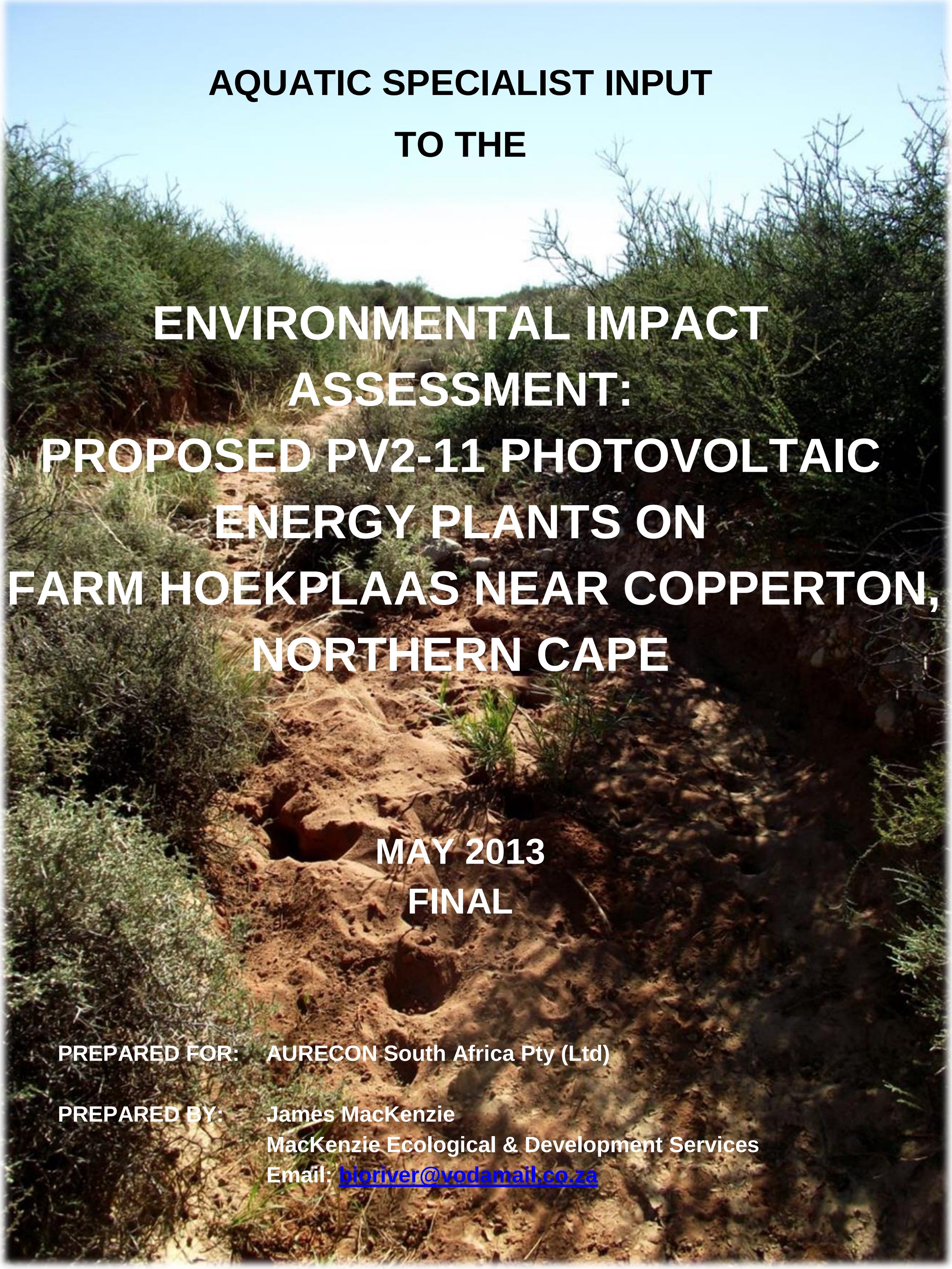
ANNEXURE C7

SPECIALIST ASSESSMENTS

- Aquatic Specialist Input



AQUATIC SPECIALIST INPUT

TO THE

ENVIRONMENTAL IMPACT ASSESSMENT:
PROPOSED PV2-11 PHOTOVOLTAIC ENERGY PLANTS ON FARM HOEKPLAAS NEAR COPPERTON, NORTHERN CAPE

MAY 2013
FINAL

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TABLE OF CONTENTS

1 INTRODUCTION ... 1-1
- 1.1 Background ... 1-1
- 1.2 Objectives of the Study ... 1-1
- 1.3 Specialist Details ... 1-2
- 1.4 Data Availability ... 1-2

2 STUDY AREA ... 2-1
- 2.1 Study Area Description ... 2-1
- 2.2 Site Description ... 2-1

3 DELINEATION OF NO-GO AREAS ... 3-3
- 3.1 Methods ... 3-3
- 3.2 Surface Water Features and no-Go Areas ... 3-3

4 IMPACT ASSESSMENT ... 4-6
- 4.1 Methods ... 4-6
- 4.2 Potential Impacts for Construction Phase ... 4-8
- 4.3 Potential Impacts for Operational Phase ... 4-11

5 CONSIDERATION OF ALTERNATIVES ... 5-17
- 5.2 Activity Alternatives ... 5-18
- 5.3 Technology Alternatives ... 5-18
- 5.4 Routing Alternatives ... 5-18

6 MONITORING / REHABILITATION REQUIRED ... 6-20

7 CONCLUSIONS AND RECOMMENDATIONS ... 7-21

8 REFERENCES ... 8-1

LIST OF TABLES

Table 1.1 Data availability for sites on the Heokplaas Farm. 1-2
Table 3.1 Description of features investigated on the farm Hoekplaas. Feature code refers to features shown in Fig. 2.2. 3-3
Table 3.2 Photographs (taken in Nov 2011) of all features investigates on the farm Hoekplaas. Feature codes and descriptions correspond to those in a Table 3.1. 3-4
Table 4.1 The criteria for spatial extent, duration and probability of an impact, and confidence in the assessment. 4-6
Table 4.2 Definitions used for mitigation potential. 4-7
Table 4.3 An assessment of cumulative impacts.. 4-14

