MOGARA SOLAR PV FACILITY

STORMWATER & EROSION MANAGEMENT PLAN

JULY 2018

REVISION 1

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SYNOPSIS

Stormwater and Erosion Management Plan for proposed Mogara solar PV development near Kathu, Northern Cape.

KEY WORDS:

Hydrology, Stormwater, Stormwater management.

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2015 which has been independently certified by DEKRA Certification under certificate number 90906882

Verification	Capacity	Name	Signature	Date
By Author	Associate	G. Joubert	G. Joubert	11/07/2018
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MOGARA SOLAR PV FACILITY
STORMWATER & EROSION MANAGEMENT PLAN

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1 TERMS OF REFERENCE

JG Afrika (Pty) Ltd was appointed by K2018091776 (SOUTH AFRICA) (Pty) Ltd to provide a Stormwater and Erosion Management Plan for the proposed Mogara Solar PV facility located on Legoko Farm 460, Portion 2, approximately 5km southeast of Kathu, Northern Cape

This scope of this study includes the following:

- quantification of stormwater runoff and peak flows;
- development of strategies for stormwater management and waste water management;
- preparation of design concepts to accommodate the anticipated flows, while ensuring continuity of natural drainage paths; and
- determination of appropriate mitigation measures, including erosion management, attenuation of flood peaks and pollution control.

2 DESCRIPTION OF THE SITE

The proposed development is located to the east of the N14 Kuruman – Olifantshoek Road southeast of Kathu, as indicated on **Figure 2-1: Locality**.

