Activity: Allepad PV (I,II,III,IV) Storm Water Management Plan

Deliverable: Draft Report

Submitted to: ILEnergy Development

Compiled by:	**Accepted by:**
____________________	______________________
ILEnergy (Pty) Ltd Ian Smit	ILEnergy Development (Pty) Ltd Dr. Louis van Heerden
Date:	Date:

Contents

List of Figures

Key Abbreviations

BMP - Best Management Practice

CBA - Critical Biodiversity area

DAFF - Department of Agriculture Forests and Fisheries

DRDLR - Department of Rural Development and Land Reform

ESA - Ecological Support Area

EPC - Engineer, Procurement and Construction Company

LM - Local Municipality

MPRD - Mineral and Petroleum Resources Development

NHRA - National Heritage Resources Act

RE - Remaining Extent

SALA - Subdivision of Agricultural Land Act

SWMP - Storm Water Management Plan

WMA - Water Management Area

WUL - Water Use License

1. Approach

This Storm Water Management Plan has been prepared by ILEnergy (Pty) Ltd, based on their experience gained with multiple solar power construction projects in Upington and the Northern Cape Province, to describe how the EPC will safely and effectively control and minimize storm water impacts arising from the construction of the proposed Allepad PV solar power generation projects (I, II, III, IV), located approximately 15km Northwest of Upington, just off the N10 in the Northern Cape Province.

2. Purpose

The purpose of this document is to describe the methodology or procedures to manage rain water on the project site.

Construction activity refers to ground surface disturbing activities, which include, but are not limited to, clearing, grading, excavation, demolition, installation of new or improved internal roads and access roads, staging areas, stockpiling of fill materials, and borrow areas.

Storm water is defined as water originating during precipitation events. Storm water that does not soak into the ground becomes surface runoff, which either flows directly into surface waterways or is channelled into storm sewers, which eventually discharge to surface waterways.

Storm water is of concern for two main reasons namely: the volume and timing of runoff water (flood control), and the potential contaminants that the water could carry, i.e. water pollution due to construction waste.

Storm water is also a resource and ever growing in importance as the Upington area is an extremely arid area. Techniques of storm water harvesting with point source water management and purification that can potentially make environments self-sustaining should always be considered and utilised where practical.

3. Methodology

The return period considered for the Allepad PV Plants and the access road is 25 years (as indicated in the Drainage Manual of The South African National Roads Agency Limited). The procedures that was used to determine the design flood peaks, for hydraulic structures (culverts and ditches) are based on the deterministic methods:

3.1 The Rational Method

The Rational method is based on a simplified representation of the law of conservation of mass. Rainfall intensity is an important input into the calculations due to the fact that uniform aerial and time distributions of rainfall have to be assumed. The method is normally only recommended for catchments smaller than about 15 km^2. Only flood peaks and empirical hydrographs can be determined by means of the rational method. Judgement and experience on the part of the user with regard to the run-off coefficient selection is important in this method.

3.2 Alternative Rational Method

The Alternative Rational method is an adaptation of the standard rational method. Where the rational method uses the depth-duration-return period diagram to determine the point precipitation, the alternative method uses the modified recalibrated Hershfield equation as proposed by Alexander in 2001, “Flood Risk Reduction Measures incorporating Flood Hydrology for Southern Africa”, S.A. National Committee on Large Dams, Pretoria for storm durations up to 6 hours, and the Department of Water Affairs’ technical report TR102.

3.3 Standard Design Flood Method

The Standard Design Flood (SDF), method was developed by Alexander in 2002, “The Standard Design Flood”, Journal of the South African Institution of Civil Engineering, Volume 44, No 1, SAICE, to provide a uniform approach to flood calculations. The method is based on a calibrated discharge coefficient for a recurrence period of 2 and 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous basins in South Africa.

