VELD PV SOUTH SOLAR ENERGY FARM

Veld PV South Hydrological Assessment

Veld PV South (Pty) Ltd

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1 Background

1.1 Introduction

Veld PV South (Pty) Ltd proposes to develop the Veld PV South Solar Farm approximately 20 km north-west of Aggeneys in the Northern Cape. The solar farm will consist of a photovoltaic (PV) energy facility with a maximum generation capacity of 75 MW. This solar farm will be part of a larger solar project comprising a secondary solar farm, with a combined generation capacity of up to 150 MW. The proposed Veld PV South Solar Farm has been designed to utilise shared infrastructure from the larger solar project where possible to minimise the overall footprint and associated impacts of the proposed. The Veld PV South Solar Farm will be assessed as standalone project so that it can be constructed under its own approvals, should this be required.

Aurecon South Africa (Pty) Ltd has been appointed to undertake the requisite environmental process as required in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, on behalf of Veld PV South (Pty) Ltd. This specialist hydrological assessment is being undertaken to inform a basic assessment (BA) with regards to the Department of Environmental Affairs (DEA) environmental authorisation process, as it relates to the hydrological (surface water) environment only. The focus of the hydrological assessment (this report) is on the proposed Veld PV South Solar Farm (see **Figure 1**) hereafter referred to as the site.

1.2 Project description

The site is located on the farm Haramoep, portion RE/53 centred at coordinates 18° 39' 27" E and 29° 7' 27" S and covers an area of approximately 244 ha. The layout of the site is illustrated in **Figure 2**.

The proposed solar farm will include the following components:

- Numerous arrays of PV solar panels;
- Internal access roads;
- An operations and maintenance building;
- A temporary construction area;
- An on-site substation, including switching yard;
- Internal cabling laid underground;
- Site access via existing roads and tracks, widened to 6 m where necessary; and
- A 2.5 km link line from the substation.

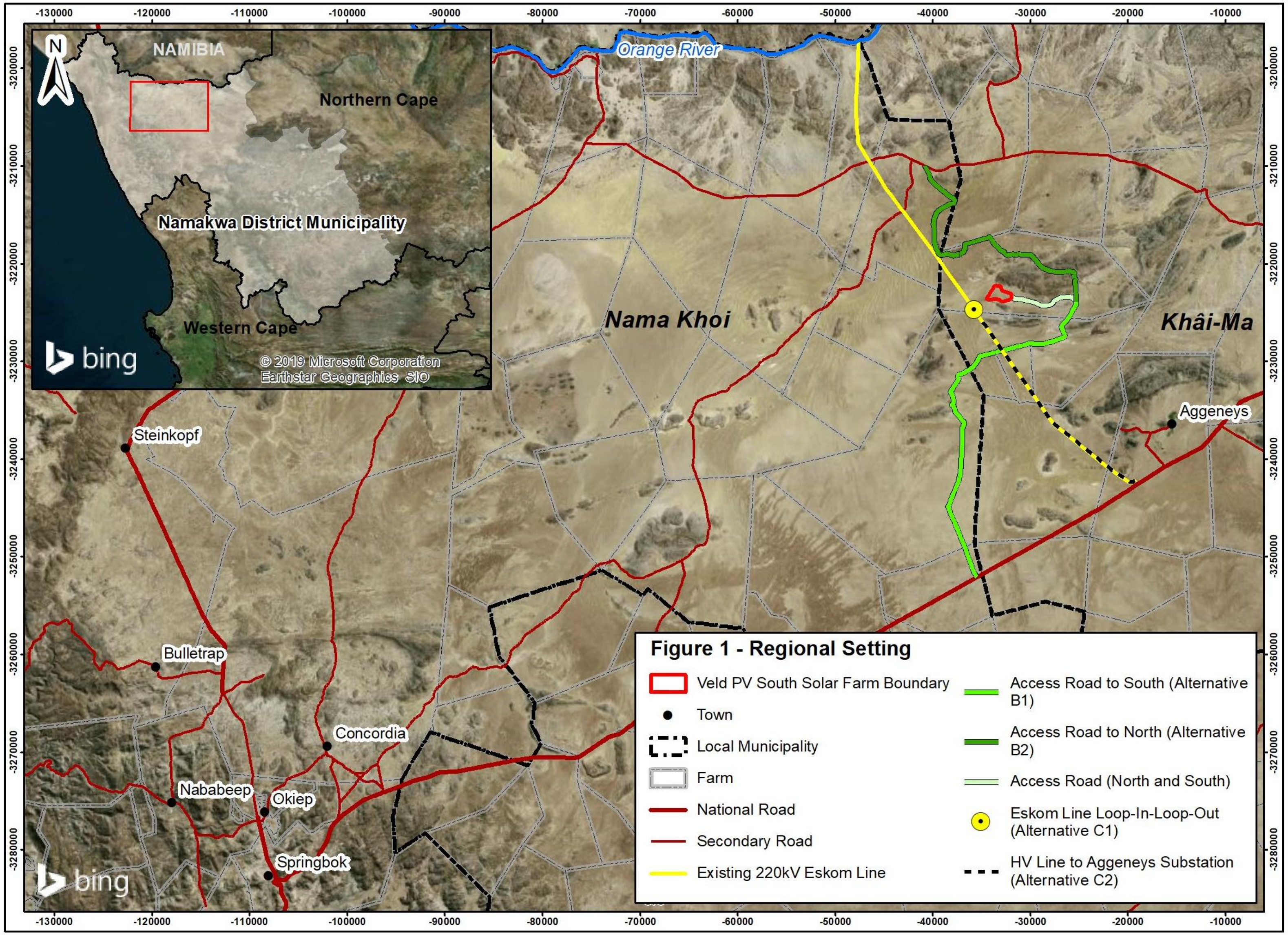

Figure 1: Regional setting

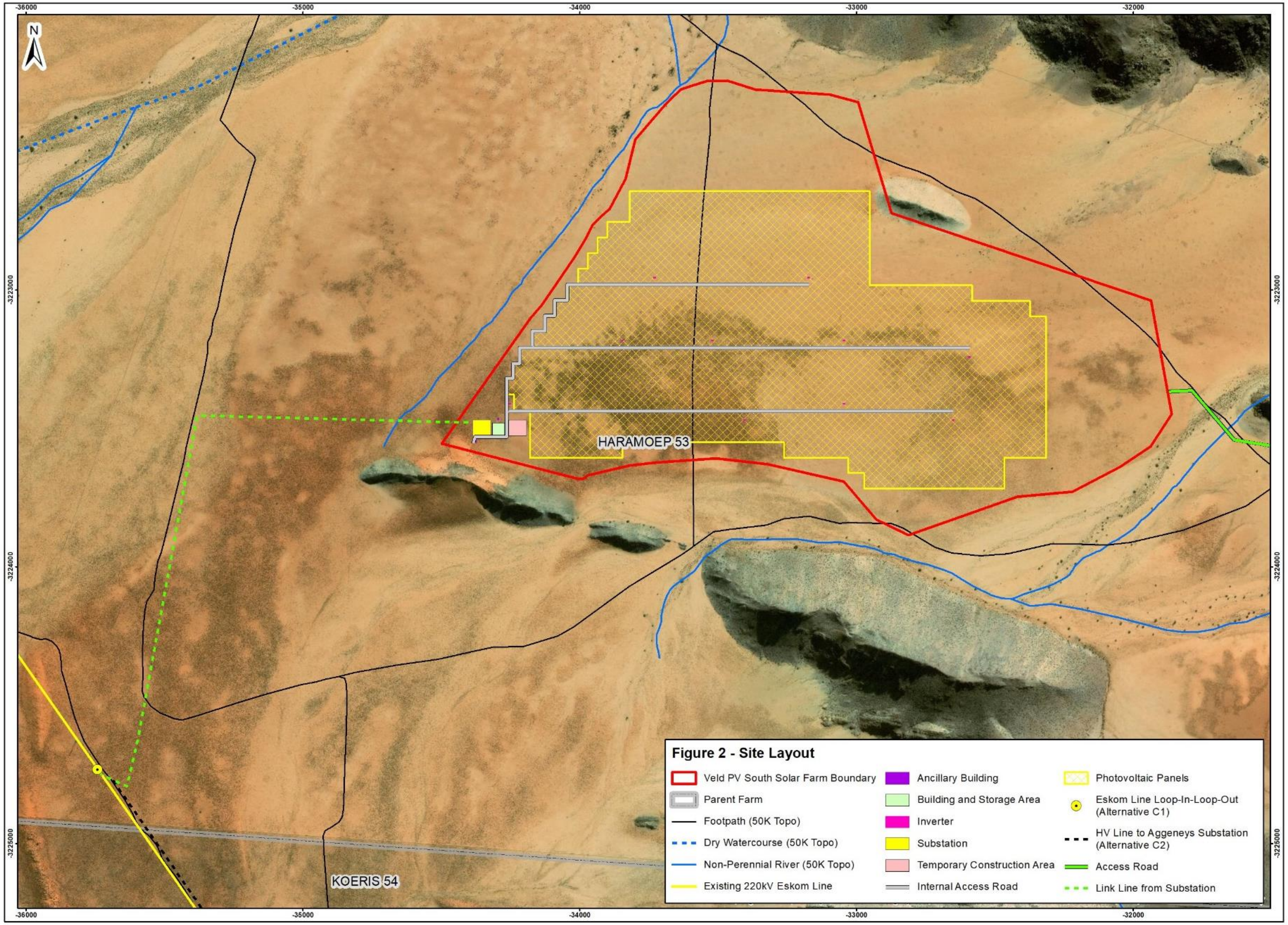

Figure 2: Proposed site layout

1.2.1 Alternatives

Alternatives have been included in this assessment and have been assessed in Section 4 of this report with regards to their comparative impact on the hydrological environment. These alternatives are as follows:

- Two alternative solar technologies are proposed namely, PV with fixed axis (alternative A1) and PV with single axis tracking (alternative A2).
- Two alternatives exist for access to the site. The first would utilise the existing farm access roads leading northwards from the N14 (alternative B1), while the second would be utilise the existing farm access roads southwards from the Pella-Goodhouse Road (Alternative B2).
- Two alternatives exist for the connection of the solar farm to the national grid. The first would utilise a loop-in-loop-out connection to the existing Eskom transmission line (Alternative C1), while the second would utilise a new 132 kV line approximately 24.5 km long, running adjacent to the existing Eskom line and connecting to the Aggeneys substation (Alternative C2).

1.3 Approach to study

The surface water assessment consists of the following:

1. Data collection and review;
2. Site visit;
3. Baseline assessment; and
4. Impact Assessment and Mitigation Measures.

1.3.1 Data collection and review

The objective of this task was to collect and review available data, agree on the interfaces with other specialist investigations, develop an understanding of the nature of the infrastructure being planned, and identify potential hydrological concerns related to the proposed development. Relevant data to support the hydrological analysis was collected and reviewed.

1.3.2 Site visit

A site visit was conducted by Dr Nicholas Walker, a hydrologist, on the 19th and 20th of October 2016 to assess the topography, drainage network and general physical characteristics of the site.

1.3.3 Baseline assessment

The baseline assessment entails the synthesis and analysis of the hydro-meteorological and other relevant spatial data that were collected during the data collection and review stage of the study. Attributes to be considered include drainage network, topography, land use, rainfall, soils and vegetation.

1.3.4 Impact assessment and mitigation measures

This step involves the identification and evaluation of predicted impacts of the proposed development alternatives using the criteria of consequence (a product of extent, duration and intensity) and probability to define impact significance as per the methodology provided by Aurecon. Potential mitigation to identified impacts are provided.

1.4 Assumptions, limitations or gaps in knowledge

This study is limited to a hydrological assessment. No floodlines have been determined for the watercourses on or near the site and no hydrological modelling or stormwater modelling has been performed. The report outlines additional hydrological investigations that should be undertaken to inform the detailed design phase, which include the definition of the 1 in 100 year recurrence interval floodline, more detailed assessment of stormwater management and analysis of river crossings.

2 Relevant legislation

This section describes the policy and legal framework within which the hydrological assessment is undertaken.

2.1 National Environmental Management Act (Act No. 107 of 1998)

NEMA, as amended, establishes the principles for decision-making on matters affecting the environment. Section 2 of the Act sets out the National Environmental Management principles which apply to the actions of organs of state that may significantly affect the environment. Furthermore, Section 28(1) states that "every person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring". If such pollution or degradation cannot be prevented, then appropriate measures must be taken to minimise or rectify such pollution or degradation.

2.2 National Water Act (Act No. 36 of 1998)

The National Water Act (NWA) (Act No 36 of 1998) provides for the sustainable and equitable use and protection of water resources. It is founded on the principle that the National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest, and that a person can only be entitled to use water if the use is permissible under the NWA. Section 21 of the NWA specifies the water uses which require authorisation from the Department of Water Affairs (DWA) in terms of the NWA before they may commence.

The National NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources. An authorisation may need to be applied for the following water use activities should they be triggered: Sections 21 (a) - abstraction, 21 (c) - change to the bed, banks and characteristics of a water course and 21 (i)- impeding and diverting the flow. This report details possible water use activities and necessary water use licences.