LIST OF FIGURES

Figure 2.1 Rainfall summary and characteristics of the Northern Cape in general (Department of Water Affairs data) 2-1
Figure 2.2 Satellite imagery (Google Earth ©, 2005) with boundaries of the farm Hoekplaas superimposed and showing the Kronos substation. Also indicated are the preferred PV sites (PV 2 to 11) and authorised PV site (PV1) as well as drainage lines and relevant surface water features. Hp 2, 3, 4 and 7 are endorheic pans and Hp 1, 5, 6, 7 and 8 forms part of an ephemeral water course. For more details of features see section 3.2. 2-2
Figure 5.1 Site layout alternatives for the farm Hoekplaas. Alternative 1 (the preferred) is shown above and alternative 2 (larger MW Plants) below. 5-17

1 INTRODUCTION

1.1 BACKGROUND

Mulilo Renewable Energy (Pty) Ltd (Mulilo) proposes to construct ten (10) additional 75 MW alternating current (AC) photovoltaic (PV) solar energy plants on the farm Hoekplaas (Remainder of Farm No. 146), near Copperton in the Northern Cape[1]. The proposed PV plants together would cover an area of approximately 2497 ha and would connect to the Kronos (preferred) or Cuprum substation via a new 132 kV distribution line. Alternatively, three PV plants, each with greater generation capacities (225 MW, 295 MW and 500 MW) and together covering an area of approximately 2770 ha are proposed. The current landuse of Hoekplaas farm is predominantly sheep farming.

In terms of infrastructure required to service the proposed activity, the following would also be required (Aurecon, 2013):

- Upgrade existing internal farm roads as well as construction of new roads to accommodate construction vehicles and access to the site.
- Construction of a new 132 kV transmission line to connect the proposed PV plants to Eskom's grid via the Kronos substation or Caprum substations.
- Erection of electrical fences to prevent trespassing.
- Construction of onsite office/s, an onsite 132kV substation per PV plant.

1.2 OBJECTIVES OF THE STUDY

The main objective of the study was to undertake an aquatic ecological assessment in order to:

1) Assess the potential impacts that may affect site hydrology (water quantity) and water chemistry (quality) of streams, drainage channels, dams or wetlands during the construction and operational phases. To this end it was necessary to conduct riparian and wetland delineation procedures in order to define no-go and higher risk areas. This was completed for the previous study (Aurecon, 2012), but is presented here again since it remains relevant to the current proposed activity.
2) Evaluate impact criteria in order to ascertain their severity.
3) Compare proposed alternatives with justification for which preference.
4) Recommend mitigating measures aimed at minimising the predicted negative impacts and conflicts while retaining reasonable operational efficiencies.

The following specific tasks were carried out:

- Undertake an initial desktop study of reputable sources to provide background information for the aquatic ecological assessment.
- Collect primary data from rivers and/or wetlands on the site to provide information regarding wetland/riparian and instream (if any) sensitivity and importance.
- Undertake the requisite field work and compile a report that considers the following aspects:
    - Broad description of the aquatic ecology of the proposed sites.
    - Delineation of any riparian zones or wetlands.

[1] Separate applications for each of the 10 proposed PV plants have been submitted to the Department of Environmental Affairs for authorisation.

- Conduct a comparative analysis for the proposed PV plants and alternatives in terms of environmental impact.
- Assessment of the ecological state, importance and sensitivity of aquatic ecosystems on the site.
- General comment on whether ecosystem processes would be affected (including comment on how these would be affected).
- Identification of potential impacts and recommendations to prevent or mitigate these.
- Outline any guidelines which may be relevant.
- Outline any monitoring requirements, should this be needed.

1.3 SPECIALIST DETAILS

Specialist	Affiliation	Relevant expertise
James MacKenzie	M.E.D.S.	Riparian Vegetation: Environmental Flow Requirements (EFR); EcoClassification (VEGRAI); Riparian and wetland delineation; Ecological Importance and Sensitivity

1.4 DATA AVAILABILITY

Data availability for the aquatic assessment is shown in Table 1.1:

Table 1.1 Data availability for sites on the Heokplaas Farm.

Hoekplaas	
Hydrology	No gauging weir of relevance.
Diatoms	No data available for the farm, but diatom data exist for other typical endorheic pans in the region (Koekemoer, pers com).
Water Quality	No data available for the farm, but given the soils forms at the site, when pans hold water it is likely to of higher salinity.
Fish	No data available for the farm, but given the degree of ephemerality no fish species are expected to occur.
Macroinvertebrates	No SASS surveys available,
Vegetation, including wetland and riparian vegetation	Satellite images (Google earth) of the area (August 2005). Biomes and vegetation types of South Africa: (Rutherford, 1997; van Wyk & van Wyk, 1997; Mucina & Rutherford, 2006). SANBI Plant of Southern Africa online database (based on several herbaria collections). Data collected during field visit (November 2011).
Avifauna, especially associated with wet environments	Data collected during field visit (November 2011). Scoping report (Aurecon, 2011). Faunal distribution maps where relevant.

2 STUDY AREA

2.1 STUDY AREA DESCRIPTION

The study area occurs in the Northern Cape near the town of Copperton within the D54D quaternary catchment and the Lower Orange DWA water management area (part of the Hartbees River system). The area is well known for endorheic pans[2] and depressions (Nel *et al.*, 2011, Allan *et al,* 1995). The study area lies within the Nama Karoo Level 2 Ecoregion (26.04) described by Kleynhans et al. (2005, 2007), the Namib-Karoo-Kaokoveld Deserts and Shrublands WWF Terrestrial Ecosystems (Olson et al., 2004). Mean annual precipitation is approximately 137mm with peaks in late summer, usually March (DIVA GIS data, Fig 2.1, Mucina & Rutherford, 2006). Soils are generally base-rich, weakly structured and shallow, mostly Glenrosa and Mispah forms, with lime a feature of the landscape. Soils drain freely, usually with <15% clay and have characteristic high levels of salt (Mucina & Rutherford, 2006).