Peak discharge (the maximum flow rate during the flood), is the most useful parameter in the calculation of the required cross-sectional area to convey a flood and to determine the upstream influence of any structure that affects the normal flow conditions. The peak discharge is directly related to the characteristics of the storm event and response of the contributing catchment area.

Although the peak discharge does not remain constant as the flood progresses along a watercourse, changes are fairly gradual where there are no tributaries or local temporary storage. It could, therefore, be postulated that the peak discharge is independent of local changes in the watercourse, such as bed slope and cross-sectional shape. With the peak discharge having been determined, the high-flood level (flood line), and associated flow velocities may be determined by means of hydraulic calculations (uniform or gradually varied flow relationships). The flood volume and temporal variance of the flow rate can then be derived from the hydrograph.

The figure below lists the methods, input data requirements, maximum recommended catchment area for which each procedure can be used, and references related to the procedures.

Method	Input data	Recommended maximum area (km2)	Return period of floods that could be determined (years)
Rational method	Catchment area, watercourse length, average slope, catchment characteristics, rainfall intensity	< 15	2 – 100
Alternative Rational method		No limitation	2 – 100
Standard Design Flood method	Catchment area, slope and SDF basin number	No limitation	2 – 200

Figure 1. Deterministic Methods for Flow Calculations.

4. Storm Water Management Plan

4.1 Introduction

Managing the quantity and quality of storm water is termed, "Storm Water Management". The term Best Management Practice (BMP), is often used to refer to both structural or engineered control devices and systems (e.g. retention ponds), to treat polluted storm water, as well as operational or procedural practices.

The Storm Water Management Plan (SWMP), will also identify possible pollutant sources that may contribute pollutants to storm water, and identify Best Management Practices (BMP's) that, when implemented, will reduce or eliminate any possible water quality impacts. The SWMP must be completed and implemented at the time the project breaks ground, and revised as construction proceeds, to accurately reflect the conditions and practices at the site at the time.

There are many forms of storm water management and BMP’s, including:

- Management of storm water to control flooding and erosion;
- Management and control of hazardous materials to prevent release of pollutants into the environment (source control);
- Planning and construction of storm water systems so contaminants are removed before they pollute surface waters or groundwater resources;
- Use and protect natural waterways where they still exist or can be rehabilitated;
- Building "soft" structures such as ponds, swales or wetlands to work with existing features or "hard" drainage structures, such as pipes and concrete channels;
- Revising current storm water regulations to address comprehensive storm water needs;
- Enhancing and enforcing existing ordinances to make sure property owners consider the effects of storm water before, during and after development of their land;
- Educating the community at large about how it’s actions affect water quality, and about what it can do to improve water quality; and
- Planning carefully to create solutions before problems occur.

4.2 Risk and The Affected Environment

Construction activities use and produce many different kinds of pollutants which may impact water quality. The main pollutant of concern at construction sites is sediment.

Grading or clearing activities remove grass, rocks, pavement and other protective ground covers, resulting in the exposure of underlying soil to the elements. The soil is then easily picked up by wind and/or washed away by rain. For example, sediment runoff rates from construction sites are typically 10 to 20 times greater than those from agricultural lands, and 1,000 to 2,000 times greater than those of forest lands.

During a short period of time, construction activity can contribute more sediment to streams than would normally be deposited over several decades, causing physical and biological harm. The added sediment chokes the river channels and covers the areas where fish spawn and plants grow. Excess sediment can cause a number of other problems for waterbodies, such as increased difficulty in filtering drinking water, and clouding the waters which can kill plants growing in the river and suffocate fish. A number of pollutants, such as nutrients, are absorbed into sediment particles and also are also a source of pollution associated with sediment discharged from construction sites.

In addition, construction activities often require the use of toxic or hazardous materials such as petroleum products, and building materials such as asphalt, sealants and cement, which may pollute storm water. These materials can be harmful to humans, plants and aquatic life.