3 Surface water baseline

The proposed Veld PV South is situated in Quaternary Catchment D82C approximately 30 km from the border of South Africa and Namibia, and the Orange River, which separates the two countries. The site is currently used for grazing of sheep and cattle due to low arability associated with sandy soils and low rainfall (see **Figure 3**). Inselbergs (defined as isolated hills or mountains rising abruptly from a plain) are present in the background of the figure and contribute runoff to the streams that cross the site.

Figure 3: View over the site

3.1 Rainfall and evaporation

The region experiences low rainfall with a mean annual precipitation (MAP) of 97 mm at the site (Smithers and Schulze, 2002). Historical annual precipitation is illustrated in **Figure 4** which shows the rainfall according to hydrological years, October to September, from 1950 to 1999 for the Aggeneys rainfall gauge, located approximately 22 km south-east of the site (Lynch, 2004). The site is situated in a very late summer rainfall area with the higher rainfall months being February to April (**Figure 5**). The inter-annual (or year-to-year) rainfall is highly variable with a coefficient of variation greater than 40% (Schulze et al., 2008).

The mean monthly evaporations for Quaternary Catchment D82C are presented in **Table 1** and add up to an annual evaporation (S-pan) of 2650mm.

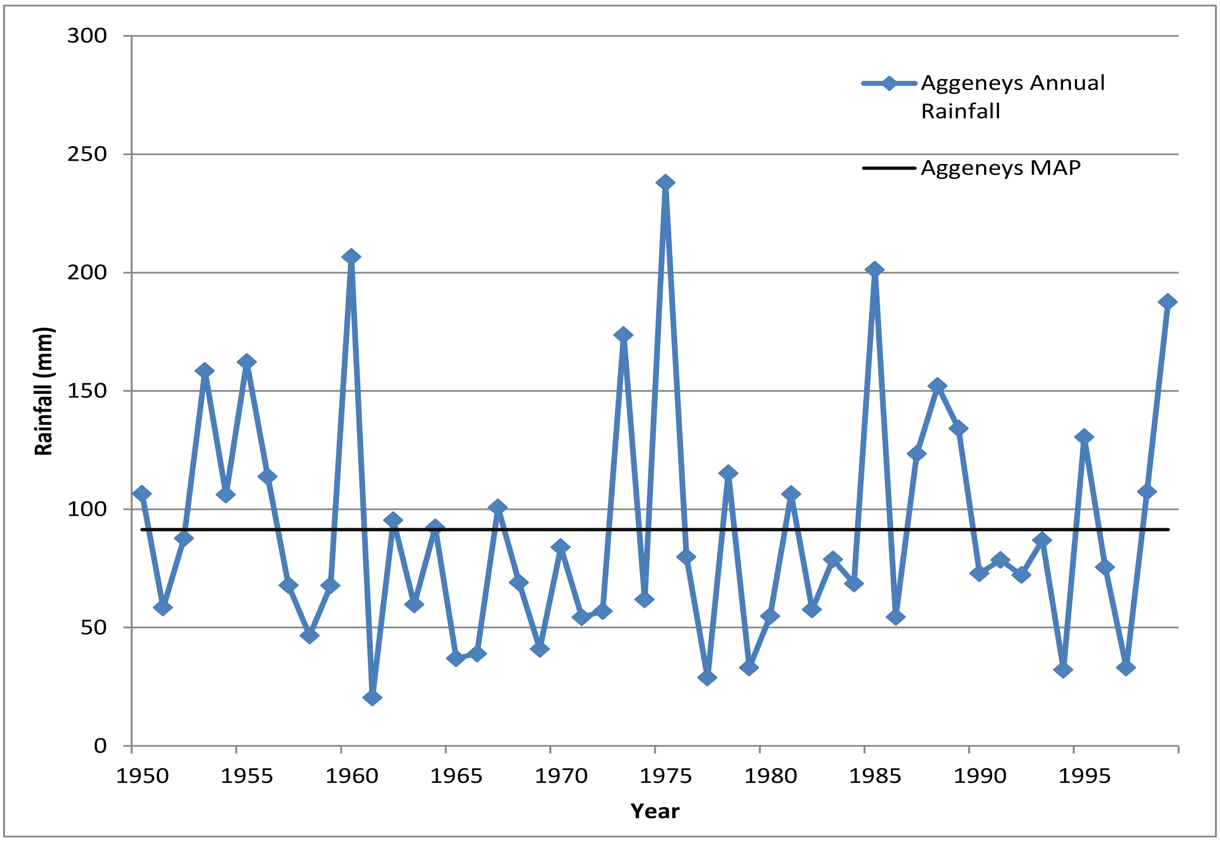

Figure 4: **Annual rainfall distribution recorded at Aggeneys rainfall station 0246555W (1950-1999) (Lynch, 2004)**

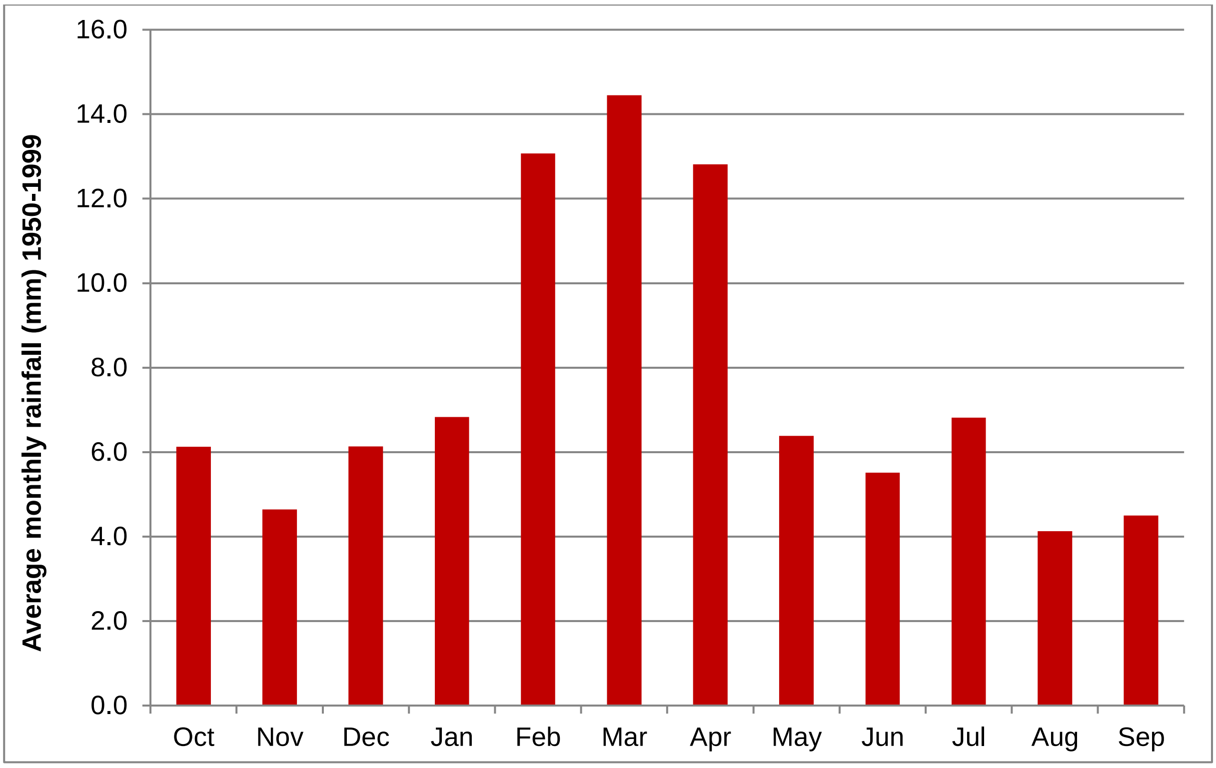

Figure 5: **Mean monthly rainfall distribution recorded at Aggeneys rainfall station 0246555W (1950-1999) (Lynch, 2004)**

Table 1: Mean monthly evaporation (S-pan) in mm for Quaternary catchment D82C (Bailey and Pitman, 2015)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
252	297	340	346	291	273	196	131	99	97	136	192

3.1.1 Design rainfall

Table 2 contains the design rainfall estimates for Veld PV South site which were sourced from Design Rainfall Estimation Software for South Africa (Smithers and Schulze, 2002). Although the MAP is low at the site at 97mm (Smithers and Schulze, 2002), thunderstorms that occur in the area can produce high intensity rainfall for short durations which is evident in the design rainfalls.

Table 2: Design rainfall estimate (Smithers and Schulze, 2002)

Recurrence Interval	1 hour design rainfall (mm)	4 hour design rainfall (mm)	24 hour design rainfall (mm)
1:2 year	14	19	26
1:5 year	23	31	43
1:10 year	30	42	57
1:20 year	39	53	73
1:50 year	52	71	98
1:100 year	63	87	120
1:200 year	77	105	145

3.2 Hydrological and topographical characteristics

Figure 6 presents the hydrological and topographical setting of the site. The topography of the site and surrounds was assessed utilising the 30m ALOS Global Digital Surface Model (DSM) data (AW3D30[1]). This dataset provides a coarse understanding of topography due to the 30m grid but was nevertheless useful in deriving flow paths and watersheds, which informed subcatchment delineation. The 30m DSM data in conjunction with the 1:50,000 topographical map 20m contours illustrate the flat terrain on the site and the sudden increase in slope associated with the inselbergs.

According to the 1:50,000 topographical map data there are a few non-perennial rivers adjacent to the site, which are ephemeral in nature (i.e. flow only after rainfall events). The eastern non-perennial rivers are associated with subcatchment 'S1' which has an area of approximately 20.9 km^2. The western non-perennial rivers have their headwaters in an inselberg to the north of the site and are associated with subcatchment 'S2' which has an area of approximately 3.9 km^2. The abovementioned rivers are part of an endorheic river basin which sees the flow from rivers around the site discharging into a series of pans or depressions located some 10 km southwest of the site.

[1] https://www.eorc.jaxa.jp/ALOS/en/aw3d30/index.htm

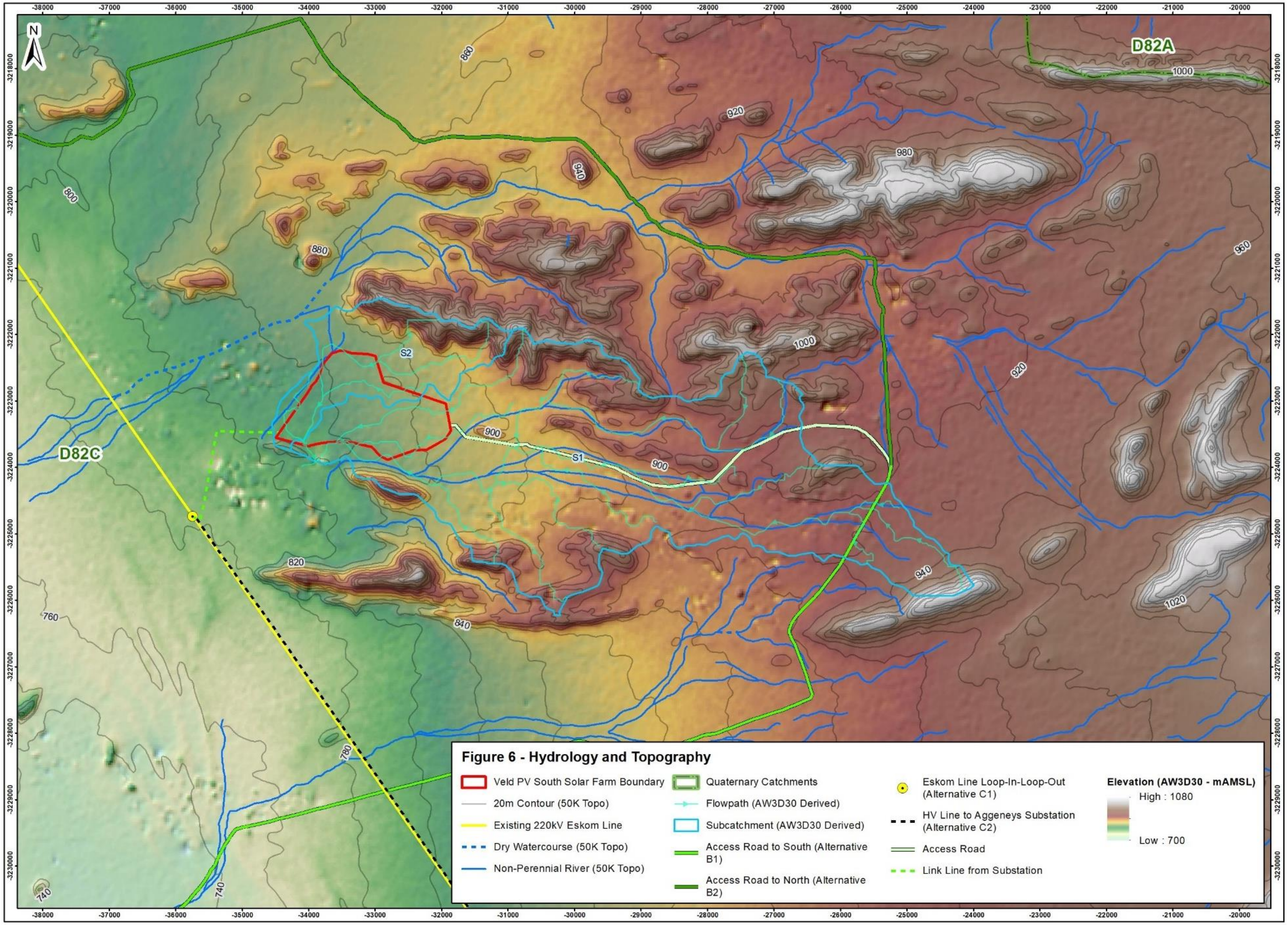

Figure 6: Hydrology and topography

Flow paths defined using the 30 m DSM generally match up with the 1:50,000 topographical data although some differences are expected given the limited accuracy of both these datasets. These differences are more pronounced, however, when considering the non-perennial rivers associated with the site, likely due to the flat topography and the associated absence of a well-defined river channel. **Figure 7** is a photograph of the non-perennial river on the eastern edge of the site and illustrates the absence of a defined river channel.