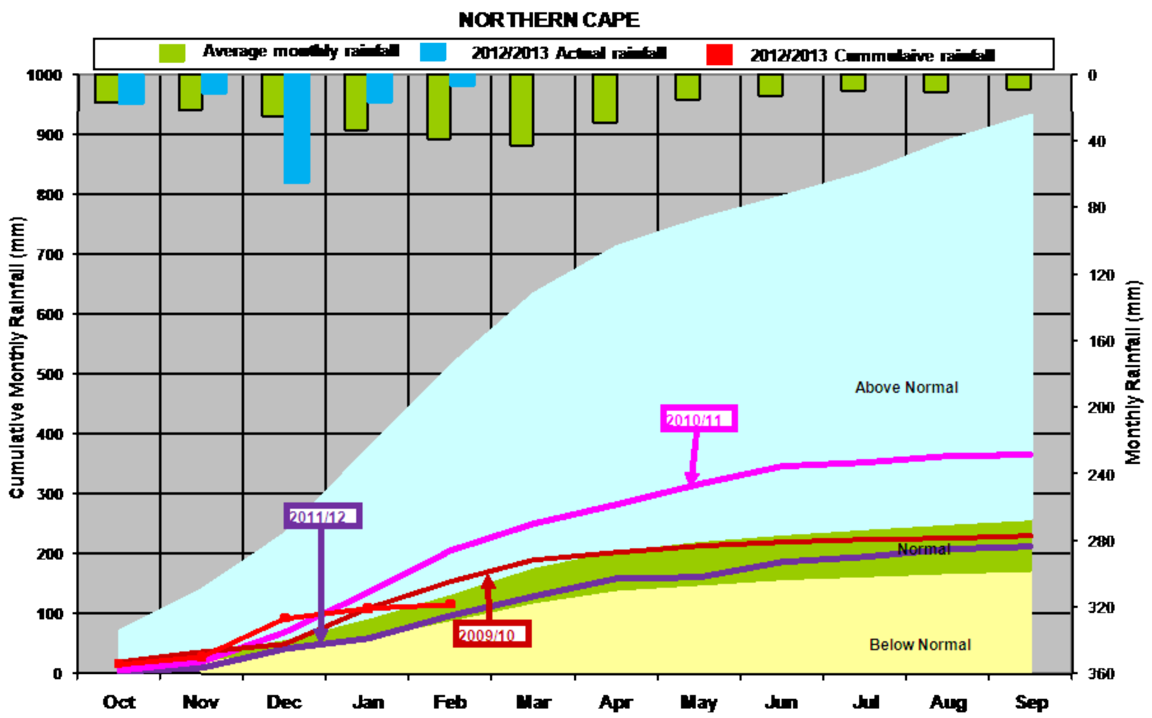

Figure 2.1 Rainfall summary and characteristics of the Northern Cape in general (Department of Water Affairs data)

2.2 SITE DESCRIPTION

The assessed area at Hoekplaas occurs in the Bushmanland Basin Shrubland vegetation type, within the Nama-Karoo Biome and the Bushmanland Bioregion (Mucina & Rutherford, 2006). The area covered by the farm is generally flat, with drainage areas and pans being variously ephemeral. Some pans are not well defined although typical endorheic pans exist (Fig 2.2) (see note on pans below for more detailed information).

[2] which are a class of wetland, DWA 2005

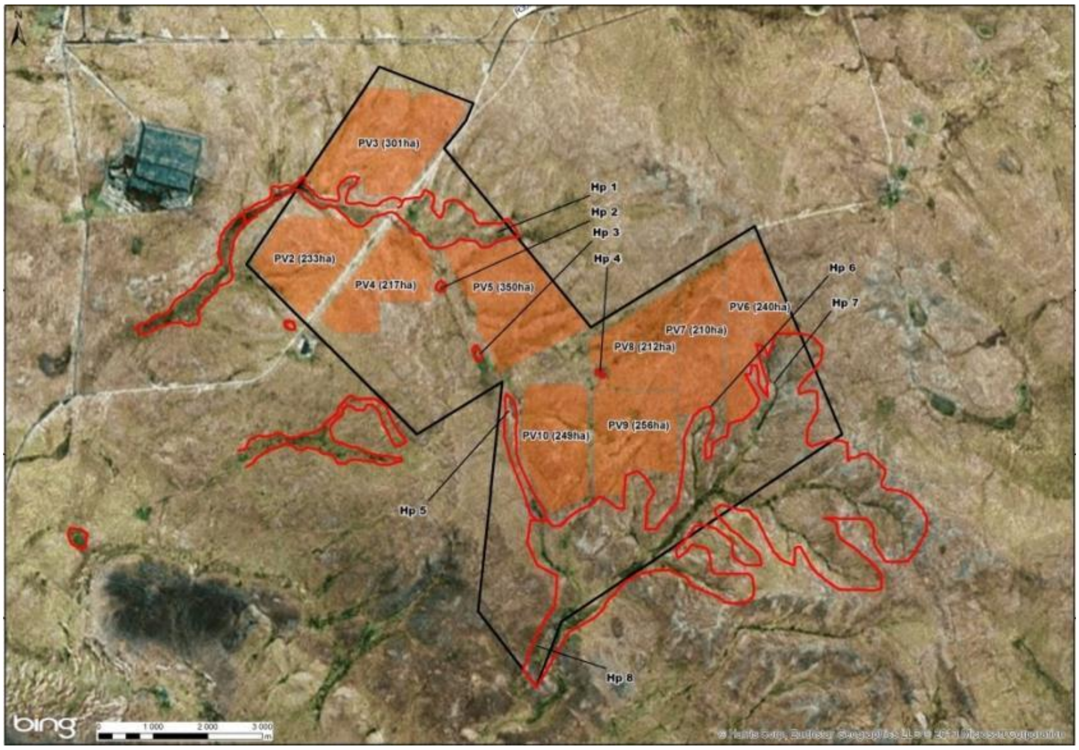

Figure 2.2 Satellite imagery Bing © (with boundaries of the farm Hoekplaas superimposed and showing the Kronos substation. Also indicated are the preferred PV sites (PV 2 to 11) and authorised PV site (PV1) as well as drainage lines and relevant surface water features. Hp 2, 3, 4 and 7 are endorheic pans and Hp 1, 5, 6, 7 and 8 forms part of an ephemeral water course. For more details of features see section 3.2.

