Collector

Impact	Intensity	Duration	Extent	Probability	Significance	Reversibility	Irreplaceability	Confidence
Impact: Further refinement of the development layout								
Without mitigation	5 (High)	6 (Ongoing)	3 (Local)	6 (Almost certain)	Moderate (-)	Medium	Medium	High
With mitigation	3 (Low)	4 (Medium term)	3 (Limited)	4 (Probably)	Minor (-)	Medium	Medium	High
Impact: Layout of access roads								
Without mitigation	5 (High)	5 (Long term)	3 (Local)	4 (Probably)	Minor (-)	Medium	Medium	High
With mitigation	4 (Moderate)	4 (Medium term)	1 (Very limited)	3 (Unlikely)	Negligible (-)	High	Low	High
Impact: Stormwater management								
Without mitigation	3 (Low)	4 (Medium term)	2 (Limited)	3 (Unlikely)	Negligible (-)	Medium	Medium	High
With mitigation	2 (Very Low)	2 (Brief)	1 (Very limited)	2 (Rare)	Negligible (-)	High	Low	High

6.2 CONSTRUCTION PHASE IMPACTS

6.2.1 Disturbance to watercourse bed and banks

During the construction phase heavy machinery and other vehicles may need to cross watercourses. While this practice should be avoided wherever possible, it may be necessary where drainage lines cross the full extent of the grid connection corridors. In areas where there are numerous drainage lines this may result in heavy machinery entering and traversing watercourses as they manoeuvre. This may destabilise consolidated sediments resulting in erosion and downstream sedimentation. It could also result in compaction of soil and destruction of riparian vegetation.

Mitigation Measures

- Where watercourse crossings are unavoidable, crossing structures should be put in place to protect the bed and banks from soil destabilisation, subsequent vegetation loss and erosion;
- Avoid having to cross the two large, high sensitivity drainage lines that transect the Bloemsmond Collector – Upington MTS Alternative A and Alternative B. These are the Helbrandkloofspruit and Helbrandleegte Stream. Where possible, the existing roads intersecting the grid connection corridors linked to the N14 should be used for access, as opposed to crossing the river beds;
- Temporarily fence high sensitivity areas (drainage lines and pans) along their buffers in the vicinity of the development with single-strand wire fencing, not danger tape. The aim is to exclude easy access by people and vehicles, but still allow the movement of fauna for the duration of construction;
- Where vehicle access and work within a watercourse is unavoidable, such as the construction of a road crossing, then demarcate the access, parking and lay down areas using temporary fencing; and,
- Where excessive damage has occurred to the watercourse bed, banks or riparian zone, this must be rehabilitated immediately under the guidance of an aquatic specialist.

6.2.2 Disturbance to riparian habitat

Drainage lines are distinguished as having the largest shrubs and trees in the landscape in the study area. These riparian zones provide important ecological functions that must be preserved wherever possible. Where roads or other infrastructure intersect drainage lines, vegetation will need to be cut or removed. In the latter case this can result in destabilisation of the soil leading to erosion.

Mitigation Measures

- Only trim or remove riparian vegetation where it is absolutely necessary;
- Areas that have been cleared should be revegetated with indigenous species after construction. If necessary, erosion control through silt traps or similar should be used;
- Where vegetation has been removed along the banks of a watercourse, it will be necessary to check for alien plant establishment which needs to be cleared on a regular basis.

6.2.3 Sedimentation of downstream watercourses

A number of construction phase activities can increase erosion at the site resulting in sedimentation of downstream watercourses. Such activities include the disturbance of soils and vegetation both in watercourses and the broader environment as large areas of disturbed soil and vegetation would be prone to erosion. These include steep slopes, access roads and recently cleared areas (e.g. laydown areas). Erosion of these areas will eventually lead to habitat degradation in watercourses downstream. This occurs where sediment accumulates, forming bars and smothering the river bed. Creation of new sand bars also provides ideal habitat for colonisation by invasive plants (alien or indigenous) which further alters the instream habitat.