Figure 7: River on the eastern edge of the site

3.2.1 Flood risk

To the west of the site, a larger non-perennial river is present. This non-perennial river with a catchment area of approximately 119 km^2 is not directly associated with the site as it flows towards the south-west (away from the site), but the river does however have the potential to overtop its southern bank and contribute flow to channels that lie on the western side of the site. This is suggested both on the 1:50,000 map and by inspection of satellite photographs which both show a flow path from the channels on the west of the site in a northerly direction to intersect the south bank of the larger river. The 1:50,000 topographical map shows a connection between the non-perennial channel immediately west of the site with this larger river, as illustrated in **Figure 8**. This figure illustrates the primary flow paths of the larger river to the north of the site and the non-perennial river to the east of the site. The larger river could theoretically overtop its banks and spill into the non-perennial river west of the site if substantial flooding occurs in the larger river. Relevant data necessary to establish the likelihood of this was, however, unavailable at the time of assessment (i.e. topographical data more detailed and accurate than the 30 m DSM). According to the farmer, Mr Aggenbag (pers. comm.), the large watercourse rarely flows on the surface due to the deep alluvial deposit in the channel which causes large channel losses. Mr Aggenbag reports that the river has not had surface water in it in the last 20 years although further upstream the river has flowed more recently. Assuming the larger river could overtop its left bank and contribute flow to the channel on the west side of the site, the peak flows generated by the 3.9 km^2 'S2' catchment could substantially increase beyond what would be expected from a subcatchment of this size, resulting in possible flooding along the western edge of the site.

To the east of the site, the primary flow path associated with a 20.9 km^2 subcatchment, has the potential to flood the southern edge of the site given the size of this subcatchment and apparent flow constrictions along this flow path as it passes adjacent to and then between three inselbergs (**Figure 8**).

Additional consideration of these potential sources of flooding to the site should consequently occur prior to detailed design and will likely require the definition of floodlines (e.g. the 1 in 100 year recurrence interval floodline).

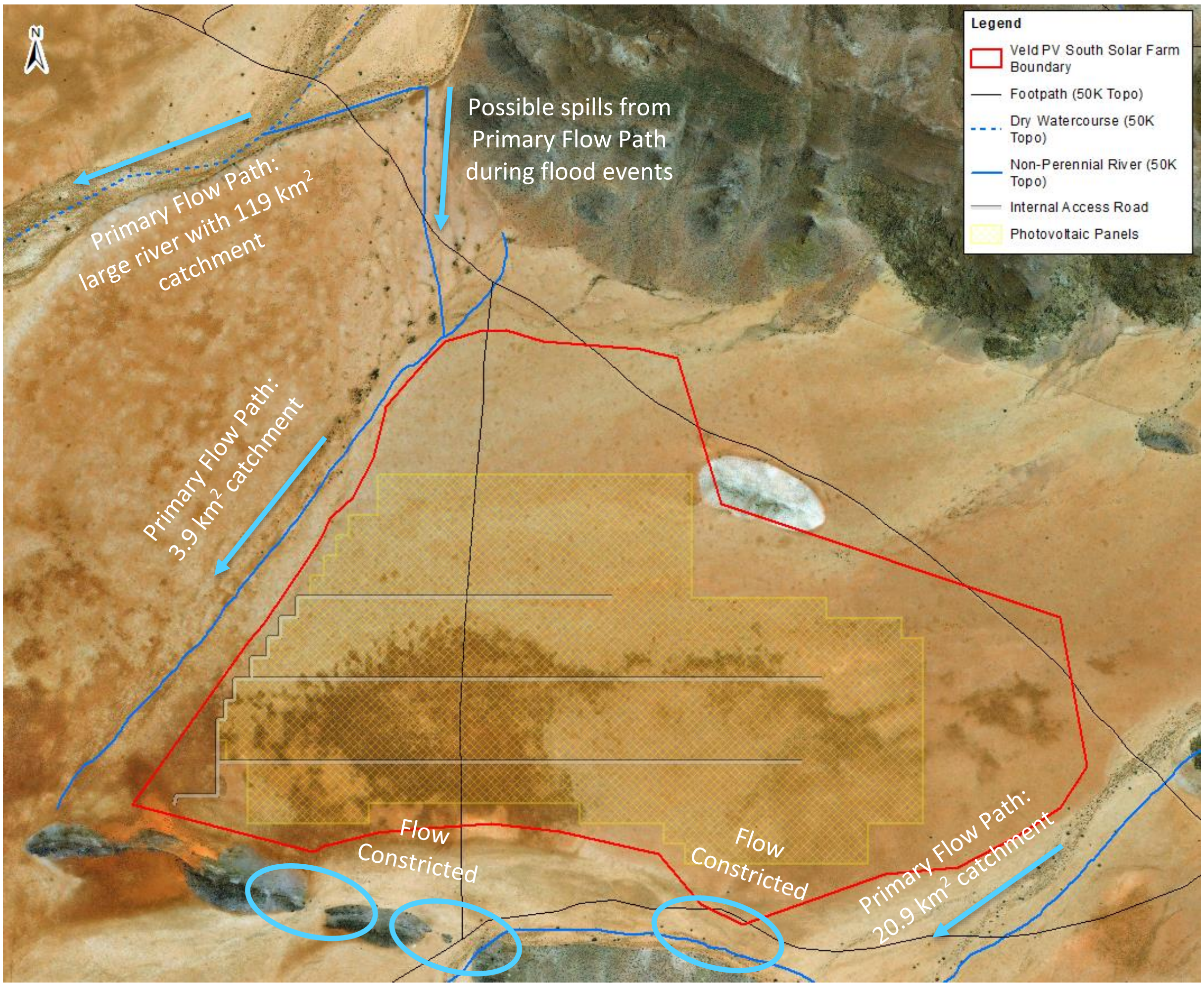

Figure 8: **Flooding considerations**

3.2.2 River buffers

River buffers based upon the NEMA 32m river buffer distance and the General Authorisation (Notice 509 of 2016) under the National Water Act (1998) 100m river buffer distance are shown in **Figure 9**. In assessing the site and adjacent rivers, a 32m buffer distance was applied to the smaller rivers on site with catchments under 5 km^2. Rivers with larger catchments were given a buffer distance of 100m.

The above buffers are smaller than those recommended by BlueScience (2017) as part of the Freshwater Assessment for this project, and hence it may be prudent to implement the buffers recommended by BlueScience (2017).

These buffers provide a starting point to protect against flooding and provide a setback from the river with regards to potential pollutants entering the watercourse. It should also be noted that these buffers should start from the top of the river bank, which cannot be defined with available data and so has instead used the 1:50,000 topographical river centrelines and an associated buffer distance.

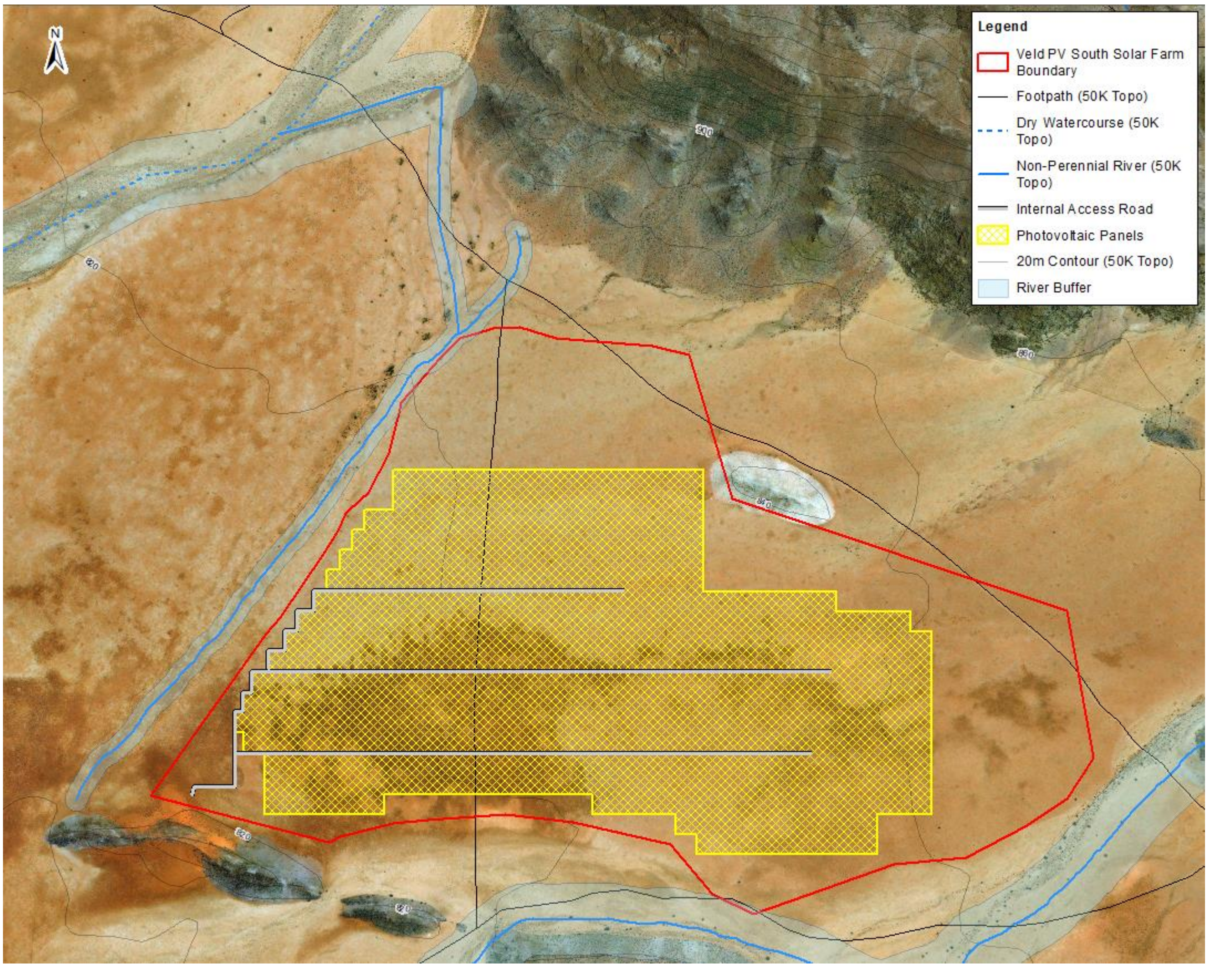

Figure 9: River buffers

3.2.3 Land-cover, vegetation and soils

Land-cover in the region of the site was extracted from the Department of Environmental Affairs (DEA) 2014 dataset and is presented in **Figure 10**. Land-cover is predominantly bare ground, Nama Karoo: bare ground and Nama Karoo: low shrub. The site is mostly associated with Nama Karoo: low shrub.

Vegetation on the site is classified as almost exclusively Bushmanland Arid Grassland with a fringe area of Bushmanland Inselberg Shrubland according to SANBI (2018). The Bushmanland Arid Grassland extends beyond the site and appears to coincide with the flat areas associated with Nama Karoo: low shrub. As illustrated in **Figure 7** to **Figure 9**, riparian vegetation exhibits greater vegetative cover compared to other areas around the site.

According to the high-level soils data included in the Water Resources of South Africa 2012 (WR2012) study (Bailey and Pitman, 2015), soils at the site and its surrounds are classified as sands to loamy sands to sandy loams. This agrees with site observations which showed sandy soils. These soils would likely be classified as being within hydrological soil group A (low runoff potential) as defined by Schulze (1995). The infiltration rate of this type of soil is well in excess of 20mm/hr (Schmidt and Schulze, 1987) and when compared to the design rainfalls in **Table 2**, suggest that even under the larger design storms, runoff on the site will be significantly reduced by infiltration.