3 DELINEATION OF NO-GO AREAS

The area covered by the farm Hoekplaas is generally flat, with drainage areas and a few endorheic pans which contribute to the biodiversity of the area (Noss, 1990). Such endorheic pans, generally defined as circular or oval, shallow, closed drainage systems, are recognised by the Department of Water Affairs as a legitimate type of wetland, and as such are protected in accordance with the National Water Act (Act No. 36 of 1998). As such, these areas have been delineated as no-go areas (see Fig. 2.2) and should be avoided by the proposed PV Plant development. In addition no abstraction of water from these no-go areas should occur, although due to their ephemeral nature it is unlikely that this will occur. Similarly, no waste waters from PV Plant activities should be decanted into these no-go areas. Alternatively, a Water Use Licence would be required should a situation arise where pans cannot be avoided.

3.1 METHODS

Satellite imagery (Bing ©) was used to do a desktop assessment of all possible wetland (including pans) or riparian (including ephemeral drainage lines) features. These were noted and each possible feature visited for field verification. Field visits were conducted in November 2011 and April 2013. While in the field, all wetland and riparian features were delineated using topography, evidence of water movement through the landscape, evidence of water pooling in the landscape and changes in vegetation species composition and structure associated with such features. Features were then highlighted on satellite images as no-go areas i.e. ecologically sensitive areas where development should not occur.

3.2 SURFACE WATER FEATURES AND NO-GO AREAS

All features associated with surface water movement and pooling on the farm Hoekplaas are shown in Fig. 2.2 and described in Table 3.1 below. Photographs of each feature are shown in Table 3.2. Pans are all rainfall dependant with little to no longitudinal connectivity in terms of water movement.

Table 3.1 Description of features investigated on the farm Hoekplaas. Feature code refers to features shown in Fig. 2.2.

Feature code	Feature Description	No-go Area
Hp1	This is an ephemeral drainage area, poorly defined, with no discernible vegetative indicators. Two wind pumps exist, one on the farm Hoekplaas, and one just the other side of the boundary. Johannes, the farmer at Hoekplaas clears all *Prosopis glandulosa*, but the green colour viewed on the next farm in satellite imagery is *P. glandulosa* clumps. According to the farmer, this area does have flowing water (sheet flow) during heavier rain events.	Recommended as such
Hp2	A true endorheic pan, covered by inner small shrub layer, followed by a grassed ring and the outer layer consists of taller shrubs (mostly *Lycium cinereum* and *Rhigozum trichotomum*). According to the farm	Yes

	owner this pan can hold water for up to 6 months of the year and he has witnessed Flamingos visiting the pan (before the construction of the Kamfer Dam near Kimberley).	
Hp3	Less developed than Hp3, nevertheless this feature is a grassed endorheic pan which holds rain water on occasion.	Yes
Hp4	Endorheic seasonal pan. Outer ring consists of a shrub zone (dominated by *Gomphocarpus fruticosus, Lycium hirsutum, L. cinereum, Salsola sp* and *Asparagus bechuanicus*) and the pan floor is grass or herbs (*Aristida congesta, Chloris virgata, Centropodia glauca* and *Solanum sp*).	Yes
Hp5	Endorheic seasonal grassed pan that also forms part of a larger drainage line. Dominant species are *Aristida adscensionis, A. congesta, Eragrostis annulata, E. bicolour, Enneapogon desvauxii, C. glauca, Brachiaria glomerulata,* and *Lycium cinereum.*	Yes
Hp6	Confirmed drainage line (seasonal to ephemeral). Characterised by *L. hirsutum, L. cinereum, Rhigozum trichotomum, Asparagus bechuanicus, Monechma incanum, A. congesta,* and *C. glauca*.	Yes
Hp7	Seasonal drainage line with distinct sandy unconsolidated channel bed. Characterised by *G. fruticosus*, *L. cinereum, R. trichotomum, A. bechuanicus, A. congesta,* and *C. glauca*.	Yes
Hp8	Seasonal stream with sandy unconsolidated channel bed and distinct riparian zone. According to the landowner this stream flows most years for short periods. Characterised by *Searsia pendulina*, L. hirsutum, *L. cinereum, R. trichotomum, A. bechuanicus, A. congesta,* and *C. glauca*.	Yes

Table 3.2 Photographs (taken in Nov 2011) of all features investigates on the farm Hoekplaas. Feature codes and descriptions correspond to those in a Table 3.1.

 Hp1	 Hp2

 Hp3	 Hp4
 Hp5	 Hp6
 Hp7	 Hp8

4 IMPACT ASSESSMENT

4.1 METHODS

Potential impacts for the construction and operational phases were assessed for the study site and mitigation measures per potential impact provided. The criteria for assessing type, spatial extent, duration, intensity and probability of potential impacts are shown in **Error! Reference source not found.**. These and the relevant abbreviations apply to all impact assessment in this report.

Table 4.1 The criteria for spatial extent, duration and probability of an impact, and confidence in the assessment.

Criteria	Categories	Abbreviation used in Tables	Explanation
Type	Negative	*N*	*Overall will represent a negative impact*
	Positive	*P*	*Overall will represent a positive impact*
Spatial Extent	Site	*S*	*Immediate area of activity*
	Local	*L*	*Area within 10km of the river site*
	Regional	*R*	*Entire drainage basin, municipal area, landscape etc*
	National	*N*	*South Africa*
Duration	Short-term	*S*	*0-1 year (or construction period)*
	Medium -Term	*M*	*1-5 years (initial operation)*
	Long-term	*L*	*5-20 years*
	Permanent	*P*	*Permanent change*
Significance	High	*H*	*Likely to lead to irreversible loss in ecosystem integrity at the spatial extent identified*
	Medium	*M*	*Likely to lead to major loss of ecosystem functionality*
	Low	*L*	*Possible loss of*

			ecosystem integrity, but no deterioration in PES
	Very Low	*VL*	*Unlikely to have measurable effect*
	Neutral	*N*	*No predicted impact*
Probability	Unlikely	*U*	
	Possible	*Po*	
	Probable	*Pr*	
	Definite	*D*	

The significance rating provided is that significance WITH mitigation and WITHOUT mitigation. Mitigation potential describes the ability to manage or mitigate an impact given the necessary resources. Some impacts, by their very nature are extremely difficult to mitigate, while others may be managed to an acceptable level with the implementation of a sound environmental management plan. The mitigation potential as presented in the sections below, is described in **Error! Reference source not found.**. Mitigation measures were recommended. It should be noted that a LOW mitigation potential does not necessarily imply that the impact is highly significant. An impact with a low significance rating may be extremely difficult to mitigate, while a highly significant impact may be relatively simple to mitigate with the implementation of the correct management measures.