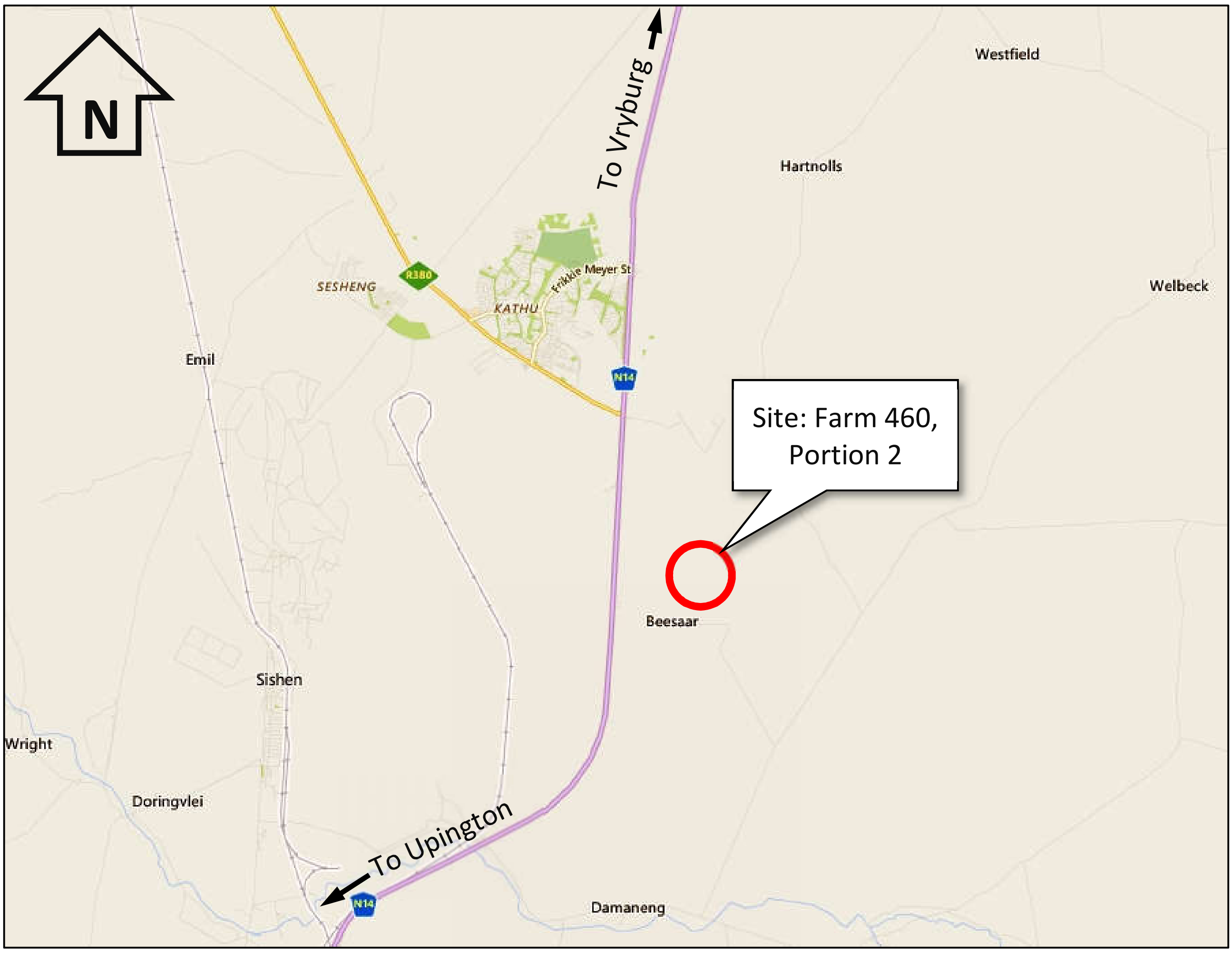

Figure 2-1: Locality

The preferred site indicated below in **Figure 2-2: Site** covers an area of 225 hectares (ha) and has a gradual fall from east to west. The topography is extremely flat (less than 0.5% in places) with poorly-defined drainage paths. The alternative site covers an area of 225 ha and has similar topography to the preferred site.