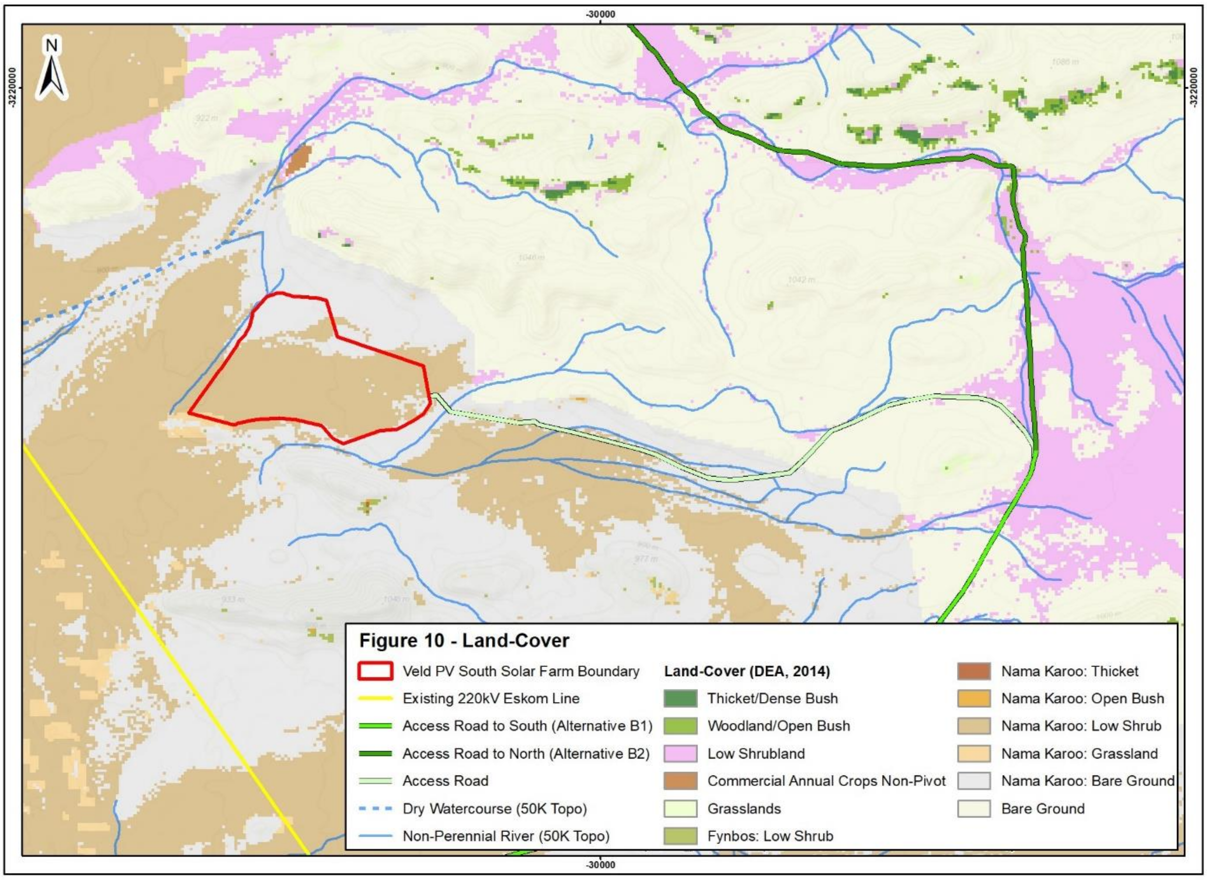

Figure 10: Land-cover

3.3 Stormwater management

The soils on site which likely have high infiltration rates, combined with flat terrain and low rainfall, will limit runoff, except during occasional intense storms when infiltration capacity is exceeded and runoff occurs. This could change if significant areas of the site are paved or covered with materials of low permeability.

A study by Cook and McCuen (2013) is of relevance to this hydrological impact assessment as it describes the hydrological effect of solar farms and whether stormwater management is required. The study found that the solar panels did not have a significant effect on runoff rates or volumes, although the presence of gravel or bare ground under the panels could significantly increase the amount of runoff generated and that under these conditions stormwater management would be required.

In considering the site, some hardened areas are proposed in the form of a substation and a building/storage area which approximate 5600 m^2 in area. Additional hardened areas will be associated with the solar panels themselves which cover approximately 1.5 km^2, resulting from the various poles and foundations used to mount the panels but this area will be relatively small and much smaller than the 1.5 km^2. The solar panels themselves do not qualify as hardened area since they do not significantly limit infiltration as the area underneath remains available for infiltration. Some compaction of soils on site is expected, particularly in relation to areas of travel, such as the internal access roads and temporary construction area and this could lead to an increase in runoff over the present situation. The effect of the road network in particular could be significant: if gravel material is imported for surfacing of the internal road network between the panels then the proportion of hardened areas could increase significantly as compacted gravel will have a lower infiltration potential than the sandy soils found on the site.

Stormwater management should be considered during detailed design given the potential for hardening of surfaces mentioned above, especially from the road network within the solar farm. Flows from upslope areas associated with the inselbergs that could generate significant runoff due to their steeper slopes and shallow soil depths should be included in the analysis. Methods to manage stormwater, where needed, can likely incorporate soft engineering approaches such as swales and detention basins and these should be designed using appropriate stormwater management methods. Strips between the panels planted with suitable vegetation, such as a native grass species which can grow in this arid environment, will promote infiltration and limit erosion caused by runoff from the panels.

As a general guide, the current natural drainage of the site should be retained as far as possible. Vegetation is important to stabilise the soil structure and any permanent removal of the vegetation should be minimised in order to maintain soil structure.

There is a risk of increased flood peaks causing an increased erosion risk to river channels downstream of the site and these can also be managed through the appropriate stormwater management methods mentioned above.

3.4 River crossings

River crossing designs did not specifically form part of this scope of work and will need to be considered prior to detailed design. There are many potential crossings with the exact number dependant on which route alternative is utilised. In the case of the access road including Alternative B1, 18 rivers are crossed, while the access road including Alternative B2 crosses 14 rivers based on the 1:50,000 topographical map data.

In most instances, drift crossings that don't elevate the river bed should suffice given the low frequency of river flows. Potential flooding during storm events should be considered and flash flooding is possible.

It is recommended that drifts be used for river crossings wherever feasible. The drifts should be designed so that the road surface follows the natural ground level as much as possible, minimising the reduction in the cross-sectional area of the channel at the drift. There may be a need for formal low-level bridges at crossings over large rivers.

The design of formal river crossings requires the selection of a suitable design recurrence interval, determination of the associated design flow rate and hydraulics at the site. Selection of the type of crossing is a function of the hydrology, , the desired level of availability of the crossing, the cost of construction and the expected maintenance/repair costs in the event of flooding. Applicable design standards for river crossings will need to be agreed with the DWS and should consider standards outlined in the South African National Roads Agency Limited (SANRAL) Drainage Manual (SANRAL, 2013).

Design of the road alignments and crossings will need to take cognisance of the 32m, 100m or other river buffers measured from the river bank and floodlines where these have been determined. so that the roads provide an acceptable level of service, and to minimise the impact on the water environment.

Management measures for river crossings to limit their impact of the water environment include the following:

- River crossings should be designed in a manner that does not alter the natural river hydraulics to a degree that would negatively impact river health or cause scour.
- If scour is expected to be caused by the crossing structure then appropriate measures should be taken to mitigate this risk using appropriate design and erosion protection measures.
- During construction, areas will be at risk of erosion. River crossings should therefore be constructed in a manner that will rapidly stabilise soils and river banks.
- Site rehabilitation should be undertaken immediately after construction and should restore surface drainage patterns as far as practically and economically feasible.

While not having the same requirements as roads, the proposed high voltage line from the site to Aggeneys substation (Alternative C2) will cross three rivers, and the link line from the substation will cross one river. Avoiding the placing of pylons in river channels and on floodplains should be possible in most instances due to the spacing between pylons, and the pylon spacing should be planned to minimise this as far as is practically possible. Figure 11 illustrates the existing Eskom line's pylon spacing.

If the placement of pylons within river channels or floodplains is unavoidable then appropriate mitigation measures should be taken to reduce the risk of scour damage to both the pylon foundations and the river environment. These measures can include planting of appropriate non-invasive and preferably indigenous vegetation, use of riprap, gabions and reno mattresses, whichever is most applicable to the situation.

Figure 11: Eskom servitude southern site looking south

4 Impacts assessment and mitigation measures

4.1 Overview

An impact is essentially any change (positive or negative) to a resource or receptor brought about by the presence of the project component or by the execution of a project related activity.

The potential impacts of the proposed development have been evaluated using a recognised risk assessment methodology developed to ensure communication of the potential consequences or impacts of activities on the hydrological (surface water) environment as set out in NEMA. As outlined below, environmental impact significance (quantified as a signifance rating) is determined based on the product of environmental consequence of the impact and the probability of the impact occurring. Consequence is calculated as the combination of the extent, intensity and duration.

Significance = consequence (extent + intensity + duration) x probability

4.2 Impact assessment methodology

Table 3 outlines the ratings used to define the variation in extent, intensity, duration and probability while Table 4 provides the ranking of consequence and significance.

Table 3: Definition of extent, intensity, duration (Consequence criteria)

Criteria	Category	Description	Rank
Extent or spatial influence of impact	**National**	Beyond a 20km radius of the site	4
	Regional	Within a 20 km radius of the site	3
	Local	Within a 2 km radius of the centre of the site	2
	Site specific	On site or within the boundaries of the property	1
	None	None	0
	High	Natural and/ or social functions and/ or processes are *severely* altered	4 or -4

Criteria	Category	Description	Rank
Intensity of impact (at the indicated spatial scale) Note: this incorporates whether the type of impact is negative (-1) or positive (+1)	**Medium**	Natural and/ or social functions and/ or processes are *notably* altered	3 or -3
	Low	Natural and/ or social functions and/ or processes are *slightly* altered	2 or -2
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered	1 or -1
	None	Natural and/ or social functions and/ or processes remain *unaltered*	0
Duration of impact	**Permanent**	More than 10 years (after operation)	4
	Long Term	5- 10 years (after operation)	3
	Medium Term	0-5 years (after operation)	2
	Short Term	Up to 18 months	1
	None	Zero time	0
Probability	**Definite**	Estimated greater than 95 % chance of the impact occurring.	4
	Very likely	Estimated 50 to 95% chance of the impact occurring	3
	Fairly likely	Estimated 5 to 50 % chance of the impact occurring.	2
	Unlikely	Estimated less than 5 % chance of the impact occurring.	1
	None	Definitely no chance of occurrence	0

Table 4: Application of consequence and significance ratings

Range		Consequence Rating		Range		Significance Rating
-12	-11	**Extremely detrimental**		-48	-37	**High – negative**
-10	-9	**Highly detrimental**		-36	-25	**Moderate - negative**
-8	-7	**Moderately detrimental**		-24	-13	**Low – negative**
-6	-5	**Slightly detrimental**		-12	-3	**Very low – negative**
-4	4	**Negligible**		-2	2	**Neutral**
5	6	**Slightly beneficial**		3	12	**Very Low - positive**
7	8	**Moderately beneficial**		13	24	**Low – positive**
9	10	**Highly beneficial**		25	36	**Moderate – positive**
11	12	**Extremely beneficial**		37	48	**High – positive**

Once significance has been calculated (both pre and post mitigation), additional consideration is required for **Confidence** (**Table 5**) in the assessed impact significance, **Reversibility** of the impacts (**Table 6**) and **Irreplaceability** of the resource being assessed (**Table 7**). Lastly, a comment on the cumulative impact is required which considers the impact of the proposed development in combination with other current or future developments in the area.

Table 5: Definition of confidence ratings

Rating	Criteria
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 6: Definition of reversibility ratings

Rating	Criteria
Irreversible	The activity will lead to an impact that is permanent.
Reversible	The impact is reversible, within a period of 10 years.

Table 7: Definition of irreplaceability ratings

Rating	Criteria
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

4.3 Identified impacts

As mentioned in **Section 1.2**, the proposed solar farm development includes three alternatives, namely:

Alternatives have been included in this assessment and have been assessed in Section 4 of this report with regards to their comparative impact on the hydrological environment. These alternatives are as follows:

- Two alternative solar technologies - PV with fixed axis (alternative A1) or PV with single axis tracking (alternative A2);
- Two alternatives for access to the site - leading northwards from the N14 (alternative B1) or leading southwards from the Pella-Goodhouse Road (Alternative B2); and
- Two alternatives for the connection to the national grid - a loop-in-loop-out connection to the existing Eskom transmission line (Alternative C1) or a new 132 kV transmission line approximately 24.5 km long (Alternative C2).

The following sections outline the impacts associated with the hydrological (surface water) environment including consideration of the alternatives listed above.

Figure 1 and **Figure 2** are of particular value in identifying the alternatives listed above.

Alternative A1 and A2 above have been grouped with the impact assessment for the site due to the near negligible difference between the two technologies and the benefit of utilising a single impact table for the site. The impact tables below which refer to the technology alternative should consequently also be noted to refer to the 244 ha site as a whole.

4.3.1 Increase in runoff

See Section 3.3 which outlines the increase in runoff as it relates to stormwater management.

The proposed PV Power Project will involve the addition of hardened areas through the establishment of solar panel foundations while some compaction of soils may occur due to site works. Service roads have the potential to further increase areas of hardening as do the temporary construction area. The substation and additional support buildings will increase hardened surfaces. The aforementioned will increase the runoff generated on site due to the addition of areas of hard surfaces and could lead to increased flood peaks downstream with increased flood risk and erosion risk. Spacing between solar panels and associated foundations will limit the accumulative influence of the proposed development on runoff as will the soil's high infiltration rates, the flat terrain and the low rainfall.