Table 4.2 Definitions used for mitigation potential.

Mitigation potential	Description	Example
HIGH:	• The impact is relatively easy and cheap to manage. Specialised expertise or equipment is generally not required. • The nature of the impact is understood and may be mitigated through the implementation of a management plan, with regular monitoring undertaken to ensure that any negative consequences remain within acceptable limits. • The significance of the impact after mitigation is likely to be LOW to Non-Significant. • These impacts are normally mitigated by “good housekeeping”.	Litter impact Clearing and nursing of protected plant species Bank stabilisation with planting (Bioengineering approach) Substrate continuity beneath crossing
MEDIUM:	• Management of this impact requires a higher level of expertise and resources in order to maintain within acceptable levels • The significance of the impact	Visual Impacts Changes to instream habitat

Mitigation potential	Description	Example
	after mitigation is likely to be LOW to MEDIUM depending on the level of management applied. • May not be possible to mitigate the impact entirely – may result in a residual impact (e.g. topographical change) • Despite mitigation being entirely possible, if complex, the experience of the assessor/s suggests that this /these mitigation measures are seldom managed successfully, and they are thus assessed as MEDIUM or LOW. This is for a number of reasons, including a lack of understanding by the developer or contractor of the severity of the consequences of not mitigating adequately; a lack of disciplined auditing by the Environmental Control Officer; and inadequate planning for seasonal flow events (e.g. floods).	
LOW:	• Will not be possible to mitigate this impact entirely regardless of the expertise and resources applied. • The potential to manage the impact may be beyond the scope of the Project • Management of this impact is not likely to result in a measurable change in the level of significance.	Alteration in local flow velocity due to channel constraint (acceleration of flow in restricted areas, e.g. culverts)

4.2 POTENTIAL IMPACTS FOR CONSTRUCTION PHASE

a) Destruction (clearing and levelling) of no-go areas

This impact would occur should any of the proposed PV Plants be placed in such a way that it covers one or more (or section) of the no-go areas that have been delineated and would result in loss of wetland habitat (i.e. pans) or loss of surface water drainage functionality (should drainage zones be cleared, levelled, traversed or disturbed). The same applies to the placement of offices or staff / construction worker accommodations, even if these are temporary, as well as access roads, power lines and pipelines. The proposed layout (Fig. 2.2) largely negates the possibility of this impact except for the traversing of drainage lines by proposed water pipelines and access roads.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Permanent
PROBABILITY:	Possible
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	High

MITIGATION

Mitigation potential is high for the placement of PV Plants since they can be placed in such a way as to avoid all no-go areas. The proposed placement of the preferred options (PV 2 – 11) does just that (Fig. 2.2), while the alternatives (PV 2 – 4, larger MW options, Fig. 5.1) seem to overlap all no-go areas.

Similarly, access roads and water pipelines to the proposed development should be placed in such a way so as to minimise disturbance within no-go areas. Where avoidance is not possible, such as the traversing of an existing drainage line, disturbance should be minimal and execution such that drainage is not impeded or diverted, and that subsequent erosion does not occur.

b) Formation of barriers to drainage areas

Ephemeral drainage areas (also no-go areas) exist in the farm Hoekplaas (see Fig. 2.2) which should not be blocked such that the movement of water is impeded or diverted.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Long term
PROBABILITY:	Unlikely
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	High

MITIGATION

Mitigation potential is high as most access roads and water pipelines are planned in areas that would minimise disturbance within no-go areas. Where avoidance is not possible, such as the traversing of an existing drainage line, disturbance should be minimal and execution such that drainage is not impeded or diverted, and that subsequent erosion does not occur.

c) Erosion and / or sediment inputs to no-go areas

Denuded areas and stockpiles of aggregates or soil should be protected in such a way that erosion or sediment inputs to no-go areas during rainfall events is prevented.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Short term
PROBABILITY:	Possible
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Use of erosion control measures (such as effective stormwater management structures) to minimise erosion at excavation / clearing sites or aggregate storage sites. Earth moving construction activities to take place in dry season as far as possible. Pans and drainage channels require a minimum buffer zone of 30m. Storm water entering pans or drainage channels should not carry undue sediment loads and would need velocity reducing structures should erosion occur.

d) Increased invasion by alien plant species, especially perennial aggressive species such as *Prosopis glandulosa*

P. glandulosa already exists on the farm and is associated with areas of elevated wetness and inundation i.e. is preferentially associated with wetland and riparian areas. Disturbance of surface substrates such as construction activities would promote the colonisation of *P. glandulosa* since recruitment opportunities are created. However, the impacts for surface water are indirect in that *P. glandulosa* alters the species composition in its vicinity (by excluding indigenous flora) and promotes open, more erodible, sub-canopy areas. Due to its provision of shade, these areas also tend to get highly trampled by sheep, which exacerbates potential erosion.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Long term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Removal of perennial alien species such as *P. glandulosa* at sites disturbed or cleared by construction activities. Care should be taken not to introduce additional seed or propagules of alien species that may be present in aggregates brought to site.

e) Waste reticulation and removal

This impact pertains to the production and handling of waste water which could pollute surface water features.

IMPACT ASSESSMENT

TYPE:	Negative

SPATIAL SCALE:	Site
DURATION:	Short term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Very Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Employ recognised best practices, and prevent spillage, especially into no-go areas e.g. composting toilets or effective soak aways.