Although the expected amount of storm water in the Upington area during construction is relatively low, uncontrolled storm water discharges from construction activity can cause negative impacts on receiving waters by changing the physical, biological, and chemical composition of the water, resulting in an unhealthy environment for aquatic organisms, wildlife, and humans.

The majority of the site area is characterised by gentle slopes which drain into small ephemeral tributaries and a major drainage line to the North East of the proposed development running in a South Easterly direction (refer to the figure below). Several small dunes are dotted around the site.

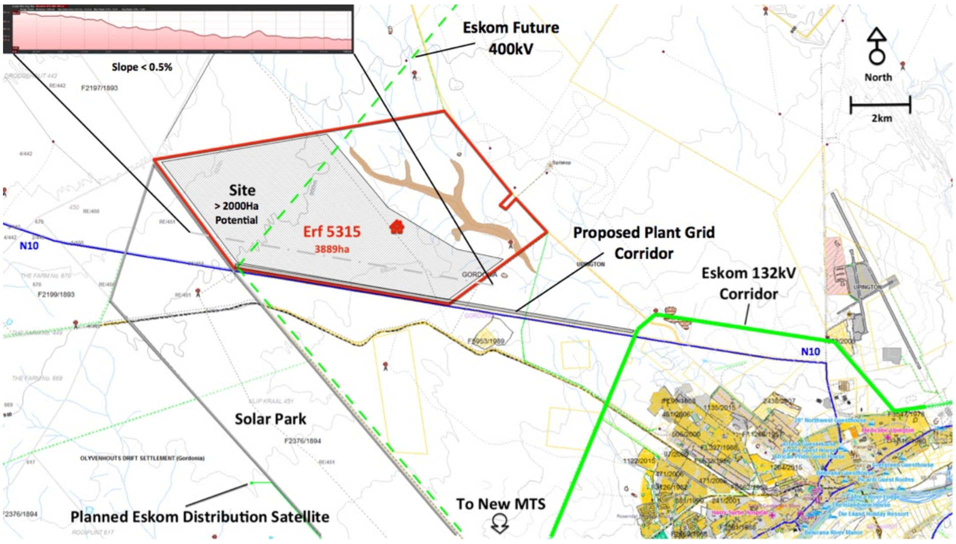

Figure 2. Site Topography and Locality to the Gariep (Orange) River.

The Weinert Climatic N-number for the area is higher than 10 (typically 12 to 14), indicating that the climate is semi-arid and mechanical weathering processes are dominant. Mean annual precipitation for this region is less than 300mm and the mean annual potential evaporation (S-Pan) is greater than 2600mm.

The study area falls within the catchment area of the Gariep (Orange) River (Quaternary Drainage Region D73E).

Although the region has a typically dry climate, flash-floods do occur now and then, and it is important not to underestimate this in the assessment of water erosion potential. Water erosion potential is directly related to the hydrology of the site which is, in turn largely affected by the geology. Infiltration of rainfall into the ground is largely determined by the thickness and permeability of the sandy soil cover. Infiltration is likely to be higher where the soil cover is thicker and relatively low in areas where the granite bedrock and calcrete or hardpan layers are near or at surface. Infiltration is inversely proportional to run-off, therefore in areas where infiltration into the ground is high, run-off is generally low, up to a point where the amount of rainfall exceeds the infiltration rate, and beyond that point excess rainfall ends up as run-off. Run-off is the primary trigger of erosion.

4.3 Management

4.3.1. General

The storm water management system consists of any measures provided to accommodate storm water runoff within project. These measures include gutters, conduits and infiltration structures.

In all the areas of the project, the water courses and built storm water infrastructure must be maintained in a clean state, free of any rubbish, debris and matter likely to pose any pollution threat to courses of the water.