Technological alternatives A1 and A2 are unlikely to differ much with regards to the impact on runoff. Access alternatives will make use of existing roads for the most part, but these could require widening. Alternative B1 is 10 km longer than alternative B2 and will consequently result in increased runoff by comparison. The alternative C1 Eskom line loop-in-loop-out, will not require the addition of a 24.5km transmission line and associated pylons, thereby reducing the impact on runoff.

The increase in runoff is applicable to the construction, operating and decommissioning phases.

Impacts for the PV technology and overall site, the access roads and transmission lines are listed in **Table 8**, **Table 9** and **Table 10**

Table 8: Impact of the PV technology on runoff

TECHNOLOGY ALTERNATIVE	Alternative A1		Alternative A2	
Short Description	Fixed axis PV		Single axis tracking PV	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	In relation to the site infrastructure including PV panels, internal access roads, buildings and laydown or temporary construction areas and any additional hardstanding			
List of negative impacts	Concentration of runoff from increased hardened surfaces and compaction of soils			
List of positive impacts	None			
List of potential mitigations	Infrastructure footprint and associated area of disturbance should be minimised as far as practically possible. Limiting the time and area over which machinery operates will limit the compaction of soils. Laydown areas should likewise be kept to a minimum with regards to area and time. The infrastructure footprint and associated area of disturbance should be minimised as far as practically possible with adequate spacing between panels to encourage grass growth. Soft engineering solutions such as vegetated buffer strips or swales should be used where necessary. Refer to Section 3.3 for more detail			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Low	Very Low	Low	Very Low
Duration	Medium term	Medium term	Medium term	Medium term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Slightly detrimental	Negligible	Slightly detrimental	Negligible
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area while the site is in separate catchment to secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	1		2	
Motivation for preferred alternative	Differences are limited with regards to influence on runoff, although possible greater maintenance requirements of single axis tracking means that a fixed setup is preferred to minimise disturbance to vegetated areas around and beneath the panels.			

Table 9: Impacts of access roads on runoff

ACCESS ALTERNATIVE	Alternative B1	Alternative B2
Short Description	Access road from south	Access road from north
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	8m wide gravel road running 10km further than Alternative B2	8m wide gravel road running 10km less than Alternative B1
List of negative impacts	Compacted surface with increase in runoff	
List of positive impacts	None	
List of potential mitigations	Infrastructure footprint and associated area of disturbance should be minimised as far as practically possible. Limiting the time and area over which machinery operates will limit the compaction of soils. Laydown areas should likewise be kept to a minimum with regards to area and time. Drift river crossings should be used where possible to limit negative hydraulic impacts on stream channels including erosion impacts. Road side drainage should promote infiltration of runoff where it becomes concentrated. Road side swales or infiltration basins would facilitate this.	

Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Low	Very Low	Low	Very Low
Duration	Medium term	Medium term	Medium term	Medium term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Slightly detrimental	Negligible	Slightly detrimental	Negligible
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area and use of existing road while access road would be shared by secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	2		1	
Motivation for preferred alternative	Having 10km less of access road reduces impact			

Table 10: Impact of transmission line on runoff

TRANSMISSION ALTERNATIVE	Alternative C1		Alternative C2	
Short Description	Loop-in-loop-out into existing Eskom transmission line		New 24.5km line to Aggeneys Substation	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	Connecting to the existing Eskom line approximately by way of a 2.5 km link line from the substation		Extending the 2.5 km link line by way of a new 24.5km transmission line running parallel to the existing Eskom line	
List of negative impacts	Addition of pylons and site works which will add minor hardened surfaces while works along route will increase compaction			
List of positive impacts	None			
List of potential mitigations	Infrastructure footprint and associated area of disturbance should be minimised as far as practically possible. Limiting the time and area over which machinery operates will limit the compaction of soils. Laydown areas should likewise be kept to a minimum with regards to area and time.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Low	Very Low	Low	Very Low
Duration	Medium	Medium	Medium	Medium
Probability	Very Likely	Fairly Likely	Very Likely	Fairly Likely
Consequence	Slightly detrimental	Negligible	Slightly detrimental	Negligible
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area while 24.5km transmission line would be shared by secondary (future) solar farm			
Conclusion				
Ranked preference (from 1-4)	1		2	
Motivation for preferred alternative	Not adding a 24.5km transmission line reduces area of impact			

4.3.2 Deterioration in water quality

The proposed development will require clearing of existing vegetation and disturbance of soils, specifically for the installation of foundations for PV modules, access roads, electrical cabling, substation, buildings and laydown areas. The solar panels will increase shading of the surface and may result in an increase or decrease in vegetation cover. If the cause is a decrease in vegetation cover then disturbed or exposed soils will increase the likelihood of soil erosion and subsequent potential sedimentation of downstream water courses during significant rainfall events. The study by Cook and McCuen (2013) found that the runoff from individual solar panels resulted in greater kinetic energy which increased potential soil erosion below panels (this potential erosion may be enhanced by panel maintenance which includes regular washing). The site is, however, located in a low rainfall area of South Africa which will reduce the potential impact with the mild topography also reducing the erosivity of runoff.

The deterioration in water quality is applicable to the construction, operation and decommissioning phases.

Impacts for the PV technology (and overall site), the access roads and transmission lines are listed in **Table 11**, **Table 12** and **Table 13**.

Table 11: Impact of the PV technology on water quality

TECHNOLOGY ALTERNATIVE	Alternative A1		Alternative A2	
Short Description	Fixed axis PV		Single axis tracking PV	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	In relation to the site infrastructure including PV panels, internal access roads, buildings and laydown or temporary construction areas and any additional hardstanding			
List of negative impacts	Erosion of soils and contamination of the environment with hydrocarbons			
List of positive impacts	None			
List of potential mitigations	The project infrastructure footprint and associated area of disturbance should be minimised as far as practically possible with adequate spacing between panels to encourage vegetative growth. The clearing of vegetation and disturbance of soils should be done considering the potential for subsequent erosion. Site rehabilitation should aim to restore surface drainage patterns, natural soil and vegetation as far as is feasible. An erosion control management plan should be utilised to prevent erosion. This may include erosion control measures such as silt fences (for areas of works) and gravel strips at the impact zone where water falls from the solar panels onto the soil surface (due to deterioration in natural shrubland because of poor maintenance or lack of solar radiation). The development of the solar farm should be done considering the potential for erosion as part of the overall storm water management of the site which will also facilitate slowing of runoff or settling of sediment. This may include 'soft' engineering solutions such as vegetated buffer strips or swales alongside service roads, underneath solar panels or downslope of a range of panels. Any vegetated buffer strips or swales will need to be maintained with a healthy grassland cover that can effectively intercept sediment suspended in runoff. Containers carrying batteries (if present) should be regularly checked for leaks. If leaks are found, these containers should be repaired, replaced immediately with leaked chemicals cleaned up as soon as possible. Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage using impermeable floors with appropriate bunding, sumps and roofing. Handle hydrocarbons carefully to limit spillage. Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited. Designate a single location for refuelling and maintenance where possible. Keep a spill kit on site to deal with any hydrocarbon leaks. Remove soil from the site which has been contaminated by hydrocarbon spillage.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Medium	Very Low	Medium	Very Low
Duration	Long Term	Short Term	Long Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Negligible	Moderately detrimental	Negligible

Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area while the site is in separate catchment to secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	1		2	
Motivation for preferred alternative	Differences are limited with regards to influence on water quality, although possible additional maintenance of single axis tracking means that a fixed setup is preferred			

Table 12: Impacts of access roads on water quality

ACCESS ALTERNATIVE	Alternative B1		Alternative B2	
Short Description	Access road from south		Access road from north	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	8m wide gravel road running 10km further than Alternative B2		8m wide gravel road running 10km less than Alternative B1	
List of negative impacts	Erosion of soils and contamination of the environment with hydrocarbons			
List of positive impacts	None			
List of potential mitigations	The clearing of vegetation and disturbance of soils should be done considering the potential for subsequent erosion. Site rehabilitation should aim to restore surface drainage patterns, natural soil and vegetation as far as is feasible. An erosion control management plan should be utilised to prevent erosion. This may include erosion control measures such as silt fences (for areas of works). Road side drainage should take cognisance of possible erosion over time and mitigate accordingly through both construction methods and maintenance. Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage using impermeable floors with appropriate bunding, sumps and roofing. Handle hydrocarbons carefully to limit spillage. Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited. Designate a single location for refuelling and maintenance where possible. Keep a spill kit on site to deal with any hydrocarbon leaks. Remove soil from the site which has been contaminated by hydrocarbon spillage.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Medium	Very Low	Medium	Very Low
Duration	Long Term	Short Term	Long Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Negligible	Moderately detrimental	Negligible
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area and use of existing road while access road could be shared by secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	2		1	
Motivation for preferred alternative	Having 10km less of access road reduces impact			

Table 13: Impact of transmission line on water quality

TRANSMISSION ALTERNATIVE	Alternative C1		Alternative C2	
Short Description	Loop-in-loop-out into existing Eskom transmission line		New 24.5km line to Aggeneys Substation	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	Connecting to the existing Eskom line approximately by way of a 2.5 km link line from the substation		Extending the 2.5 km link line by way of a new 24.5km transmission line running adjacent the existing Eskom line	
List of negative impacts	Erosion of soils and contamination of the environment with hydrocarbons			
List of positive impacts	None			
List of potential mitigations	The clearing of vegetation and disturbance of soils should be done considering the potential for subsequent erosion. Site rehabilitation should aim to restore surface drainage patterns, natural soil and vegetation as far as is feasible. An erosion control management plan should be utilised to prevent erosion. This may include erosion control measures such as silt fences (for areas of works). Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage using impermeable floors with appropriate bunding, sumps and roofing. Handle hydrocarbons carefully to limit spillage. Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited. Designate a single location for refuelling and maintenance where possible. Keep a spill kit on site to deal with any hydrocarbon leaks. Remove soil from the site which has been contaminated by hydrocarbon spillage.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Site specific	Local	Site specific
Intensity	Medium	Very Low	Medium	Very Low
Duration	Long Term	Short Term	Long Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Negligible	Moderately detrimental	Negligible
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Reversible			
Irreplaceability	Medium			
Cumulative Impact	Negligible due to little development in area while 24.5km transmission line could be shared by secondary (future) solar farm			
Conclusion				
Ranked preference (from 1-4)	1		2	
Motivation for preferred alternative	Not adding a 24.5km transmission line reduces area of impact			

4.3.3 Flood risk

Flood risk is considered here for the proposed development only, as the stormwater management mentioned earlier will mitigate changes in flood risk to downstream areas due to the development itself. Section 3.2.1 outlines flood risk to the site by the rivers to the east and west of the site and with a possible overtopping of the larger river to the north-west. Additional flood risk is applicable to the access roads and transmission lines due to various rivers that are crossed.

Flood risk is applicable to the construction, operating and decommissioning phases.

Impacts for the PV technology, overall site, the access roads and transmission lines are listed in **Table 14**, **Table 15** and **Table 16**

Table 14: Impact of flood risk on the PV technology

TECHNOLOGY ALTERNATIVE	Alternative A1		Alternative A2	
Short Description	Fixed axis PV		Single axis tracking PV	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	In relation to the site infrastructure including PV panels, internal access roads, buildings and laydown or temporary construction areas and any additional hard surfaces			
List of negative impacts	Flooding from rivers adjacent the site			
List of positive impacts	None			
List of potential mitigations	Floodline modelling should be undertaken to define likely extents and depths of flooding and consequent site design. Possible flood defences could be included where relevant although most of the site infrastructure is compatible with low depths of flooding (i.e. the raised solar panels). Flood buffers as outlined in this report should be used for the time being as a starting point for flood protection. Mitigation of surface water flooding can potentially be incorporated into a storm water management plan of the site with water routed around sensitive infrastructure. Refer to Section 3.2.1 for more detail.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Intensity	High	Low	High	Low
Duration	Short Term	Short Term	Short Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Slightly detrimental	Moderately detrimental	Slightly detrimental
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Irreversible			
Irreplaceability	High			
Cumulative Impact	Negligible due to little development in area while the site is in separate catchment to secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	1		1	
Motivation for preferred alternative	Differences are negligible as the technology has no bearing on flooding or visa versa			

Table 15: Impacts of flood risk on the access roads

ACCESS ALTERNATIVE	Alternative B1		Alternative B2	
Short Description	Access road from south		Access road from north	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	8m wide gravel road crossing 18 rivers		8m wide gravel road crossing 15 rivers	
List of negative impacts	Flooding of river crossings with a risk to users, especially during flash flood events.			
List of positive impacts	None			
List of potential mitigations	Flooding of river crossings should be accounted for in their design. Drift crossings will likely require limited flood input, however, low-level crossings where relevant should consider possible flooding. A flood response plan should be in place for users which considers the response to episodes of flash flooding and makes users aware that there is a risk despite the appearance of dry rivers. Refer to Section 3.4 for more detail.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local

Intensity	High	Low	High	Low
Duration	Short Term	Short Term	Short Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Slightly detrimental	Moderately detrimental	Slightly detrimental
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Irreversible			
Irreplaceability	High			
Cumulative Impact	Negligible due to little development in area and use of existing road while access road could be shared by secondary solar farm			
Conclusion				
Ranked preference (from 1-4)	2		1	
Motivation for preferred alternative	Fewer rivers are crossed by the access road from the north (although the flood significance of these rivers hasn't been assessed).			