4.3 POTENTIAL IMPACTS FOR THE OPERATIONAL PHASE

a) Increased surface water runoff from panel washing activities

This impact has the potential to change the water balance in the vicinity of its application since average annual rainfall is so low and panel washing activities would introduce additional water (which supersedes rainfall) to the runoff surface. Additional water to a cleared surface has to potential to erode surface substrates (presumably bare soil in this case), but would also illicit a vegetative response in that vegetation (including alien species) will readily colonise the area due to elevated and regular soil moisture availability. Also, since the medium for washing would be water mixed with a mild detergent, the potential exists for altered water quality to nearby areas, depending on how runoff is dealt with and the exact dilution and chemical nature of the mix.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Long term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

- This impact has both a quantity and quality component, and the severity of each depends on factors which are not exactly known i.e. the potential of falling water to erode soils would depend on the nature of the application and the erodability of the substrate, while the alteration to soil chemistry (which would also affect micro-organism dynamics) would depend on the dilution and chemical nature of the washing medium. To best mitigate this impact it would be necessary to monitor both soil chemistry and erosion and only mitigate if required. Should mitigation be required it should not be difficult to channel runoff in such a way as to minimise erosion, or to employ soil stabilising techniques in vulnerable areas. Should soil chemistry be affected (this is likely to be an increase in salinity), the nature of the washing mixture could be changed, or acceptable waste treatment employed. Monitoring, together with the development of an environmental management plan as operation proceeds would be the most effective strategy. It should be noted that waste water from the proposed PV plants should not be diverted to or decanted into any of the defined no-go areas. Storm water should not increase in volume but is likely to have altered dissipating properties e.g. higher velocities due to increased hard surface are. Storm water entering pans or drainage channels should not carry undue sediment loads and would need velocity reducing structures should erosion occur.

b) Increased invasion by alien plant species, especially perennial aggressive species such as *Prosopis glandulosa*

P. glandulosa already exists on the farm and is associated with areas of elevated wetness and inundation i.e. is preferentially associated with wetland and riparian areas. Operational activities (especially maintenance of cleared areas and elevated moisture availability from panel washing) would promote the colonisation of *P. glandulosa*, which is a deep-rooted tree that utilises groundwater. However, the impacts for surface water are indirect in that *P. glandulosa* alters the species composition in its vicinity (by excluding indigenous flora) and promotes open more erodible sub-canopy areas. Due to its provision of shade, these areas also tend to get highly trampled which exacerbates potential erosion.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Long term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Very Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Removal of perennial alien species such as *P. glandulosa* at sites disturbed or cleared, or where panel washing occurs. This would likely be an ongoing maintenance activity since the shade cast by *P. glandulosa* would be undesirable near the proposed PV plants. Furthermore should runoff occur from panel washing activities, *P. glandulosa* would need to be cleared in these areas as well.

c) Domestic waste reticulation and removal.

This impact pertains to the production and handling of domestic waste water i.e. ablution facilities at offices.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Long term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Very Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Employ recognised best practices, and prevent drainage from septic tanks / soak aways to enter no-go areas.

4.4 POTENTIAL IMPACTS FOR THE DECOMMISSIONING PHASE

a) Increased surface erosion in denuded area

When the PV plant is removed there are likely to be denuded areas with little or no vegetation cover. These areas would be vulnerable to soils erosion during rain events until such a time that vegetation is established.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Medium term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

Should denudation be severe, rehabilitation of these areas would be necessary. Mitigation would involve establishing vegetative cover comparable to surrounding indigenous vegetation. Planting grasses by means of seeds would likely be the easiest and quickest form of mitigation. It is critical that no alien species are used for re-vegetation.

b) Remnants of vegetation with altered species composition

It is possible that at the time of decommissioning alien vegetation would be promoted to colonise open areas, especially species such as *P. glandulosa*.

IMPACT ASSESSMENT

TYPE:	Negative
SPATIAL SCALE:	Site
DURATION:	Medium term
PROBABILITY:	Probable
SIGNIFICANCE WITH MITIGATION:	Very Low
SIGNIFICANCE WITHOUT MITIGATION:	Medium

MITIGATION

The area would need to be inspected for the presence of alien species and these removed. This should occur on an annual basis for at least the first 3 years following decommission.

4.5 CUMULATIVE IMPACTS

An assessment of cumulative impacts is shown in Table 4.3.

Table 4.3 An assessment of cumulative impacts.

Construction Phase	Key impacts	No mitigation /Mitigation	Spatial Scale	Duration	Significance	Probability	Reversibility	Mitigation measures
Hoekplaas	a) Destruction of no-go areas (clearing and levelling)	No mitigation	Site	Permanent	High	possible	Irreversible	Mitigation potential is high for the placement of PV Plants s such a way as to avoid all no-go areas.
		Mitigation			Low			
Local extent		No mitigation			High			
		Mitigation			Low			
Regional extent		No mitigation			Medium			
		Mitigation			Low			
Hoekplaas	b) Formation of barriers to drainage areas	No mitigation	Site	Long Term	High	Unlikely	Reversible	Mitigation potential is high as most access roads and water areas that would minimise disturbance within no-go areas. possible, such as the traversing of an existing drainage line, minimal and execution such that drainage is not impeded o subsequent erosion does not occur
		Mitigation			Low			
Local extent		No mitigation			High			
		Mitigation			Low			
Regional extent		No mitigation			Low			
		Mitigation			Low			
Hoekplaas	c) Erosion and / or sediment inputs to no-go areas	No mitigation	Site	Short Term	Medium	possible	Reversible with difficulty	Use of erosion control measures (such as effective stormwa structures) to minimise erosion at excavation / clearing site sites. Earth moving construction activities to take place in d Pans and drainage channels require a minimum buffer zone entering pans or drainage channels should not carry undue need velocity reducing structures should erosion occur.
		Mitigation			Low			
Local extent		No mitigation			Medium			
		Mitigation			Low			
Regional extent		No mitigation			Low			
		Mitigation			Low			
Hoekplaas	d) Increased	No	Site	Long Term	Medium	Probable	Reversible	Removal of perennial alien species such as P. glandulosa at