Mitigation Measures

- Limit disturbance to soil and vegetation as far as possible to reduce the risk of erosion.
- Ideally construction should be planned outside of the "wet" season to minimise the risk of erosion. However the area is naturally arid, and heavy rainfall is therefore a low risk for most of the year.
- Establish sediment traps (e.g. silt fences or erosion berms) on areas prone to erosion. Although rainfall is an unlikely event, it must be planned for. Allowance must be made to clear sediment from the traps if erosion occurs during the construction period.
- If active erosion results in the formation of gullies, these areas must be infilled with topsoil and covered with hessian or a geotextile (e.g. hessian sheets or geotextiles) prior to revegetation.
- Where sedimentation downstream occurs as a direct result of construction activities this must be assessed and manual removal (using spades) under the supervision of a freshwater ecologist or environmental site officer may be recommended.

6.2.4 Water Quality Impacts

Construction activities have the risk of introducing a range of detrimental contaminants into watercourses. Even if there is no flow at the time of construction, these contaminants may leach into groundwater, or be washed into river systems during periods of flowing water. Possible contaminants include hydrocarbons (fuel and oil from vehicles) or cement waste. In addition, solid waste such as plastic litter could be dispersed by construction workers. Erosion (as described above) results in increased suspended sediment loads when rivers are flowing.

Mitigation Measures

- Vehicle parking and refuelling areas must be located > 50m from the edge of watercourses, and be clearly defined. No refuelling or vehicle maintenance should take place within 50 m of a watercourse.
- Any fuel storage areas must be bunded to prevent spills from spreading if they occur.
- Waste collection and removal must be arranged on a regular basis, and allowance must be made for conducting a litter clean-up for up to 100m downstream and upstream of the watercourses at the development site.
- Follow recommended mitigation measures for sedimentation of downstream watercourses as above.

6.2.5 Alien plant introduction

Wide-scale disturbance during construction has the potential to facilitate invasion by alien plants such as Mexican poppies (*Argemone Mexicana*) and mesquite (*Prosopis juliflora).* Mesquite was not observed at the study area although it is meant to occur on and adjacent to Bloemsmond Farm 455 according to Van den Berg (2010).

Mitigation Measures

- Any imports of foreign material to the site should be cleared with a botanical specialist to ensure they do not pose a risk and do not originate from areas with high levels of alien invasion.
- Alien plants must be continually removed from disturbed areas throughout the construction period. Any uncertainty about plant identification must be clarified with a botanical specialist.

Table 12. Summarised impact rating table for the construction phase for the corridor alternatives from the facility substations to the Bloemsmond Collector

Impact	Intensity	Duration	Extent	Probability	Significance	Reversibility	Irreplaceability	Confidence
Impact: Disturbance to watercourse bed and banks								
Without mitigation	5 (High)	4 (Medium term)	2 (Limited)	4 (Probably)	Minor (-)	Medium	Low	High
With mitigation	3 (Low)	3 (Short term)	2 (Very limited)	3 (Unlikely)	Negligible (-)	High	Low	High
Impact: Disturbance to riparian habitat								
Without mitigation	3 (Low)	4 (Medium term)	1 (Very limited)	4 (Probably)	Minor (-)	High	Low	High
With mitigation	2 (Very low)	3 (Short term)	1 (Very limited)	4 (Probably)	Negligible (-)	High	Low	High
Impact: Sedimentation of downstream watercourses								
Without mitigation	4 (Moderate)	4 (Medium term)	3 (Local)	4 (Probably)	Minor (-)	Medium	Low	High
With mitigation	3 (Low)	3 (Short term)	2 (Limited)	3 (Unlikely)	Negligible (-)	High	Low	High
Impact: Water quality impacts downstream								
Without mitigation	3 (Low)	3 (Short term)	2 (Limited)	4 (Probably)	Negligible (-)	High	Low	Medium
With mitigation	2 (Very low)	2 (Brief)	1 (Very Limited)	2 (Rare)	Negligible (-)	High	Low	Medium
Impact: Alien plant introduction								
Without mitigation	5 (High)	5 (Long term)	3 (Local)	4 (Probably)	Minor (-)	Medium	Medium	High
With mitigation	2 (Very low)	3 (Short term)	2 (Limited)	3 (Unlikely)	Negligible (-)	High	Low	High

6.3 OPERATIONAL PHASE IMPACTS

6.3.1 Alien Vegetation Management

Disturbance to soil and vegetation that occurred during construction is likely to create opportunities for the establishment of alien vegetation. If left to spread unmanaged, these plants (particularly *Prosopis* spp.) can displace indigenous plant species and degrade habitat. Furthermore, unmanaged alien vegetation provides a source for dispersal to neighbouring areas.