Table 16: Impact of flood risk on transmission line

TRANSMISSION ALTERNATIVE	Alternative C1		Alternative C2	
Short Description	Loop-in-loop-out into existing Eskom transmission line		New 24.5km line to Aggeneys Substation	
Description of alternative specific attributes (environmental / socioeconomic / Technical and financial)	Connecting to the existing Eskom line approximately by way of a 2.5 km link line from the substation which crosses 1 river.		Extending the 2.5 km link line by way of a new 24.5km transmission line running adjacent the existing Eskom line which crosses four rivers.	
List of negative impacts	Flooding from rivers over which the proposed transmission lines cross, could be a risk to personnel with pylons potentially altering the flood flow regime and causing scour in the river beds and on floodplains.			
List of positive impacts	None			
List of potential mitigations	The positioning of pylons should account for likely flood extents with pylons placed outside of the anticipated floodplain while personnel involved with the construction and maintenance of the transmission lines, should be aware of the potential of flash flooding (given the dry rivers which will instil a sense of little risk). Refer to Section 3.4 for more detail. Pylons located within river channels or on floodpains should be design to minimise scour potential.			
Assessment	Without Mitigation	Residual Impact (with Mitigation)	Without Mitigation	Residual Impact (with Mitigation)
Nature	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Intensity	High	Low	High	Low
Duration	Short Term	Short Term	Short Term	Short Term
Probability	Very Likely	Unlikely	Very Likely	Unlikely
Consequence	Moderately detrimental	Slightly detrimental	Moderately detrimental	Slightly detrimental
Significance	Low	Very Low	Low	Very Low
Confidence	Sure			
Reversibility	Irreversible			
Irreplaceability	High			
Cumulative Impact	Negligible due to little development in area while 24.5km transmission line could be shared by secondary (future) solar farm			
Conclusion				
Ranked preference (from 1-4)	1		2	
Motivation for preferred alternative	The addition of a 24.5km transmission line crosses an additional 3 rivers.			

4.4 Recommendation

The hydrological impacts are largely limited, with flooding being of greatest significance despite a similar significance rating to deterioration in water quality. Mitigation improves all impacts. Of the alternatives considered, panel axis alternatives A1 or A2 make little difference (although a fixed axis PV is preferred) while the access road from the north (Alternative B2) and the loop-in-loop-out into the existing Eskom line (Alternative C1) are preferred.

No surface water monitoring plan is possible given the ephemeral rivers on and near the site and consequently no surface water monitoring is expected to occur.

The proposed development should consequently be authorised inclusive of recommended mitigation measures outlined which should as far as possible, result in the mimicking of the natural hydrology.

5 Summary

Baseline information including rainfall, evaporation, design rainfall, soils, vegetation, land cover, topography and hydrology have been considered for the proposed Veld PV South Solar Farm.

The proposed development will impact receiving water resources through both the removal of vegetation with an increase in associated soil erosion potential, as well as result in an increase in runoff through increased hard surfaces. Surface water flooding may also impact the site due to the presence of non-perennial watercourses adjacent to the site.

With regards to areas of sensitivity, the river buffers recommended in the Freshwater Assessment (BlueScience, 2017) should be used.

Three aspects of the proposed development were identified requiring consideration during the detailed design phase and include flood risk to the development, stormwater management with a view to reducing flood and erosion risk downstream of the development, and river crossings. Of these, flood risk to the development is important due to potential flooding from the large river to the north-west of the site and potential backwater effects on floodwaters caused by nearby inselbergs in association with the river to the east of the site.

The hydrological impacts are largely limited, with flooding being of greatest significance. Mitigation improves all impacts. Of the alternatives considered, panel axis alternatives A1 or A2 make little difference while the access road from the north (Alternative B2) and the loop-in-loop-out into the existing Eskom line (Alternative C1) are preferred.

No surface water monitoring plan is possible given the ephemeral rivers on and near the site and consequently no surface water monitoring is expected to occur.

The proposed development should consequently be authorised inclusive of recommended mitigation measures outlined which should as far as possible, result in the mimicking of the natural hydrology.

6 References

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Appendix B: CV of Martin Kleynhans

Curriculum vitae: Mr M KLEYNHANS

Name	:	**KLEYNHANS, MARTIN**
Date of Birth	:	21 July 1977
Profession/Specialisation	:	Water Engineer
Years with Firm	:	12
Years' experience	:	19

Key qualifications

Martin is a civil engineer with more than 15 years of experience in water resources planning, flood hydrology, river hydraulic modelling including environmental hydraulics and flood modelling, engineering in rivers and wetlands, design and construction supervision of large hydraulic and flood protection structures, stormwater modelling and water resources systems modelling.

Environmental hydraulics projects he has been involved with include hydrodynamic modelling of the Nylsvlei floodplain for impact assessment and determining eco-system services delivered by the wetland; writing a chapter on river rehabilitation for a guide to environmental hydraulics in South Africa; and acting as the hydraulics expert for the determination of the environmental water requirements on several rivers including the Limpopo, Mzimkhulu, Mzimvubu and Senqu Rivers.

He has worked on numerous flood studies and river hydraulics projects, including the flood hydrology, hydrodynamic modelling and where relevant, the design of erosion protection measures. He has set up a hydrodynamic model for the operation of a river system to optimise releases from dams to the relevant downstream users and has undertaken 2D hydraulic modelling for fish, invertebrate and vegetation habitat.

Some major water resources projects that he has worked on entailed setting up and running a system model to analyse current and future water resources development scenarios in the Maputo River Basin (Mozambique, Swaziland, South Africa), setting up and running a system model of the Limpopo River Basin, and conducting water resources work for a feasibility study into six surface water resource development options for the augmentation of the water supply to Cape Town.

He has worked on the design of a dam and water supply scheme in Madagascar, a three-year project to plan and design structures to prevent and remediate erosion in wetlands across South Africa, the rehabilitation and redesign of the Malawian surface water monitoring network, the design and construction supervision of structures to reduce flood risk to numerous villages in Southern Malawi and the design of large hydraulic structures and stormwater systems in Nigeria.

Martin obtained a Master of Science in Engineering in 2004 and a Bachelor of Science in Civil Engineering in 1999, both from the University of the Witwatersrand (Wits) in South Africa. He is registered as a professional engineer with the Engineering Council of South Africa (ECSA) and is a member of the South African Institution of Civil Engineering (SAICE).

Employment record

01/2007 - Date	Aurecon, Water Engineer
2004 - 2006	Stewart Scott International, Water Engineer
2000 - 2001	Murray & Roberts Civils (Pty) Ltd, Site Engineer

Experience record

Upgrading of Somerset East wastewater treatment works (WWTW): Phases 2 and 3, Eastern Cape Province, South Africa, Blue Crane Route Municipality (BCRM), 01/2007 - 12/2020, Water Engineer

The project entailed the upgrading of the Somerset East wastewater treatment works (WWTW). The upgrade includes improvements and new facilities, incorporating the inlet works, bioreactor, secondary settling tanks, process pipelines, return activated sludge (RAS) and effluent pump stations, irrigation, chlorination and control buildings. Aurecon compiled a technical report outlining the shortcomings of the existing works, the parameters to which such a WWTW should comply and the needs to meet these parameters. The report formed the basis of a municipal infrastructure grant (MIG) application. Responsible for determining the flood lines, including design flood determination and hydraulic modelling of the Little Fish River at Somerset East.

Determination of water resource classifications and associated resource quality objectives (RQOs) for the Berg River Catchment, Western Cape Province, South Africa, Department of Water and Sanitation (DWS), 05/2016 - 05/2019, Hydraulics Expert

Aurecon was appointed to determine the water resource classifications for the Berg River Catchment as well as the associated resource quality objectives (RQOs). The main objectives of the study are to coordinate the implementation of the water resource classification system (WRCS), as required in Regulation 810 in Government Gazette 33541, by classifying all significant water resources as part of the Berg Catchment, and RQOs. Aurecon is also involved in determining RQOs using the Department of Water and Sanitation's (DWS's) procedures to determine and implement RQOs for all significant water resources in the Berg River Catchment. As part of this process, extensive stakeholder engagement is being undertaken. Responsible for training of a colleague, undertaking the surveys and data collection and determination of basic hydraulics for the EWR.

Determination of water resource classifications and resource quality objectives (RQOs) in the Breede-Gouritz catchment area, Western Cape Province, South Africa, Department of Water and Sanitation (DWS), 05/2016 - 12/2018, Hydraulics Expert

The main objectives of the study are to coordinate the implementation of the water resource classification system (WRCS), as required in Regulation 810 in Government Gazette 33541, by classifying all significant water resources as part of the Breede-Gouritz Water Management Area (WMA). Aurecon is also involved with determining resource quality objectives (RQOs) using the Department of Water and Sanitation's (DWS's) procedures to determine and implement RQOs for all significant water resources in the Breede-Gouritz catchment area as part of the Breede-Gouritz WMA. As part of this process, extensive stakeholder engagements is being undertaken. The project also includes capacity-building of DWS staff. Responsible for determination of basic hydraulics.

Design contract for the Nigeria Erosion and Watershed Management Project (NEWMAP), Edo State, Nigeria, Nigeria Erosion and Watershed Management Project (NEWMAP), 10/2014 - 12/2018, Hydraulic Design Engineer

Aurecon was appointed to assist the EDO State Project Management Unit (PMU) in the engineering design and supervision of erosion control sites over a three-year period. This included 10 new sites for engineering design/supervision, namely Ibore and Emu/Ohodua gully erosion sites in Esan; Ewu Esan gully erosion; Igbe quarters flood and gully erosion; Auchi; Edo College gully erosion; Iwogban quarters/Ekhaguare street gully; Ogiso/Osunde flood and gully erosion site; Fugar-Agenebode road flood and gully erosion; Warake gully erosion and Gapiona watershed catchment. The appointment also includes supervision of three priority sites which had previously been designed by others, namely Oshiobugie gully erosion in Auchi, Queen Ede gully erosion and Ekehuan road gully erosion sites. Responsible for determining design flows, conceptual layouts and designs for various stormwater and erosion control infrastructure, the optimisation of the options through stormwater systems modelling at 11 distinct sites and providing input during the detailed design process and to the resident engineer for the construction phase. Many of the sites involved large hydraulic structures and large design flows.

Environmental flow assessment for Niger Delta, Guinea and Mali, IWMI, 02/2017 - 09/2018, Hydraulic Expert

Environmental flow requirements have never been determined for the upper Niger and Inner Niger Delta and this project is aimed at informing the future basin planning that includes significant proposed developments. A 2D hydrodynamic model of the delta, developed in Canada, and 1D models of various sites in the upstream rivers were used to test the impact of various flow scenarios. Responsible for determination of basic hydraulics.

Shire River Basin Management Programme - Flood Risk Management (FRM) component, Shire River Basin, Malawi, Department of Disaster Management Affairs (DoDMA), 04/2015 - 07/2018, Hydraulic Design Engineer

This project forms part of the Shire River Basin Management Programme, Phase 1 (SRBMP-1) project, which aims to transform the largely sectoral planning approaches in the Shire River Basin into inclusive stakeholder-based development planning and management of the basin's water and related natural resources. Aurecon, in association with BRL Ingénierie (France) and WEMS (Malawi), was appointed as the implementation service provider (ISP) for flood risk management, which focuses on the districts of Chikwawa and Nsanje, the Elephant Marsh and main tributaries. The project includes developing national guidelines for community-based flood risk management; facilitating the planning, design, tendering and construction supervision of flood mitigation and adaptation measures; supporting the roll-out and connectivity of a basin-wide flood forecasting and early warning system, as well as the design of community-based flood protection measures to be built through labour-intensive means. Responsible for the conceptualisation, prioritisation, design, tendering and construction supervision of flood mitigation measures to protect approximately 187 000 people. This includes hydrodynamic modelling of flood protection options for the various areas in both 1D and 2D, design of the flood protection structures, stormwater channels, dykes, safe river crossings, evacuation areas, flood attenuation structures, compilation of drawings and tender documents and construction supervision. Also contributed to the national guidelines for community-based flood risk management, design of labour-intensive works interventions and the flood forecasting and early warning system.

Pre-feasibility study into the upgrading of the Welvanpas water treatment works (WTW) versus other options, Western Cape Province, South Africa, Drakenstein Local Municipality, 08/2008 - 04/2017, Water Engineer

Aurecon was appointed to investigate 10 options for augmenting the water supply to the Drakenstein Local Municipality, including the upgrading of various sources that supply water to the Welvanpas reservoir and water treatment works (WTW). The Antoniesvlei option was identified as the most cost-effective option available to increase the flow to the Welvanpas reservoir and WTW. The project involved the replacement of the existing cast iron pipeline with a high-density polyethylene (HDPE) pipe. Numerous valves, hydrants, air valves and a scour were also installed. Responsible for helping to conceptualise the various augmentation options, pre-feasibility design of the options, costing and determination of unit reference values (URVs) for comparison as well as writing of a report.