	invasion by alien plant species, especially perennial aggressive species such as Prosopis glandulosa	mitigation						by construction activities. Care should be taken not to intro propagules of alien species that may be present in aggregat
		Mitigation			Low			
Local extent		No mitigation			Medium			
		Mitigation			Low			
Regional extent		No mitigation			Low			
		Mitigation			Low			
Hoekplaas	e) Waste reticulation and removal	No mitigation	Site	Short Term	Medium	Probable	Reversible	Employ recognised best practices, and prevent spillage, esp composting toilets or effective soak aways.
		Mitigation			Very Low			
Local extent		No mitigation			Low			
		Mitigation			Very Low			
Regional extent		No mitigation			Very Low			
		Mitigation			Very Low			
Operation Phase	**Key impacts**	**No mitigation /Mitigation**	**Spatial Scale**	**Duration**	**Significance**	**Probability**	**Reversibility**	**Mitigation measures**
Hoekplaas	a) Increased surface water runoff from panel washing activities and stormwater runoff	No mitigation	Site	Long Term	Medium	Probable	Reversible	To best mitigate this impact it would be necessary to monit erosion and only mitigate if required. Should mitigation be difficult to channel runoff in such a way as to minimise eros stabilising techniques in vulnerable areas. Should soil chem likely to be an increase in salinity), the nature of the washin changed, or acceptable waste treatment employed. Storm in volume but is likely to have altered dissipating properties to increased hard surface are. Storm water entering pans o not carry undue sediment loads and would need velocity re erosion occur.
		Mitigation			Low			
Local extent		No mitigation			Medium			
		Mitigation			Low			
Regional extent		No mitigation			Low			
		Mitigation			Low			
Hoekplaas	b) Increased invasion by alien plant	No mitigation	Site	Long Term	Medium	Probable	Reversible	Removal of perennial alien species such as P. glandulosa at or where panel washing occurs. This would likely be an ong since the shade cast by P. glandulosa would be undesirable
		Mitigation			Very Low			

Local extent	species, especially perennial aggressive species such as Prosopis glandulosa	No mitigation			Medium			plants. Furthermore should runoff occur from panel washin would need to be cleared in these areas as well.
		Mitigation			Very Low			
Regional extent		No mitigation			Low			
		Mitigation			Very Low			
Hoekplaas	c) Domestic waste reticulation and removal.	No mitigation	Site	Long Term	Medium	Probable	Reversible	Employ recognised best practices, and prevent drainage fro aways to enter no-go areas .
		Mitigation			Very Low			
Local extent		No mitigation			Low			
		Mitigation			Very Low			
Regional extent		No mitigation			Very Low			
		Mitigation			Very Low			

5 CONSIDERATION OF ALTERNATIVES

5.1 SITE LAYOUT ALTERNATIVES

There are two site layout alternatives (Figure 5.1) for consideration (Aurecon, 2013). Alternative 1 (also the preferred option) consists of the ten proposed 75 MW AC PV plants and associated infrastructure (PV2 to 11). These layouts take cognisance of the 75 MW Department of Energy cap as well as the environmentally sensitive areas that were identified in the 2012 EIA process. Alternative 2 consists of three larger PV facilities (225 MW, 290 MW and 500 MW) which are an extension and combination of the proposed 75 MW AC plants.

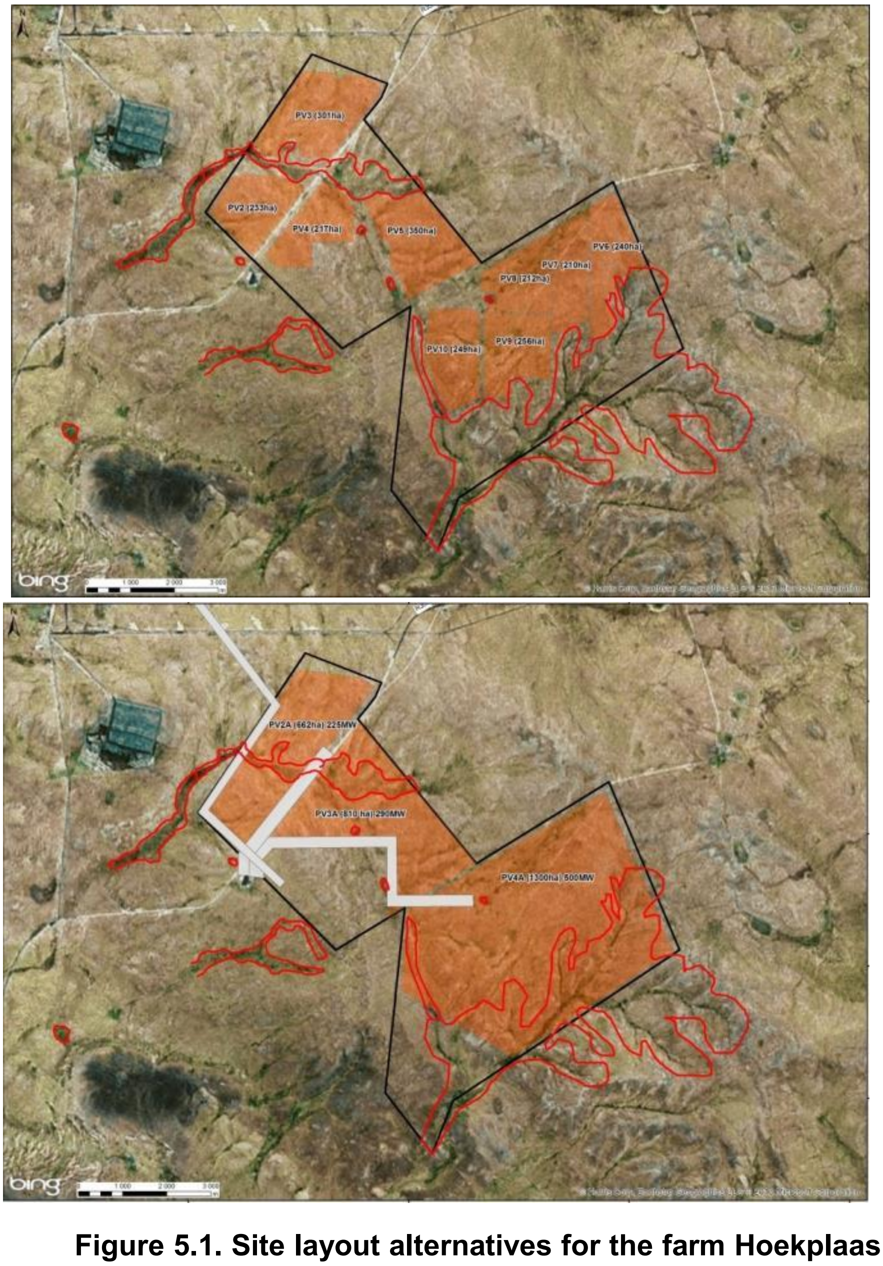

Figure 5.1. Site layout alternatives for the farm Hoekplaas. Alternative 1 (the preferred) is shown above and alternative 2 (larger MW Plants) below.