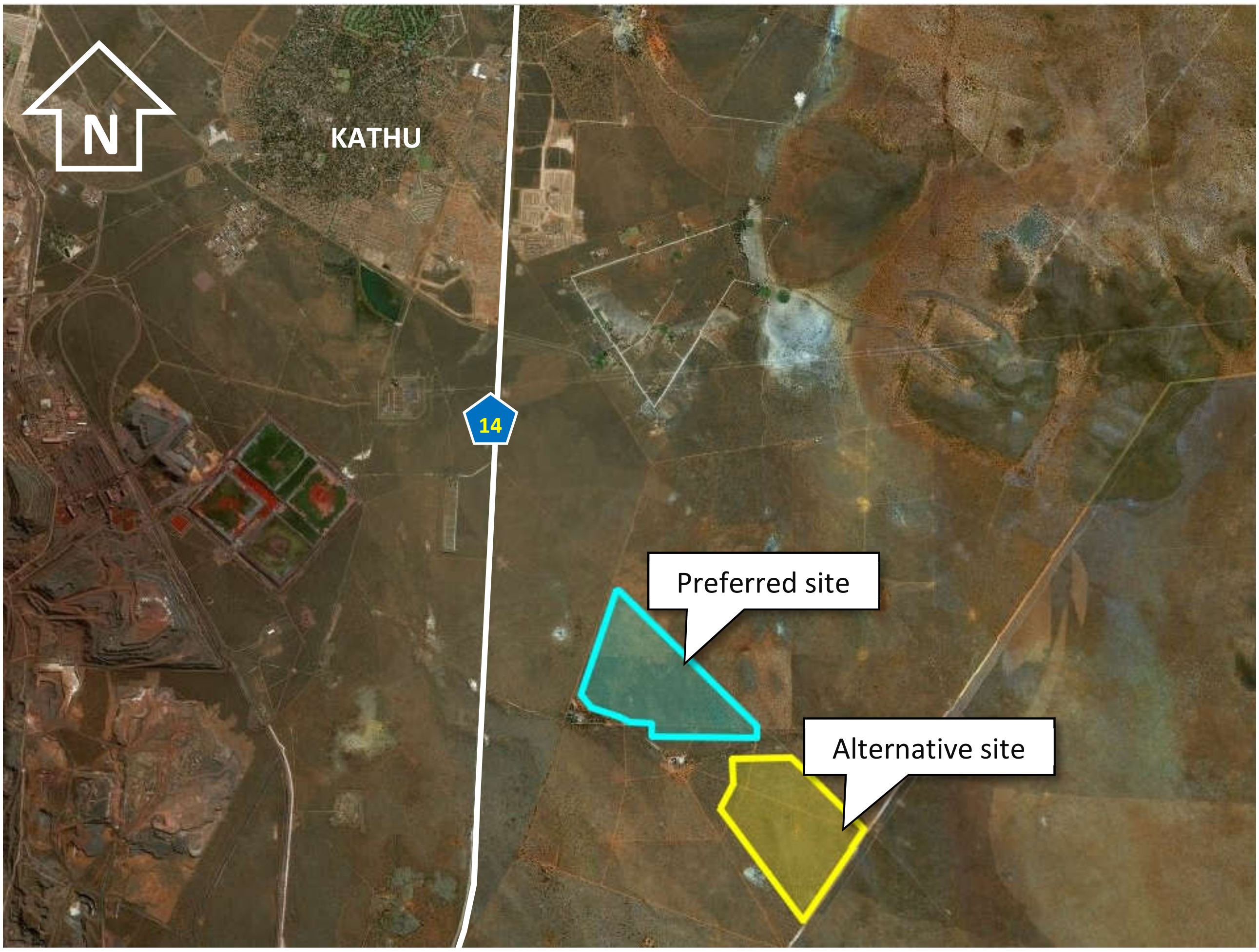

Figure 2-2: Site

The catchments draining towards the sites are shown on **Figure 2-3: Catchments**. The topographical information used was taken from the 1:10 000 Orthophoto series provided by National Geo-Spatial Information (Department of Rural Development and Land Reform).

Catchment A covers an area of 70.2 km^2 and drains via the preferred site. Catchment B covers an area of 9.7 km^2 and drains via the alternative site.

Owing to the flat topography, particularly in the vicinity of the proposed development, sheet flow is likely to occur and the majority of aboveground runoff will be routed via wide, flat poorly-defined drainage paths. Consequently, flow velocities will be relatively low and flow depths will be shallow.

