STORMWATER MANAGEMENT PLAN

1. PURPOSE

By taking greater cognisance of natural hydrological patterns and processes it is possible to develop stormwater management systems in a manner that reduces these potentially negative impacts and mimics nature. The main risks associated with inappropriate stormwater management are increased erosion risk and risks associated with flooding. Therefore, this Stormwater Management Plan is closely linked to the Erosion Management Plan (Appendix F) and the two should be managed together.

This Stormwater Management Plan addresses the management of stormwater runoff from the development site and significant impacts relating to soil erosion and downstream sedimentation, etc. The main factors influencing the planning of stormwater management measures and infrastructure are:

» Topography and slope gradients;
» Placing of infrastructure and infrastructure design;
» Annual average rainfall; and
» Rainfall intensities;

The objective of the plan is therefore to provide measures to address runoff from disturbed portions of the site, such that they:

» do not result in concentrated flows into natural watercourses i.e. provision should be made for temporary or permanent measures that allow for attenuation, control of velocities and capturing of sediment upstream of natural watercourses.
» do not result in any necessity for concrete or other lining of natural watercourses to protect them from concentrated flows off the development if not necessary.
» do not divert flows out of their natural flow pathways, thus depriving downstream watercourses of water.

This Stormwater Management Plan must be updated and refined once the construction/civil engineering plans have been finalised following detailed design.

2. RELEVANT ASPECTS OF THE SITE

The Ash River is situated within the Upper Vaal Water Management Area (WMA), which is a tributary of the Liebenbergsvlei which flows into the Wilge River, and thereafter follows the natural watercourse down to the Vaal Dam. Since the Lesotho Highlands Water Project (LHWP) was implemented in January 1998, the flows in the Ash River increased considerably. Since the Ash River became a conduit to transfer water from Lesotho to South Africa, its flow regime became severely altered, with no natural (reference state) elements remaining. The increased and regulated flows have severely incised and increased the channel and almost all in-channel geomorphological features have been removed.

LK Scheme:
The area surrounding the LK Scheme has been divided into three units based on soil characteristics and land use (refer to Figure 1):
» **Unit 1:** This unit is characterised by very shallow soils and rock outcrops. The soil properties indicate that the area has low potential non-arable land due to shallow soils with rocky outcrops rendering mechanical restrictions for cultivation. Normal run-off-control measures will be sufficient to protect the area against erosion.

» **Unit 2:** This unit is characterised by structured soil with a wetness hazard. The wetness is caused by the terrain position and gleyed horizon under the structured layer. This is a duplex soil because of the abrupt change between A and B-horizons in texture (15% clay increased to 45% clay) and structure from weak crumbly to strong blocky. These characteristics restrict water infiltration and root development, and have high erodibility risk. The terrain position increases the possibility for water logging because of the flat footslope. As a precaution to possible erosion, run-off-water from the construction areas of the inlet sill and headrace must be diverted with a cut-off drain. Because of the flat slope, erosion potential will be low between the construction area and river.

» **Unit 3:** This is medium to low potential soil due to medium depth and limiting layers of soft plinthic or lithocutanic B-horizons. The land is irrigated but soil properties relating to permeability, and effective depth, deprive it from being ideal for irrigation. Stormwater should be properly managed. The land is equipped with contour banks to combat stormwater erosion. The current contours convey part of the stormwater close to the northern boundary of Unit 3. The stormwater released by the contours, flows perpendicularly down and deposits sediment onto the lower contour. The lower contour is not designed to manage the extra load and will therefore break and lead to erosion.

![Figure 1: Study area of the LK Scheme divided into utilisation units.](image)
MK Scheme:

The area surrounding the MK Scheme has been divided into two units based on soil characteristics and land use (refer to Figure 2):

- **Unit 1**: The soils in this unit are grouped on the basis of similarity in cultivation and production properties. Soils in this unit are similar in capability for cash crop production. The unit has a medium agricultural potential due to effective rooting depth and climatic environment. Stormwater management within this unit is deemed sufficient due to
  - Discharge runoff in a natural waterway (wetland);
  - Discharge without danger that discharged water will reach underlying contour;
  - Keep water in the catchment area;
  - Area between last contour and riparian area /wetland have a slope less than 2% runoff from this area is intercepted by vegetation, which reduces flow speed before reaching the streambank.

- **Unit 2**: This soil type has an extremely strong structure and the tendency to shrink and swell with changes in water content. When dry, the soil profile is very hard and is prone to develop cracks. The shrink and swelling movement in the soil may break roots of crops not suitable to withstand these movements within the soil. When wet, the soil becomes unworkable due to excessive wetness and stickiness.

![Figure 2: Study area of the MK Scheme divided into utilisation units.](image)
3. STORMWATER MANAGEMENT PRINCIPLES

In the design phase, various stormwater management principles should be considered including:

» Prevent concentration of stormwater flow at any point where the ground is susceptible to erosion.

» Reduce stormwater flows as far as possible by the effective use of attenuating devices (such as swales, berms, silt fences). As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.

» Minimise the area of exposure of bare soils to minimise the erosive forces of wind, water and all forms of traffic.

» Ensure that development does not increase the rate of stormwater flow above that which the natural ground can safely accommodate at any point in the sub-catchments.