Mitigation Measures

- When conducting inspections of any infrastructure on site, include a checklist of likely alien plants to check for throughout the site;

- Staff at the plant must be educated and made aware of alien vegetation that could be present and that must be eradicated;
- Depending on the species that establish, it is essential that recommended methods of control be employed and adequate stores of herbicide / tools are kept on site for this purpose. Alternatively a reputable contractor can be used for ongoing control of aliens; and,
- Alien plant control requires ongoing control and commitment. Therefore, alien plant management must form an integral part of the plant's Environmental Management Programme.

6.3.2 Spills and Waste Management

During operation of the grid connection infrastructure there may be occasional spills (e.g. petrochemicals) related to vehicles and grid connection infrastructure. There may be residual waste associated with the construction phase (e.g. materials). The management of these aspects should be covered in the grid connection infrastructure's Environmental Management Programme.

Mitigation Measures

- If spills occur (e.g. oil or hydraulic fluid) there must be a procedure for the containment and management thereof;
- Any waste construction materials must be disposed of responsibly, such as at the local landfill site;
- Human waste should be stored in septic tanks kept well away from any watercoursesA reliable contractor must be appointed for the removal of refuse from the plant; and,
- General refuse must be contained in animal-proof bins.

Table 13. Summarised impact rating table for the operational phase for the corridor alternatives from the facility substations to the Bloemsmond Collector

Impact	Intensity	Duration	Extent	Probability	Significance	Reversibility	Irreplaceability	Confidence
Impact: Alien Vegetation Management								
Without mitigation	5 (High)	6 (Ongoing)	3 (Local)	4 (Probably)	Minor (-)	Medium	Medium	High
With mitigation	2 (Very low)	3 (Short term)	2 (Limited)	2 (Rare)	Negligible (-)	High	Low	High
Impact: Spills and Waste Management								
Without mitigation	4 (Moderate)	4 (Medium term)	2 (Limited)	3 (Unlikely)	Negligible (-)	Medium	Medium	Medium
With mitigation	2 (Very low)	1 (Immediate)	1 (Very limited)	1 (Highly unlikely)	Negligible (-)	High	Low	High

6.4 CUMULATIVE AND LANDSCAPE-SCALE IMPACTS

This section of the impact assessment considers both the cumulative impacts of multiple PV arrays planned for Bloemsmond Farm 455 as well as other solar developments in the vicinity. The cadastral units where solar projects have either been approved or are being processed are shown in Figure 12. While the actual footprint of each project is not shown, this map provides an indication of the area at the landscape scale that is earmarked for developed.

While most of the environmental impacts in their mitigated state (related to aquatic ecosystem health) may be considered negligible at the scale of a single PV development, power line or road, the accumulation of impacts at the landscape scale could be a concern. Bloemsmond Farm 455 and surrounding areas are located within Renewable Energy Development Zone (REDZ) 7 which has been identified for large scale renewable energy facilities. The increase in solar developments in REDZ zones has not been matched by an increase in the depth of understanding of associated environmental impacts, particularly the cumulative impacts (Rudman *et al*., 2017). However, the consideration of cumulative impacts is constrained by the current approach to assess developments separately.

A substantial portion of the SQR of the Helbrandkloofspruit and the Helbrandleegte Stream will potentially be affected by solar developments. Disturbance during construction phases at the very least will reduce vegetation cover and disturb soil over an extended area which is likely to increase the amount of erosion and subsequent sedimentation along this drainage line and associated tributaries, ultimately reaching the Orange River. Given the infrequency of rainfall in the area this may fortunately happen at a relatively slow rate. Wide-scale disturbance to vegetation is likely to exacerbate erosion and may lead to significant invasion by alien vegetation if this issue is not consistently managed by the various land owners and plant management.

Although the vegetation types Kalahari Karroid Shrubland and Bushmanland Arid Grassland are classified as Least Threatened, they are both in the top five vegetation types affected by solar developments. Bushmanland Arid Grassland is one of the most targeted vegetation types for solar power development (Rudman *et al*., 2017).