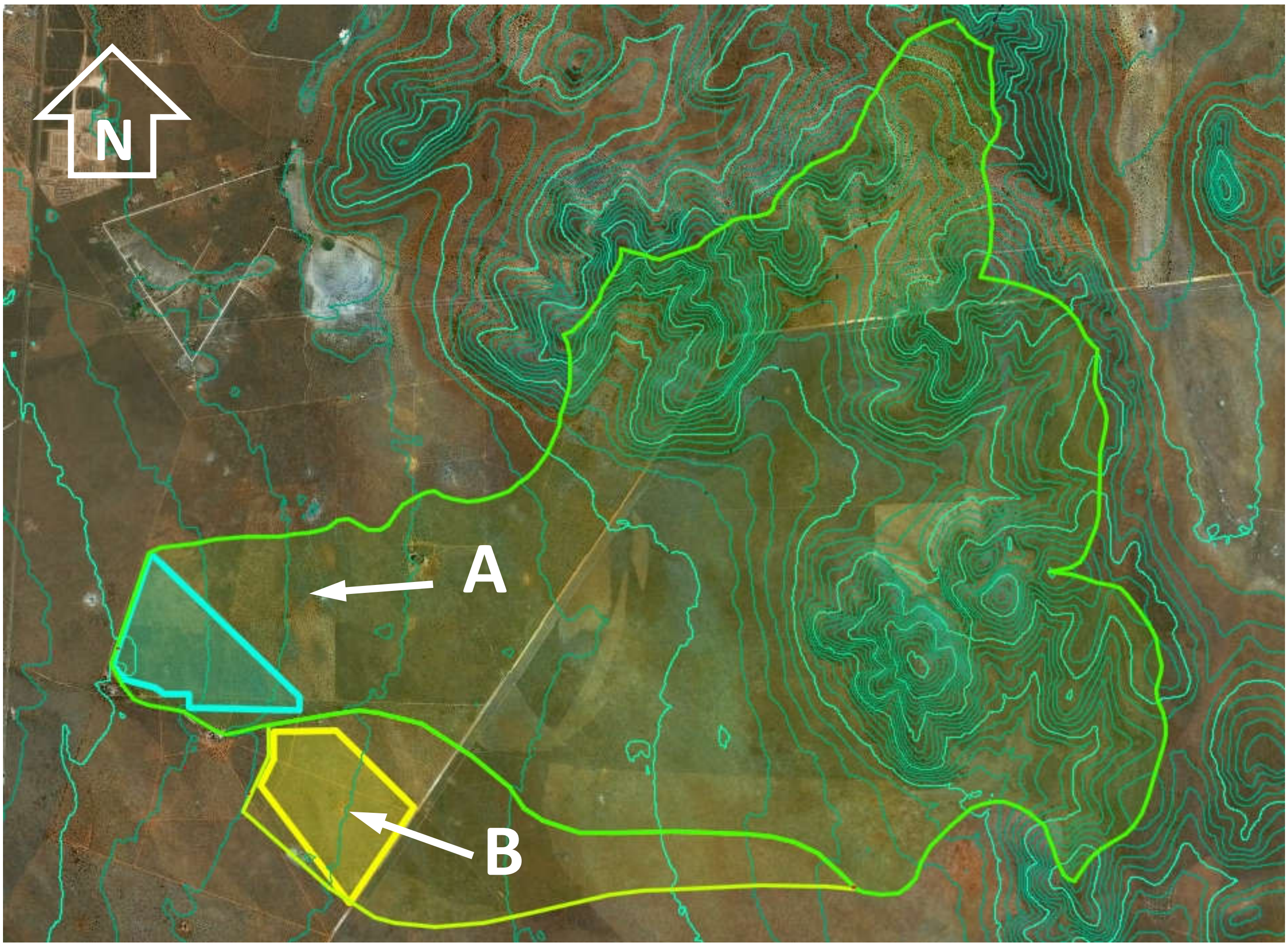

Figure 2-3: Catchments

Figure 2-4: Vegetation

More detailed survey information will be required to identify specific drainage paths beyond the high level adopted for this study, but examination of the available aerial photography reveals no obvious areas where erosion is taking place.

The soils consist of a relatively shallow layer of permeable sand overlying impermeable calcrete. During rainfall events, this combination results in relatively high initial infiltration rates, reducing progressively as the sand layer becomes saturated and a temporary perched water table develops above the calcrete. Localised shallow ponding is likely to occur during high-order rainfall events.

The vegetation across the site is mainly scrub and low bush, with scattered thorn trees, as indicated on **Figure 2-4**: **Vegetation**.

Neither of the proposed sites fall within the floodplain of any nearby rivers or streams and therefore do not encroach on any 1 in 50-year floodline.

3 MODELLING

The catchments were modelled in EPA-SWMM 5.1, using the rainfall and runoff data below.

3.1 Design Rainfall

The Intensity-duration-frequency data was derived from *Rainfall Statistics for Design Flood Estimation in South Africa* (Smithers & Schulze. 2012) and is tabulated below for design storm events with return period of 5 and 50 years for various durations:

T (years)	Design storm duration (h)				
	1	2	4	8	12
	Average intensity (mm/h)				
5	37.4	24.8	14.3	8.3	6.0
50	63.9	42.3	24.5	17.7	10.3

Table 3-1: Design Rainfall

3.2 Runoff

The runoff parameters used are listed below:

- Impervious area roughness coefficient: 0.018
- Pervious area roughness coefficient: 0.040
- Impervious area depression storage: 1 mm
- Pervious area depression storage: 4 mm
- Infiltration method: Horton
- Soil type: A/B
- Antecedent moisture condition: Moist
- Maximum infiltration rate: 70 mm/h
- Minimum infiltration rate: 5 mm/h
- Drying time: 4 days

4 EXISTING CONDITIONS

4.1 Existing Infrastructure

The site is accessed via a gravel road linking to the N14 to the west. There is no formal stormwater infrastructure on the site. The stormwater is conveyed overland via informal preferential drainage paths in a westerly direction.

Figure 4-1: Access from the N14

4.2 Modelling Results

Runoff was computed for both minor (5-year) and major (50-year) design events of various durations up to 12 hours. The results were cross-checked via the Rational Method and found to be reasonable.

The peak flows are tabulated below:

Catchment	5-year return period		50-year return period	
	Peak flow (m^3/s)	Design storm duration (h)	Peak flow (m^3/s)	Design storm duration (h)
A	8.0	2	40.0	4
B	1.8	2	8.5	4

Table 4-1: Peak flows – existing scenario

For the minor (5-year) design event, shorter duration storms produce the highest peak flows for the catchments, while longer duration storms produce the highest peak flows for the major (50-year) design event.

The peak flows for Catchment A (i.e. draining via the preferred option) are substantial. However, the flat topography is such that the runoff is spread out in the lower reaches of the catchment. As a consequence, for design storm events of return period up to 50 years, flow velocities will be low (< 0.3m/s) and flow depths in the poorly-defined drainage paths are likely to be shallow (< 250mm).