The following will be achieved by storm water management to:

- Maintain adequate ground cover at all places and at all times to negate the erosive forces of wind, water and all forms of traffic.
- Prevent concentration of storm water flow at any point where the ground is susceptible to erosion.
- Reduce storm water flows as much as possible by the effective use of attenuating devices.
- Study the possibility to create systems of rainwater harvesting in order to reduce erosion and allow natural water flow during rainfalls.
- Ensure that all storm water control works are constructed in a safe and aesthetic manner in keeping with the overall development theme for the project area.
- Prevent pollution of water ways and water features by suspended solids and dissolved solids in storm water discharges.
- Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations.
- Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

The following rules are to be observed by the EPC and subcontractors:

- Designs for the buildings and site development in general must avoid concentration of storm water runoff both spatially and in time and may be required to provide for attenuation of storm water.
- Detailed plans to control and prevent erosion by water must be agreed with prior to the commencement of works, including site clearance on any portion of the site.
- Removal of vegetation cover must be carried out with care and attention to the effect, whether temporary or long term, that this removal will have on erosion potential.
- Precautions shall be taken at all times on building sites to contain soil erosion and prevent any eroded material from being removed from the site.
- On-site storm water control systems, such as swales, berms, soil fences and detention ponds are to be constructed before any construction commences on the site. As construction progresses, the storm water control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
- Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilisation and erosion control measures shall be implemented immediately.
- Storm water must not be allowed to pond in close proximity to existing building foundations.
- It is important that all building designs provide for maximum on-site storm water attenuation and that the EPC instructs it's professional teams accordingly.
- It is important that level and near-level areas, such as building roofs and parking areas, are used to best take advantage of storm runoff.

Refer to Appendix A for Best Practice Guidelines.

4.3.2. Erosion Control

Access of trucks and vehicles to the site as a result of construction activities and associated earth disturbance activities may potentially increase levels of soil erosion on the project site. In addition, the occurrence of rainfall may potentially result in significant levels of erosion due to the lack of vegetation cover and the dryness of the soil at the project site. However, the likelihood of rainfall is very low in the area and thus the risk of erosion by storm water is significantly reduced.

Nevertheless, the dry and windy climate and conditions (flat topography, low vegetation cover and dryness of soil), at the project site are conducive to wind erosion of soils.

This Erosion Control Plan covers all activities with potential to cause sedimentation and erosion impacts within and surrounding the project site. This Plan establishes a series of mitigation and management measures to control and minimize these issues where required. The objective of this plan is to minimize soil erosion. Best Management Practices (BMP's), encompass a wide range of erosion and sediment control practices, both structural and non-structural in nature, that are intended to reduce or eliminate any possible water quality impacts from storm water leaving the construction site. The BMP's shall be classified in:

- Non-structural BMP's, such as preserving natural vegetation, preventive maintenance and spill response procedures, schedules of activities, prohibition of specific practices, education, and other management practices which are mainly operational or managerial techniques.

- Structural BMP's include treatment processes and practices ranging from diversion structures and silt fences, to retention ponds and inlet protection.

This Plan is based primary on controls used during ground surface disturbing activities. This focus means that many sediment control BMP's, such as silt fence and inlet protection, must be installed before disturbing activities begins, not after.

4.3.3. Pollution Prevention

Soil and groundwater pollution can occur as a result of chemical or fuel spills or inadequate disposal of waste.

The direct impact of such spills or leaks is soil contamination and the possibility of percolation of the spilled oil or fuel to groundwater. The indirect impact of spills and leaks will be on animals through exposure to the toxic pollutants from soil or water by ingestion, inhalation or skin contact with those receptors. Potential sources/activities include:

- Use, storage and disposal of oil, fuel and chemical materials;
- Operation of mobile and fixed machinery and equipment;
- Assembly Plant;
- Substation;
- Vehicle wash-down facilities;
- Concrete and cement wash-down facilities; and
- Solid waste storage and sanitary facilities.