» Ensure that all stormwater control works are constructed in a safe and aesthetic manner in keeping with the overall development.

» Plan and construct stormwater management systems to remove contaminants before they pollute surface waters or groundwater resources.

» Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.

» Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

» Design and construct roads to avoid concentration of flow along and off the road surface. Where flow concentration is unavoidable, measures to incorporate the road into the pre-development stormwater flow should not exceed the capacity of the culvert. To assist with the stormwater run-off, gravel roads should typically be graded and shaped with a 2-3% crossfall back into the slope, allowing stormwater to be channelled in a controlled manner towards the natural drainage lines, and to assist with any sheet flow on the site.

» Design culvert inlet structures to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point. Provide detention storage on the road and/or upstream of the stormwater culvert.

» Design outlet culvert structures to dissipate flow energy. Any unlined downstream channel must be adequately protected against soil erosion.

» Where the construction of a building causes a change in the vegetative cover of the site that might result in soil erosion, the risk of soil erosion by stormwater must be minimised by the provision of appropriate artificial soil stabilisation mechanisms or revegetation of the area. Any inlet to a piped system should be fitted with a screen, or grating, to prevent debris and refuse from entering the stormwater system.

» Preferably all drainage channels on site and those contained within the larger area of the property (i.e. including buffer zone) should remain in the natural state so that the existing hydrology is not disturbed.

3.1. Engineering Specifications

A detailed engineering specifications Stormwater Management Plan describing and illustrating the proposed stormwater control measures must be prepared by the Civil Engineers during the detailed design phase. This should include erosion control measures. Requirements for project design include:
» Erosion control measures to be implemented before and during the construction period, including the final stormwater control measures (post construction).

» All temporary and permanent water management structures or stabilisation methods must be indicated within the Final/Updated Stormwater Management Plan.

» The drainage system for the site should be designed to specifications that can adequately deal with a 1:50 year intensity rainfall event or more to ensure sufficient capacity for carrying storm waters around and away from infrastructure.

» Procedures for managing stormwater flow through a project site need to take into consideration both normal operating practice and special circumstances. Special circumstances in this case typically include severe rainfall events.

» An onsite Engineer or Environmental Officer should be responsible for ensuring implementation of the erosion control measures on site during the construction period.

» The EPC Contractor holds ultimate responsibility for remedial action in the event that the approved stormwater plan is not correctly or appropriately implemented and damage to the environment is caused.

During the construction phase, the contractor must prepare a Stormwater Control Method Statement to ensure that all construction methods adopted on site do not cause or precipitate soil erosion, and shall take adequate steps to ensure that the requirements of the Stormwater Management Plan are met before, during and after construction. The designated responsible person on site, must be indicated in the Stormwater Control Method Statement and shall ensure that no construction work takes place before the relevant stormwater control measures are in place.

An operational phase Stormwater Management Plan should be designed and implemented if not already addressed by the mitigations implemented as part of construction, with a view to preventing the passage of concentrated flows off hardened surfaces and onto natural areas.

4. STORMWATER MANAGEMENT PRELIMINARY DESIGN

4.1. Flows estimation

The preliminary storm water flows are evaluated thanks to the topographic data and rainfall data. The flow rates for each area were identified using the following formula:

\[
Q = \frac{\phi \cdot A \cdot i}{360}
\]

Where:
- \( Q \) is the flow expressed in \( m^3/s \);
- \( \phi \) is the coefficient of influx (0.3);
- \( A \) in the area expressed in hectare;
- \( i \) is the maximum registered rainfall expressed in mm/h.

Not having available complete data of rainfall, in favour of safety, the calculations are made using the highest 24-hour recorded rainfall of 103 mm.

In the following table indicate the results obtained for the areas of the two power plants:
### Lower Kruisvallei

<table>
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<tr>
<th>#</th>
<th>φ</th>
<th>A [ha]</th>
<th>i [mm/h]</th>
<th>Q [m³/s]</th>
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<tr>
<td>Unit 1</td>
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<td>3.62</td>
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<td>0.31</td>
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<td>103</td>
<td>0.48</td>
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<tr>
<td>Unit 3</td>
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<td>4.95</td>
<td>103</td>
<td>0.42</td>
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### Middle Kruisvallei

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<th>#</th>
<th>φ</th>
<th>A [ha]</th>
<th>i [mm/h]</th>
<th>Q [m³/s]</th>
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<td>103</td>
<td>0.88</td>
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<tr>
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<td>103</td>
<td>0.87</td>
</tr>
</tbody>
</table>

#### 4.2. Flows management

It is not expected that the construction of the power plants can bring an appreciable variation in the current state of the area because:

- the only area that is waterproofed is that of powerhouse (less than 500 mq for each power plant);
- the surrounding land is all fallow, agricultural, to pasture therefore the ground has already a good draining capacity;
- the biggest structures that will be realized are canals that therefore constitutes in itself elements adapted to water management;
- is not present a sewer network to check and there isn’t need to build a new one.

To be sure that the safety of the site is assured, to manage these stormwater during the phases of construction will be made an suitable drainage systems (cut-off drain, pumps, coffer dam etc.) meanwhile during the normal operation phases the rain will be collected and conveyed into the headrace canals.