Catchment B (i.e. draining via the alternative option) is considerably smaller than Catchment A, but in the lower reaches, the topography is similarly flat. Consequently, the peak flows will be substantially lower than those for Catchment A and as a result, the anticipated flow velocities are < 0.2m/s and flow depths are < 100mm.

More detailed survey will be required to model specific drainage paths and provide more accurate flow computations.

Despite the obvious differences between the preferred site and the alternative, the anticipated flow depths are shallow and flow velocities are sufficiently low for both sites, that there is no significant benefit to favouring one over the other from a stormwater perspective.

5 PROPOSED INFRASTRUCTURE

5.1 Proposed Infrastructure

It is anticipated that the Solar PV facility will contain the following infrastructure:

- On-site switching station / substation;
- Photovoltaic (PV) solar panels;
- Mounting structures to support the PV pPanels;
- On-site inverters (possibly string inverters);
- Transformer and internal electrical reticulation (underground cabling);
- Auxiliary buildings (such as gate house and security, control centre, office, warehouse, canteen and visitors centre);
- Temporary laydown areas;
- Internal and perimeter access roads and fencing;
- Rainwater tanks and
- Security infrastructure.

Access will be gained via the existing gravel farm road. Any alterations to the access road will require suitable provisions for the management of stormwater.

5.2 Pre-Construction Conditional Assessment

A conditional assessment of the site and access road must be carried out prior to the commencement of construction. The areas to be used for the site camp, stockpiles and other temporary works must similarly be assessed.

The existing state of the downstream properties and infrastructure, as well as areas earmarked for temporary works, must be photographed and compiled into a baseline record.

5.3 Proposed Stormwater Mitigation Measures

To avoid creating downstream issues, it is essential that any disturbance of the areas earmarked for development must be minimised. In this regard, vegetation must be preserved; overland runoff must be permitted to continue unimpeded as far as possible; and concentration of flow must be avoided.

5.3.1 Internal and Perimeter Access Roads

Gravel access roads should be constructed at-grade to allow continuity of flow from upstream to downstream. Side drains will interrupt and concentrate the natural flow paths and should be avoided where possible. Where the roads are intersected by preferential drainage paths, stabilisation by means of stone protection on either side will mitigate against scour.

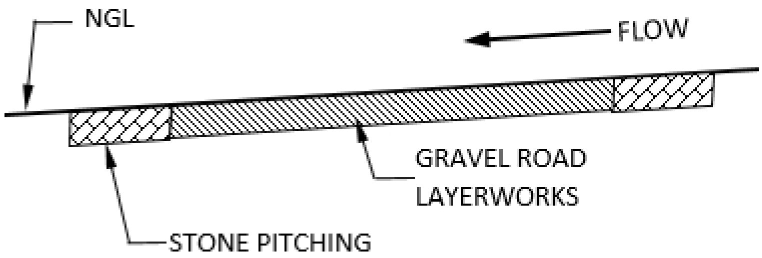

Figure 5-1: Access Road Cross-Section

5.3.2 Structures

Structures (e.g. substations, buildings etc.) will need to be protected by means of channels to divert runoff around them. However, the runoff must be returned to its original flow path as rapidly as possible, with suitable erosion protection downstream of the structure to reduce the velocity and spread the flow out. Gabions and stone pitching should be used to encourage infiltration.