This Storm water management plan covers all project construction activities with the potential to cause pollution to the groundwater and/or soils. This establishes a series of mitigation measures as a guide to minimizing the likelihood of occurrence of spills, the volume of spills and the contingency measures following a spill occurrence. The objective of this plan is to minimize the risk of pollution of the groundwater and soils.

Appendix A – Best Practice Guidelines

The following guidelines are intended to assist with the planning of site layouts, the design of the major and minor storm water systems infrastructure and to ensure that the objectives of this Storm Water Management Plan are met during the planning, design, construction and operational phases of the proposed Allepad PV developments.

1. Storm Water Runoff Control

Formal surface and underground storm water systems are provided in the overall development for the acceptance of storm water drainage from the project site, but it is important that the peak runoff rate does not exceed the hydraulic capacities of the individual elements in the total storm water system. The following are general guidelines for storm water control:

1.1. Buildings

Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building.

The EPC shall ensure that the flow path of the storm water on his site is adequately protected against erosion and is sufficiently roughened to retard storm water flow to the same degree, or more, as that found in the natural predevelopment state of the site.

Where the construction of a building causes a change in the natural flora of the site that might result in soil erosion, the risk of soil erosion by storm water must be eliminated by the provision of approved artificial soil stabilization devices, or alternative flora suited to the changed conditions on the site.

Any inlet to a piped system shall be fitted with a screen or grating to prevent debris and refuse from entering the storm water system. This must be done immediately on installation of the piped system.

No building works, earthworks, walls or fences may obstruct or encroach on a watercourse inside or outside the site without approved plans and an approved WUL (Sec 21 C&I).

1.2. Parking Areas and Yards

Any external parking area, yard or other paved area must be designed to attenuate storm water runoff from a major storm to an acceptable degree.

1.3. Internal Tracks

Internal tracks shall not be constructed to deflect or channel runoff onto a roadway, or to concentrate runoff along a particular path that is not a natural water course, without prior consent.

Internal tracks and paths should be designed and constructed such that the rate of flow of storm water across and along the driveway or path is not increased when compared with the pre-development state.

Where the internal tracks join the main roads, they must not obstruct the flow in any open channel, whether lined or unlined, found along the road verge.

1.4. Roads

The principle of overland flow should apply to roadways where possible and roads should be designed and graded to avoid concentration of flow along and off the road.

Where flow concentration is unavoidable, measures to incorporate the road into the major storm water system should be taken, with the provision of storage facilities at suitable points.

Inlet structures at culverts must be designed to ensure that the capacity of the culvert does not exceed the pre-development storm water flow at that point and sump storage should be provided on the road and/or upstream of the storm water culvert.

Outlet structures at a road culvert or a natural watercourse must be designed to dissipate flow energy and any unlined downstream channel must be adequately protected against soil erosion.

1.5. Storm Water Facilities

The effectiveness of on-site storage to meet storm water reduction requirements within the minor and major storm water systems is the responsibility of the EPC.

Any storage sump shall be integrated with the landscape on the site and maintained in good condition.

Storage sumps shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.

1.6. Subsurface Removal of Storm Water

Any construction providing for the subsurface disposal of storm water should be designed to ensure that such disposal does not cause slope instability, or areas of concentrated saturation or inundation.

Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

1.7. Channels

Lined and unlined channels may be constructed to convey storm water to a natural watercourse where deemed necessary and unavoidable.

Channels must be constructed with rough artificial surfaces, or lined with suitable, hardy vegetation, to be non-erodible and to provide maximum possible energy dissipation to the flow.

1.8. Energy of flow

Measures should be taken to dissipate flow energy wherever concentrated storm water flow is discharged down an embankment or erodible slope and the resulting supercritical flow poses a significant risk to the stability of the waterway.

1.9. Flow Retarders and Diverters

Storm water flow should be retarded wherever possible through the use of surface roughening or other flow restricting devices (gabions, rip-rap et al), provided these are designed and built to avoid blockages that could result in environmental and structural damage.

All such devices must be regularly maintained by the EPC.