Cape Critical Rivers (CCR) Project: freshwater ecosystem priority areas (FEPAS) validation and flows study, Western Cape Province, South Africa, Freshwater Research Centre (FRC), 05/2014 - 11/2016, Hydraulics Expert

This project involved the validation of freshwater ecosystem priority areas (FEPAs) and flows study for the Cape Critical Rivers (CCR) Project, which aims to bridge biodiversity conservation with water resource management in the Western Cape through a river flow monitoring system. The system offers a cost-effective, simple way to measure the flow of water in critical rivers around the Western Cape, predicts the flows required for maintaining the fish populations and compares the two to visually show where actual flows are not meeting the requirements for healthy fish populations. Aurecon's scope included FEPAs validation, scaling and disaggregation of hydrological data for the study area, derivation of a rating curve and generation of cross-sections for specified sites in the study area. Responsible for setting up and rating suitable monitoring locations at natural river hydraulic controls, providing time-series of discharges for each site based on logged water levels, producing habitat hydraulics for each site through habitat hydraulic modelling and setting up a rainfall-driven hydrological model to determine the required environmental flows at the various sites and which was simple enough for the layman to use.

Instream flow and environmental water requirements (IFRs and EWRs) for Polihali Dam, Lesotho, Institute of Natural Resources (INR), 01/2013 - 09/2016, Hydraulics Expert

Aurecon was appointed as part of a team of consultants to determine the instream flow requirements (IFRs) or environmental water requirements (EWR) and to design an EWR compliance monitoring system for the Senqu River downstream of the planned Polihali Dam. This involved developing a new model (PROBFLO), which brought together three internationally accepted approaches, namely the Ecological Limits of Hydrologic Alteration (ELOHA) framework, probability modelling using Bayesian networks and regional risk assessments of scenarios. The results of the EWR assessment were fed into the design of the Polihali Dam. The project formed part of the second phase of the Lesotho Highlands Water Project (LHWP). Responsible for the hydraulic work, including 1D and 2D hydraulic modelling of the river for habitat prediction at five sites, two of which were modelled in 2D using River2D.

Establishment of an integrated water resources management system (IWRMS), Malawi, National Water Development Programme (NWDP), 07/2010 - 06/2016, Water Engineer

Aurecon was appointed to establish an integrated water resources management system (IWRMS), including hydraulic and hydrological models and decision support tools, for the National Water Development Programme (NWDP). The project entailed the development and establishment of a management information system (MIS) and supporting databases. The project further consisted of the technical capacity in re-establishing surface water, ground water and water quality monitoring systems. Responsible for the surface water components related to conducting field trips, assessing the present situation and needs, designing an improved surface water monitoring system, including equipment and network coverage, and training government officials.

Malgas pumping scheme, Western Cape Province, South Africa, George Local Municipality, 11/2008 - 05/2015, Water Engineer

The project consisted of the design of a pump station and pipeline to transfer water from Malgas River to the water treatment works (WTW) at George. Responsible for determining the flood lines at the pump station site, including design flood determination and hydraulic modelling of the Malgas River at the site.

Limpopo River Basin monograph study, Botswana, Mozambique, South Africa and Zimbabwe, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 01/2012 - 12/2014, Water Resources Engineer/Hydraulics Expert

The study aimed to fulfil the objectives of the revised Southern African Development Community (SADC) Protocol on Shared Watercourses; foster closer cooperation for judicious, sustainable and coordinated management, protection and use of shared watercourses and advance the SADC's agenda of regional integration and poverty alleviation. It addressed the challenges of insufficient coordination and policy framework integration and development plans in the Limpopo Basin shared between Botswana, Mozambique, South Africa and Zimbabwe. The study highlighted the gaps in capacities in the field of water resources management and lack of adequate legislative and institutional capacities in the member states. Responsible for setting up and running a system model of the Limpopo River Basin for all the sub-basins that weren't covered by existing system models using the water resources yield model (WRYM); which amounted to just over half of the basin area. In addition, the yields of the various sub-basins were determined at 1:5-year assurance levels and an environmental reserve determination was undertaken for seven sites in the basin at a Rapid III level and one site at Rapid I level. Also responsible for conducting the field surveys and eco-hydraulic modelling of the sites for habitat prediction using the HABitat-FLOw simulation software (HABFLO) model.

Hydrodynamic model for operation of the Komati Basin Water Authority (KOBWA) system, Mpumalanga Province, South Africa, Komati Basin Water Authority (KOBWA), 01/2014 - 08/2014, Hydraulics Expert

The project involved the configuration and calibration of the Hydrologic Engineering Center's River Analysis System (HEC-RAS) model for the Komati Basin Water Authority's (KOBWA's) water management system (WMS) and the application of the model as a decision support tool (DST) to facilitate releases from the Maguga and Driekoppies Dams. Releases from the dams are used to augment incremental runoff to meet irrigation demands and maintain cross-border minimum flows into Mozambique. Detailed training was provided to KOBWA personnel and an operator's manual was prepared. Responsible for supervising survey of key structures; setting up, calibrating and verifying the hydrodynamic model and setting up a predictive model using the ungauged lateral inflows module in HEC-RAS.

Western Cape pre-feasibility and feasibility studies, Western Cape Province, South Africa, Department of Water Affairs (DWA), 09/2008 - 05/2014, Water Engineer

The project entailed pre-feasibility and feasibility studies for the proposed six surface water schemes in the Western Cape, including the Mitchell's Pass diversion scheme; the first phase augmentation of Voëlvlei Dam; further phases of Voëlvlei Dam augmentation; the Molenaars River diversion; the Upper Wit River diversion and further phases of the Palmiet transfer scheme. The water resources yield model (WRYM) was applied to re-determine the integrated system yield based on the Berg River updated hydrology. The water resources planning model (WRPM) was used to assess scenarios of implementation options and water requirement scenarios. Responsible for determining the yields for six different surface water resource options and being involved in conceptualising infrastructure for the six options as well as the costing of these options at a pre-feasibility level. Also responsible for helping to conceptualise the two short-listed options for the second feasibility study phase, determining yields for these and costing some of the infrastructure required as well as writing some of the reports on the projects.

South African National Biodiversity Institute (SANBI): Working for Wetlands Programme, Western Cape Province, South Africa, South African National Biodiversity Institute (SANBI), 08/2011 - 09/2013, Water Engineer

Aurecon was appointed to undertake the planning, design and environmental, project and risk management of the South African government's Working for Wetlands Programme. Aurecon assembled a team of wetland ecologists, environmentalists, hydrologists and engineers to repair and rehabilitate over 100 wetland sites in the Western Cape through the implementation of interventions, usually in the form of engineered structures. Appropriate hydrological assessments and engineering techniques were devised to enable design and construction, in many cases without anchoring in bedrock.

Investigating links between riparian vegetation and river hydraulics, South Africa, Water Research Commission (WRC), 03/2012 - 06/2013, Hydraulics Expert

This research project aimed to establish links between the zonation of vegetation on river banks in headwater streams and various hydraulic parameters, such as inundation durations, velocities during floods and flood return frequencies at various levels on the river bank. Undertook research to determine the relevant flow time series and modelled the hydraulics at the nine research sites. Also co-wrote a paper on the research.

Working for Wetlands rehabilitation programme, Various provinces, South Africa, South African National Biodiversity Institute (SANBI), 12/2009 - 06/2013, Water Engineer

Aurecon was appointed to conduct the planning and implementation of rehabilitation interventions for the Working for Wetlands programme in the Gauteng, KwaZulu-Natal, Free State, Eastern and Western Cape, Limpopo and North West Provinces. The focus was on wetland conservation and poverty reduction through job creation and skills development. The project's key objective was to support and enable the protection, rehabilitation and sustainable use of South Africa's wetlands through cooperative governance and partnerships. The main work components included assessing wetland health for identification and prioritisation of remedial measures, obtaining environmental authorisation and undertaking the engineering design and site support for the implementation thereof. Responsible for the design of erosion protection structures in various wetlands in the Eastern Cape and KwaZulu-Natal Provinces to restore the wetland flooding regime and prevent further erosion. Labour-intensive construction (LIC) methods were used.

Environmental reserve determination on the Mzimvubu River, Eastern Cape Province, South Africa, Water Research Commission (WRC), 07/2012 - 05/2013, Hydraulics Expert

An environmental reserve determination was undertaken for three sites in the Mzimvubu River catchment, two were done at a Rapid III level and one at an Intermediate level. Responsible for acting as the hydraulics expert in the environmental reserve determination and to train a hydrologist in the field. The work included field surveys, hydraulic analyses, attendance of the workshop and writing of a report and training of the hydrologist to undertake Rapid level hydraulics for the environmental water requirement (EWR).

Determination of the split in flows at a diversion weir on Voëlvlei Farm for a court case, Western Cape Province, South Africa, Voëlvlei Farm, 03/2012 - 07/2012, Water Engineer

Two adjacent farmers were involved in a dispute over the sharing of water at a diversion weir. Responsible for hydraulic modelling of the present day diversion weir and various proposed weir layouts to determine the flow splits for each farmer.

Modelling the impact on flows of various proposed diversion schemes on Verlorenvlei Farm, Western Cape Province, South Africa, Verlorenvlei Farm, 01/2012 - 04/2012, Water Engineer

Verlorenvlei Farm wished to augment the yield of their dams through the addition of water from adjacent catchments through diversion schemes. Responsible for modelling flow time-series of the various proposed diversion options at an hourly time-step and determination of their impact on the environmental reserve flows.

Determination of flows and diversions at Verlorenvlei Farm for a court case, Western Cape Province, South Africa, Verlorenvlei Farm, 05/2011 - 12/2011, Water Engineer

Two adjacent farmers were involved in a dispute over the sharing of water from various rivers in the mountain catchment upstream. Responsible for setting up an hourly time-step model for the various catchments and modelling the various diversions and canals for the present day situation and for various proposed scenarios to provide information for the court case.

Water resources study for the Mzimkhulu River catchment, KwaZulu-Natal Province, South Africa, Department of Water and Sanitation (DWS), 04/2009 - 12/2011, Hydraulics Expert

The project entailed conducting a water resource study to identify potential and conditions for the further afforestation of the Mzimkhulu River catchment and to develop scenarios for the development of the catchment. The study included the updating of hydrology and the calibration of surface and groundwater models. The land use was assessed and future water requirements were analysed. A reserve determination was carried out and options were given for future development scenarios. River conservation and the implications of developments were also included in the study, and a water export scope and the modelling on water resources information management systems (WRIMSs). Responsible for acting as the hydraulics expert in the environmental water requirement determination, working together with other experts. The work included field surveys and hydraulic analyses.

Rapid environmental reserve determination for the Mthinzima and Rietspruit Rivers, KwaZulu-Natal Province, South Africa, uMgungundlovu District Municipality, 06/2010 - 01/2011, Hydraulics Expert

In this project, an environmental reserve determination was done for the two rivers to aid decision making for the suitable river to discharge to from a proposed wastewater treatment works. Responsible for acting as the hydraulics expert in the environmental reserve determination, working together with other experts. The work included field surveys and hydraulic analyses.

Bulk water planning study for the Drakenstein Local Municipality, Western Cape Province, South Africa, Drakenstein Local Municipality, 05/2008 - 07/2010, Water Engineer

The project entailed a planning study of the municipal water resources and bulk water infrastructure in the Drakenstein municipal area. The study determined optimal bulk water augmentation schemes for the municipality. Responsible for determining bulk infrastructure capacities and water resource yields, making projections of bulk water demands for the next 20 years, determining spare bulk water infrastructural capacities, conceptualising and costing various bulk water augmentation schemes and making recommendations for the way forward.

Design and construction supervision of erosion control structures and security flap gates on Diep River, Western Cape Province, South Africa, Alphen Farm Estate at Constantia, 04/2009 - 07/2010, Water Engineer

The project involved the design and construction supervision of gabion erosion control structures, including two weir structures and three steel security flap gates designed to flap open during floods. Responsible for designing the gabion erosion control structures and security flap gates, drawings, writing specifications and scheduling quantities.

Mandena Mine weir, water and sewerage, Fort Dauphin (Taolagnaro), Madagascar, Rio Tinto, 01/2005 - 06/2009, Water Engineer

This project consisted of the design and construction supervision of water supply and wastewater infrastructure for the proposed Mandena Mine in Madagascar, from feasibility to detailed design. The project further involved an extensive investigation and design for a 130 m-long salinity exclusion rockfill weir in an estuarine river to enable the provision of 20 000 m^3/d of fresh water for the mining process. Responsible for the detailed design of a salinity exclusion weir, temporary water supply to the construction village and of permanent water supply to the various mining villages and ports, as well as tender documentation and drawings.

Development of a methodology to value the ecosystem services provided by wetlands and application in a case study on the Nylsvlei Wetland, Limpopo Province, South Africa, Water Research Commission (WRC), 11/2007 - 06/2009, Hydraulics and Hydrology Expert

This research project developed a methodology to value the ecosystem services that the wetlands were providing and applied the methodology in a case study on the Nylsvlei Wetland. Responsible for developing a methodology to value the flow regulation services delivered by wetlands at various levels of confidence and applying this to the Nylsvlei Wetland using simple hydrological methods and hydraulic modelling.