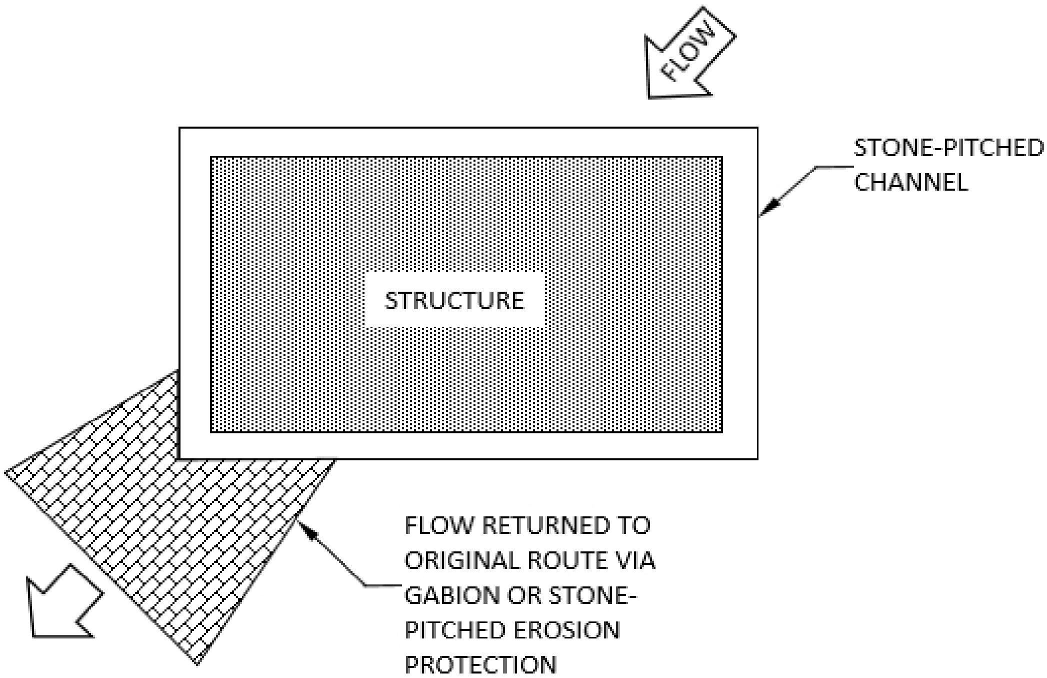

Figure 5-2: Plan View on Typical Structure

5.3.3 PV Panels

The supports to the PV panels should be designed to limit their impact on natural drainage patterns.

Owing to their smooth, impermeable surfaces, the runoff from each individual panel will be close to 100%. However, since each panel is separate, there will be no accumulation of runoff and the rainwater will be routed directly to the ground where it can infiltrate. In practical terms, there will be no significant increase in runoff. Furthermore, if the panels are constructed close to ground level, the runoff from individual panels will not increase the risk of erosion.

5.4 Management of Stormwater Impacts During Construction

5.4.1 Open trenches

Open trenches will be kept to a minimum and will be filled in progressively as construction proceeds. Excavated material to be used as backfill will be placed close to the trench on the upstream side to avoid loose material from washing away.

5.4.2 Stockpiles

Material stockpiles must be located away from any identified preferential drainage paths. Gravel, sand and stone stockpiles must be covered or kept damp to minimise dust. Temporary silt curtains or straw bales must be located immediately downstream of stockpiles to intercept grit wash-off.

5.4.3 Construction traffic

The crossing of any preferential drainage paths by construction traffic must be limited to a set number of strategic crossing points. The crossings must be protected with stone pitching and the downstream drainage paths must be protected with appropriately-placed temporary silt curtains or straw bales.

Refuelling and maintenance of construction vehicles must be carried out in a controlled manner on impermeable surfaces to avoid hydrocarbon contamination of the soil.

5.4.4 Rehabilitation

Periodic monitoring during construction will be necessary to ensure that if damage does occur, it is addressed immediately and not be permitted to escalate.

Areas not occupied by permanent infrastructure (e.g. roads, parking areas etc.) must be rehabilitated to their original condition after construction is complete.

Any downstream damage directly attributable to construction activities must be repaired and the areas returned to their original condition.

5.5 Operation Phase Management of Stormwater Impacts

5.5.1 Detention

On-site treatment of stormwater will be by means of informal infiltration. The construction of formal structures such as swales and detention ponds will interfere with natural drainage paths and should be avoided.

5.5.2 Waste Water Management

The washing of the solar panels will take place twice annually using clean water to remove wind-blown dust and accumulated residue. As long as no detergents are used, there is consequently no risk of groundwater pollution, as the material that will collect on the panels currently settles directly on the ground surface and/or vegetation in the area.

The volume of water required for cleaning the panels is approximately 3 litres/m^2 and the process will be carried out over a period of several weeks. This translates into an average of 0.02 m^3/s for the entire site. The flow is therefore negligible when compared to the runoff from design storm events and can be ignored. In this regard, the cleaning of panels is also not likely to take place during rainfall events of any significance.