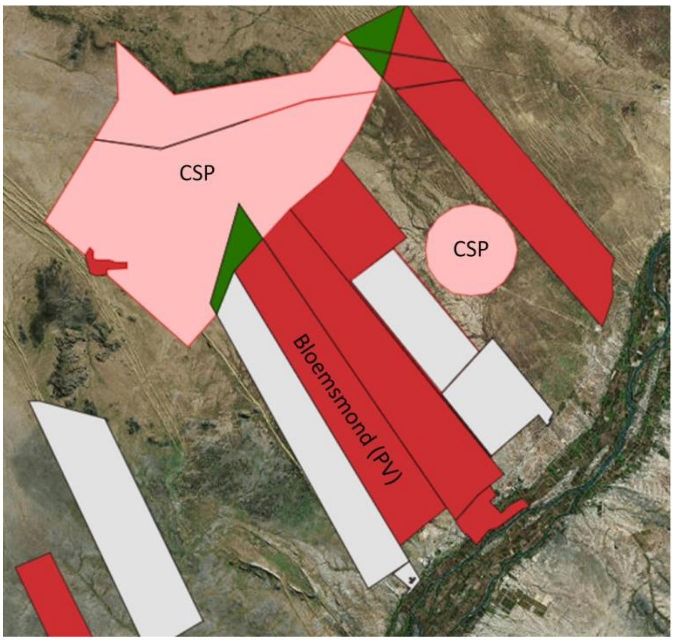

Figure 12. Map showing the location of DEA-registered PV (red) and CSP (pink) projects at the cadastral unit scale in the vicinity of Bloemsmond Farm 455.

A total of five PV facilities (Bloemsmond 1 – 5) have been planned for Bloemsmond Farm 455. In all cases specialists have been consulted upfront regarding the proposed layout of the PV facilities through the provision of sensitivity maps. At Bloemsmond Farm 455 this has ensured that the impacts affecting medium and high sensitivity watercourses (particularly pans and large wooded drainage lines) will be kept to the absolute minimum, with other impacts being unavoidable access roads crossing watercourses. This is also very important for maintaining a degree of connectivity at the landscape level, as drainage lines are frequently used for movement and other functions by a wide range of animals. They also provide additional habitat for wildlife occurring along the Orange River. A large proportion of sensitive habitat at the site will be left intact between solar arrays which will provide corridors for wildlife. Additional cumulative impacts will be related to the construction of power lines assessed in this study. It is likely that further power lines will be required to connect the other PV developments proposed in the area.

From a hydrological and geomorphological perspective, the main cumulative impact is likely to be an overall increase in concentrated flows in drainage lines due to increased levels of runoff when it rains. The resulting effect on habitat will be to erode some stream sections and increase sediment deposits in larger river beds, which are already naturally sandy. Provided these effects are not too severe at the landscape level, they should not result in major detrimental impacts on water resources at the site or in the Orange River.

<u>Mitigation Measures</u>

- Future planning of solar developments should follow a similar process in that environmental specialists should be consulted during the planning and layout phase to identify any sensitive or no-go areas so they can be avoided;
- The grid connection infrastructure (e.g. power lines) should have little to no infrastructure within the medium to high sensitivity drainage lines as well as their buffers;
- Riparian vegetation along medium to high sensitivity drainage lines should be left untouched as far as possible;
- Access roads should be planned to utilise existing tracks (even between neighbouring properties if possible) and limit stream crossings to the absolute minimum;
- Monitor the PES of major watercourses at specific sites in order to detect long term changes and isolate impacts requiring intervention. Focus on levels of sedimentation and erosion, as well as other habitat degradation indicators;
- Select and recommend development options that maintain connectivity in the landscape to support the movement of wildlife and limit the impact to watercourses as far as possible. The latter would include corridors to pans to ensure access by a range of fauna.

7 CONCLUSIONS

The watercourses assessed in this study were in a very good ecological state. Both drainage lines and pans provide important ecological and hydrological functions in the landscape, and it is important that these functions are preserved as far as possible. The PV developments and associated infrastructure proposed for Bloemsmond Farm 455 have been well planned in terms of considering environmentally sensitive areas in the planning and layout phase. The layout can be further refined using the suggested mitigation measures in this report. While impacts to watercourses at Bloemsmond Farm 455 and within the footprint of roads and power lines are inevitable, the majority of these are considered negligible in their mitigated state. Provided the site is well managed during the construction and operational phase, following suggested mitigation measures, the development is considered as a positive contribution to the alternative energy needs of South Africa.

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