South African Handbook of Environmental Hydraulics, South Africa, Water Research Commission (WRC), 02/2007 - 03/2009, Hydraulics Expert

This project entailed writing a handbook on environmental hydraulics for South Africa aimed at water engineers across the country. Responsible for synthesising South African environmental hydraulics research literature and writing a chapter on river rehabilitation and environmental hydraulic structures for the handbook.

Investigation into the presence of wetlands and the pattern of stormwater flows at the Bradis crushing site, Western Cape Province, South Africa, Bradis Crushing, 09/2008 - 02/2009, Water Engineer

This project consisted of investigating whether wetlands existed on the site of the Bradis crushing plant in Phillippi, as well as determining the existing and historical stormwater and surface and groundwater hydrology of the site. Responsible for inspecting the site and surrounding areas, using historical aerial photographs to determine previous land uses, investigating stormwater infrastructure and flows in the area and making recommendations for improved stormwater management.

Integrated comprehensive study of the water resources of the Maputo River Basin, South Africa, Swaziland and Mozambique, Government of the Kingdom of Swaziland, Ministry of Natural Resources, 01/2006 - 10/2008, Water Engineer

In order to fulfil the social and economic goals and alleviate poverty of the communities in the shared Maputo River Basin, it was imperative that Mozambique, South Africa and Swaziland formulate strategies and action plans to effectively manage water as a social and economic resource within the context of environmental sustainability. The Tripartite Permanent Technical Committee (TPTC) was responsible for providing advice on the equitable use and management of the shared waters. The Interim IncoMaputo Agreement (IIMA) identified a comprehensive agreement as a requirement for enabling the watercourse states to participate in the process in the form of the Joint Maputo River Basin Study (JMRBS). The objectives were to provide a detailed water resource assessment and recommend management and development options and propose suitable institutional and financial arrangements for the Maputo River Basin. Responsible for setting up a model of the river basin using the water resources yield model (WRYM) and determining yields at various points in the system, including existing schemes and proposed future schemes. Also responsible for attaching reliability to some of these yields using stochastic techniques. Further responsibilities included optimising the operation of dams in the system to maximise the yield whilst allowing for optimal environmental flow releases as well as optimising future development scenarios and testing.

Design of erosion protection works for the Vaal River bank, Gauteng Province, South Africa, Rand Water, 10/2007 - 06/2008, Water Engineer

The project comprised the design of erosion protection and slope stability measures on the bank of the Vaal River bank at Zuikerbosch water treatment works (WTW). Responsible for design flood determination, including analysis of historical floods and the operation of the Vaal Dam upstream, hydraulic modelling of the river, determining the flood lines, and designing appropriate erosion protection measures.

Water Resources of Southern Africa 2005 study (WR2005), South Africa, Water Research Commission (WRC), 01/2005 - 12/2007, Water Engineer

The project included a water resource study of Southern Africa at a quaternary catchment level, as well as updating and adding new aspects of water resources (such as groundwater) to the previous national study - Surface Water Resources of South Africa 1990. Responsible for updating and patching rainfall data.

Development of reconciliation strategies for the Amatole bulk water supply system, Eastern Cape Province, South Africa, Department of Water and Sanitation (DWS), 01/2005 - 10/2006, Water Engineer

This project entailed developing strategies to ensure continued water supply security for the Amatole region up to 2030. Responsible for reviewing the literature and estimating the current and future water demands.

Flood line determination for Piesang River, Plettenberg Bay, Western Cape Province, South Africa, Private developer, 11/2005 - 02/2006, Water Engineer

This project entailed determining flood lines for Piesang River through Plettenberg Bay. Responsible for design flood determination and hydraulic modelling of the river and estuary to determine flood lines.

Investigation into flooding problems at Medolino, Eastern Cape Province, South Africa, Ndlambe Local Municipality, 09/2004 - 11/2005, Water Engineer

This project consisted of flood line determination for the Medolino depression in Port Alfred, a review of various reports, and providing an expert witness in a court case. Responsible for determining flood lines, including design flood determination, modelling water levels in the depression and reviewing various reports.

Coega River flood study, Port Elizabeth, Eastern Cape Province, South Africa, Coega Development Corporation (Pty) Ltd (CDC), 11/2004 - 10/2005, Water Engineer

This project comprised modelling of the Coega River to determine flood lines, flood attenuation, canalisation and sediment control options. The project also involved the preliminary design of canalisation and infill options. Responsible for developing a steady and unsteady hydraulic model of the river, determining flood lines, investigating flood attenuation and canalisation options, and the preliminary design of canalisation and infill options.

Review of the Rainfall Information Management System (Rain IMS), South Africa, Department of Water and Sanitation (DWS), 08/2005, Water Engineer

This project consisted of reviewing the South African Department of Water and Sanitation's (DWS's) computer program called Rain IMS. Responsible for reviewing the functionality and ergonomics of the software program and testing the rainfall data patching programs PatchR and ClassR within the Rain IMS using specific scenarios as well as comparing these to the results from other similar programs.

Flood line determination for Sandpan, Benoni, Gauteng Province, South Africa, Private developer, 06/2005, Water Engineer

This project consisted of the determination of flood lines for the Sandpan in Benoni - a pan without anoutflow. Responsible for determining design rainfalls and flood volumes, as well as modelling the pan using the Pitman model to determine the flood lines.

Integrated waste management plan for Metsweding District Municipality, Gauteng Province, South Africa, Metsweding District Municipality, 01/2004 - 12/2004, Solid Waste Engineer

This project entailed the development of an integrated waste management plan for the Metsweding District Municipality. Responsible for developing a solid waste cost model and applying the model to determine the optimum solid waste system at least cost.

Hydrologic and hydraulic study of the behaviour of the Nyl River floodplain, Limpopo Province, South Africa, University of the Witwatersrand (Wits), 02/2002 - 05/2004, Masters Student

This project consisted of hydrological modelling of the Nyl River catchments and hydraulic modelling of the Nyl River floodplain for an environmental impact assessment (EIA) of catchment developments on the floodplain. Responsible for developing an unsteady hydraulic model of approximately 30 km of the Nyl River floodplain, investigating evapotranspiration and infiltration losses of flood water on the floodplain, linking this model to the response of floodplain biota to inundation, and investigating the impact of various catchment development scenarios on floodplain inundation and the biota using the model.

Karonga-Chilumba-Chiweta road project, Malawi, Roads Authority, Malawi, 01/2000 - 12/2003, Site Engineer

This project consisted of the construction of 110 km of surfaced national road including earthworks, layer works, drainage and bridges. Responsible for the day-to-day supervision of the construction teams on the bridges and sub-base, programming the works, coordinating the sub-contractors, coordinating staff, cost control and procuring materials.

Education

2004	:	MSc Civil Engineering, University of Witwatersrand (Wits), South Africa
1999	:	BSc Civil Engineering, University of Witwatersrand (Wits), South Africa

Career enhancing courses

2015	:	Free Surface Flow 2D New HEC-RAS version 5.0

Professional affiliations

Professional Engineer, Engineering Council of South Africa (ECSA)
Member, South African Institution of Civil Engineering (SAICE)

Languages

	Reading	Writing	Speaking
Afrikaans	Good	Poor	Good
English	Excellent	Excellent	Excellent

Research projects

Paxton P, Dobinson L, Kleynhans M and Howard G, 2014 - 2016. "Developing an Elementary Tool for Ecological Reserve Monitoring in South Africa's Freshwater Ecosystem Priority Areas (FEPAs): A Pilot Study in the Kouebokkeveld". Hydraulic Expert for the Water Research Commission (WRC) to set up monitoring sites at natural hydraulic controls, determination of habitat hydraulics at the sites and set up of the modelling tool.

Reinecke K, and Kleynhans MT, 2012 - 2013. "Linking Flow to Riparian Vegetation Zones". Hydraulic Expert for the Water Research Commission (WRC) to help investigate the links between vegetation zones on river banks in headwater streams and river flow.

James CS, and King JM, 2007 - 2009. "Ecohydraulics for South African Rivers: A Review and Guide". Co-wrote a chapter on river rehabilitation and impact mitigation structures that formed part of a publication for the Water Research Commission (WRC).

Turpie JK, and Kleynhans MT, 2007 - 2009. "Wetland Eco-system Services and their Valuation". Hydraulics and Hydrological Expert on a project for the Water Research Commission (WRC) to determine and value the flow regulation services delivered by wetlands, including proposing a methodology and applying this in a case study of the Nylsvlei wetland.

Kleynhans MT, 2002 - 2004. "Hydraulic and Hydrological Modelling of the Nyl River Floodplain for Environmental Impact Assessment (EIA)". Simulating inundation of floodplain through a calibrated hydraulic model to simulate current and future catchment development scenarios and linking of the inundation predicted by the model to growth of the grass "Oryza longistaminata" on the floodplain.

Honours and awards

Second prize for best paper at the South African National Committee for the International Association of Hydrological Sciences (SANCIAHS) National Hydrology Symposium held in Pietermaritzburg, KwaZulu-Natal, in September 2009.

Publications

Paxton P, Dobinson L, Kleynhans MT and Howard G, 2016. "Developing an Elementary Tool for Ecological Reserve Monitoring in South Africa's Freshwater Ecosystem Priority Areas (FEPAs): A Pilot Study in the Kouebokkeveld". Water Research Commission (WRC) Report K5/2340.

Kleynhans MT, Dhlamini S, Jonker V and Visser JB, 2015. "Development of a Hydrodynamic Model for Operation of the Komati and Lomati Rivers using the HEC-RAS Ungauged Lateral Inflows Module". Proceedings of the Engineers Australia 36th Hydrology and Water Resources Symposium (HWRS 2015), Hobart.

Reinecke MK, Brown CA, Esler KJ, King JM, Kleynhans MT and Kidd M, 2015. "Links between Lateral Vegetation Zones and River Flow". Wetlands Volume 35, Issue 3, pp 473-486.

Reinecke MK, Kleynhans MT and Kidd M, 2013. "Links between Lateral Zones and Flow". In Reinecke MK and Brown CA, 2013: Links between Riparian Vegetation and Flow, Water Commission Report (WRC) No. 1981/1/13.

Kleynhans MT, English G, Botha K, and Mugumo M, 2011. "Investigation of Future Surface Water Options to Augment the Western Cape Water Supply System". Proceedings of the 15th South African National Hydrology Symposium, South African National Committee for the International Association of Hydrological Sciences (SANCIAHS), Rhodes University, Grahamstown.

Turpie JK, and Kleynhans MT, 2010. "Wetland Eco-system Services and their Valuation". Wetland Valuation Volume 4: A Protocol for the Quantification and Valuation of Wetland Eco-system Services - Water Research Commission (WRC) Report TT443/09.

Kleynhans MT, Turpie JK, Rusinga F, and Görgens AHM, 2010. "Quantification of the Flow Regulation Services Provided by Nylsvlei Wetland Using Hydrological and Hydraulic Modelling". Turpie JK (Ed) Wetland Valuation Vol. 2 Wetland Valuation Case Studies, report emanating from the Water Research Commission (WRC) Wetland Health and Importance Research Programme (WRC Report K5/1584), Pretoria.

Kleynhans MT, Turpie JK, Rusinga F, and Görgens AHM, 2009. "Case Study of a Wetland Flow Regulation Services Estimation Method at Nylsvlei, South Africa". Proceedings of the 14th South African National Hydrology Symposium, University of KwaZulu-Natal (UKZN), Pietermaritzburg.

Kleynhans MT, Abban B, Shand MJ, James CS (Ed), and King JM (Ed), 2008. "River Rehabilitation and Impact Mitigation Structures, in Ecohydraulics for South African Rivers: A Review and Guide". Water Research Commission (WRC) Report Number TT 1767 (in print).

Birkhead AL, James CS, and Kleynhans MT, 2007. "Hydrologic and Hydraulic Modelling of the Nyl River Floodplain Part 2: Modelling Hydraulic Behaviour". Water SA Vol. 33 No. 1, January 2007, Water Research Commission (WRC), Pretoria.

Kleynhans MT, James CS, and Birkhead AL, 2007. "Hydrologic and Hydraulic Modelling of the Nyl River Floodplain Part 3: Applications to Assess Ecological Impact". Water SA Vol. 33 No. 1, January 2007, Water Research Commission (WRC), Pretoria.

Birkhead AL, James CS, and Kleynhans MT, 2004. "The Hydrologic and Hydraulic Study of the Behaviour of the Nyl River Floodplain: Hydraulic Modelling". Report Number: P WMA 01/A61/00/0503 to the Department of Water and Sanitation (DWS), Directorate: Water Resources Planning.

James CS, Birkhead AL, and Kleynhans MT, 2004. "Predicting the Hydro-Ecological Impact in a Seasonal Floodplain". Proceedings of the 5th International Symposium on Ecohydraulics (ISE), Madrid, Spain.

Birkhead AL, Kleynhans MT, James CS, Bailey A, and Havenga B, 2003. "Modelling the Flooding Regime of the Nylsvlei Floodplain". Proceedings of the 11th South African National Hydrology Symposium, South African National Committee for the International Association of Hydrological Sciences (SANCIAHS), Port Elizabeth Technikon.

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Bringing ideas to life

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Swaziland, Tanzania, Thailand, Uganda,
United Arab Emirates, Vietnam, Zambia,