The low flow rates mean that there is no erosion risk from the cleaning operation. Furthermore, owing to the high infiltration potential of the soil, the cleaning water will be absorbed directly into the soil and no additional collection or treatment will be required.

5.5.3 Monitoring

Runoff towards the west will be largely unchanged. Periodic monitoring of drainage paths and access roads downstream of the site must be done against the baseline assessment during the construction maintenance period to check for evidence of scour and / or siltation. Any damage directly attributable to operational activities will be repaired and the drainage paths returned to their original condition. Appropriate mitigation measures will be put in place to prevent recurrence of damage.

The erosion management strategy can be summarised in the following flow-chart:

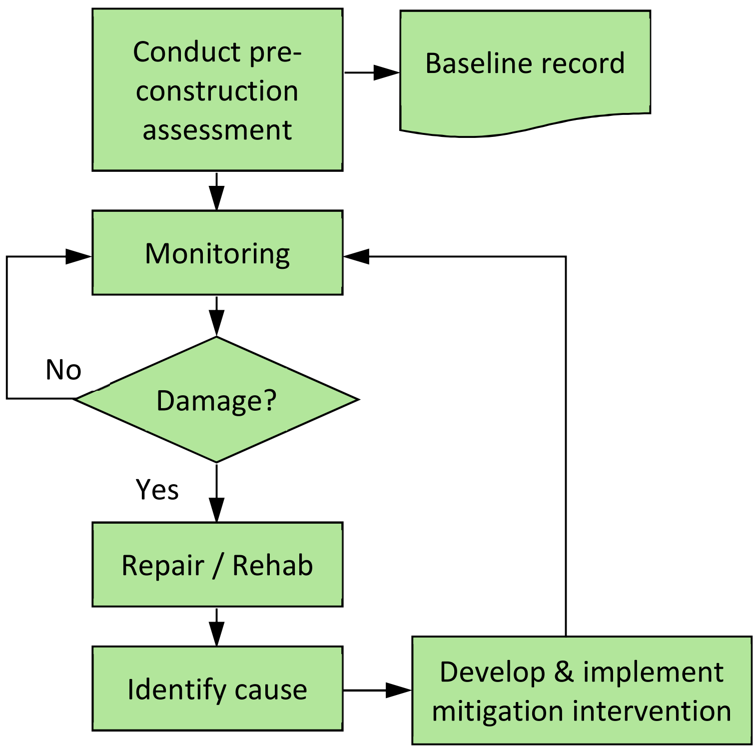

Figure 5-3: Erosion Management

6 CONCLUSIONS AND RECOMMENDATIONS

It may be concluded that:

- As long as the proposed new infrastructure is designed to maintain existing drainage patterns, the requirement for formal stormwater interventions will be limited;
- A pre-construction assessment will be necessary to ensure that construction and operational stormwater impacts are managed; and
- For most storm events, overland flow via poorly-defined drainage paths will be the primary form of conveyance.

It is recommended that:

- The interventions described in Sub-sections 5.2 to 5.5 be implemented; and
- The interventions described in Sub-section 5.4 be incorporated into the construction specification.

7 REFERENCES

1. Smithers, JC & Schulze, RE. 2012. Rainfall Statistics for Design Flood Estimation in South Africa. WRC Project K5/1060.
2. Bailey, AK & Pitman, WV. 2015. *Water Resources of South Africa, 2012 Study (WR2012)*. WRC Report No K5/2143/1.

Annexure A: Modelling Results

4816 MOGARA SOLAR PV SWMP

Rev 0 26/06/2018

Model: 4816 Legoko SW_EXIST_REV0_20180619.inp

RUNOFF

CATCHMT	T = 5 years					*Peak flow (m^3/s)*	*Storm duration (h)*
	Storm duration (h)						
	1	2	4	8	12		
A (MOG1)	4.32	7.98	7.66	4.36	1.08	*7.98*	*2*
B (ALT3)	0.96	1.76	1.67	0.94	0.23	*1.76*	*2*

CATCHMT	T = 50 years					*Peak flow (m^3/s)*	*Storm duration (h)*
	Storm duration (h)						
	1	2	4	8	12		
A (MOG1)	23.69	37.55	39.94	35.18	27.09	*39.94*	*4*
B (ALT3)	5.21	8.13	8.46	7.19	5.41	*8.46*	*4*