In terms of surface water drainage and their associated features (dry river beds and pans) alternative 1 is also the preferred option. According to the project information provided, (layout comparison in Fig. 5.1) the layout of alternative 1 is advantageous because it accounts for all known surface water features and is planned in such a way as to not cause direct disturbance to them. Alternative 2 however, overlaps with several no-go surface water features.

5.2 ACTIVITY ALTERNATIVES

Two activity alternatives exist, namely 1) solar energy generation via a PV plant, or 2) a "no-go" alternative to solar energy production. The no-go alternative is the baseline (or *status quo*) against which all other alternatives are assessed. As stated before, the current (*status quo*) landscape use is livestock farming with little to no impacts on surface water or surface water features. As such this is the preferred alternative as far as impacts to surface water dynamics is concerned.

5.3 TECHNOLOGY ALTERNATIVES

The technology alternatives relate to the type of solar panel under consideration as well as the mechanism for mounting panels. Although three types of solar panels were initially considered, only conventional PV solar cells and concentrated photovoltaic (CPV) technologies will be considered hereinafter. Both technologies have similar water requirements of about 19 L/MWh (Aurecon, 2012) for operation and maintenance and hence are equally preferable.

Solar panels can be mounted in various ways to ensure maximum exposure of the PV panels to sunlight. Single axis and fixed axis tracking systems are to be considered. Since the alternatives do not affect water use, they are equally acceptable in terms of this assessment.

5.4 ROUTING ALTERNATIVES

Two potential routing alternatives are considered.

Alternative 1
It is proposed that each PV plant have an onsite substation which would feed into one central onsite multibay substation by means of an overhead 132 kV transmission line before connecting to the Kronos Substation. The shortest routes have been identified for the proposed transmission lines.

Alternative 2
It is proposed that the transmission lines would connect to the Cuprum Substation along a corridor of approximately 6.3 km in length (measured from the farm boundary) and 180 m wide.

In terms of potential impacts to surface water features and dynamics, routing alternative 1 is the preferred option since it negates the need for a 6.3 km long corridor which traverses drainage lines on neighbouring farms. Nevertheless, while overhead 132kV transmission lines cannot easily be routed in such a way so as not to cross drainage lines, they should be routed such that they do not cross any of the demarcated pans in the area.

6 MONITORING / REHABILITATION REQUIRED

The National Water Act (NWA, Act No. 36 of 1998) requires the establishment of a national monitoring system that must provide for the collection of appropriate data and information necessary to assess water resources (DWAF, 2009a)[3]. Such a system should collect relevant information that contributes to the management of the resource in a desirable ecological condition.

The need for pragmatic and easy to apply methods to monitor instream habitat led to the development of the Rapid Habitat Assessment Method (RHAM) (DWA, 2009b). This method aims to provide a rapid approach to assess instream habitat conditions in wadeable and to a more limited degree, non-wadeable streams. The premise of the RHAM is that suitable habitat conditions will indicate the likely presence, abundance and frequency of occurrence of particular biota. Baseline conditions are used to assess the possible future change in habitat conditions and the derived impact on the indicator biota. Available data and expert knowledge is used to associate particular habitat conditions with different indicator biota and the relevant ecological categories (ECs).

However, since all features on the farm Hoekplaas are rainfall dependant systems, one cannot speak of environmental flow requirements[4] in that there are no upstream or downstream requirements or obligations. As long as waste water from the proposed PV Plant activities does not enter any of the defined no-go areas, and as long as surface water is not abstracted from pans or drainage channels when water occurs, there should not be a need for monitoring in the no-go areas. As mentioned above, monitoring of soil chemistry and erosion in areas directly associated with the proposed PV plants are required and the results would define any operational mitigation or post plant decommissioning rehabilitation that may be required. To this end it is recommended that the development of the proposed PV plants go hand in hand with the development of an environmental management plan, to be executed during the operational phases.

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[3] It should be noted that ephemeral drainage lines are classified as streams and endorheic pans as a recognised type of wetland, and as such enjoy protection under the Act

[4] these are flows that are required to maintain a riparian zone or wetland in a predefined ecological category/state

7 CONCLUSIONS AND RECOMMENDATIONS

The area covered by the farm Hoekplaas is generally flat, with drainage areas and a few endorheic pans which contribute to the biodiversity of the area (Noss, 1990). Such endorheic pans, generally defined as circular or oval, shallow, closed drainage systems, are recognised by the DWA as a legitimate type of wetland, and as such are protected in accordance with the NWA. As such, these areas have been delineated as no-go areas (see Fig. 2.2) and should be avoided by the proposed PV plants. In addition no abstraction of water from these no-go areas should occur, although due to their ephemeral nature it is unlikely that this would occur. Similarly, no waste water from PV Plant activities should be decanted into these no-go areas.

Since the proposed developments would get water from the Alkantpan pipeline, water use of the water resource at the site would be insignificant. However, the additional water spilled to the soil surface from washing of solar panels has the potential to elevate soil erosion and /or alter soil chemistry. This impact has both a quantity and quality component, and the severity of each depends on factors which are not exactly known i.e. the potential of falling water to erode soils would depend on the nature of the application and the erodability of the substrate, and the alteration to soil chemistry would depend on the dilution and chemical nature of the washing medium. To best mitigate this impact it would be necessary to monitor both soil chemistry and erosion and develop mitigation strategies if required. Should it be required it should not be difficult to channel runoff in such a way as to minimise erosion, or to employ soil stabilising techniques in vulnerable areas. Should soil chemistry be affected (this is likely to be an increase in salinity), the nature of the washing mixture could be changed, or acceptable waste treatment measures employed. Monitoring, together with the development of an environmental management plan as operation proceeds would be the most effective strategy.

With developments such as the proposed PV plants, NEMA requires that alternatives be considered during the EIA process. Should the proposed development of additional PV plants go ahead, the following alternatives are the preferred options in terms of potential impacts to surface water features and dynamics. Site layout: the proposed placement of 10 x 75MW PV plants (Fig. 5.1). Technology: No preference of alternatives, however should there be different water requirements, systems that require less water for operation would be preferred. Routing: alternative 1 with connection to Kronos.

Should the proposed PV plants be developed, the key mitigation measures include the prevention of erosion or incision of existing drainage channels, the prevention of sedimentation of existing pans or drainage channels, the prevention of chemical alteration of pan substrates and the exclusion and/or management of a possible increase in alien vegetation species.

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