STORM WATER MANAGEMENT PLAN REPORT

Version: Final

SUPPORTING REPORT FOR THE BASIC ASSESSMENT PROCESS:

HYDROLOGICAL ASSESSMENT AND OUTLINE FOR THE STORM WATER MANAGEMENT REPORT FOR THE PRIORITIZED MTS DEVELOPMENT SITE ON THE FARM VETLAAGTE 4 HANOVER

COMPILED FOR:

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UPON INSTRUCTION FROM:

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Declaration

I hereby declare that Matukane and Associates (Pty) Ltd and the directors of the company are independent of MULILO, and the projects related to this report in terms of the definition of "independent" as stated in the Environmental Impact Assessment Regulations of 2014.

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ENVIRONMENTAL MANAGEMENT PROGRAMME CONCEPTS FOR THE STORM WATER MANAGEMENT REPORT

1. Introduction

Matukane and Associates (Pty) Ltd was appointed by LANDSCAPE DYNAMICS to conduct a desktop study, and to compile a report on the STORM WATER MANAGEMENT PLAN for the proposed Main Transmission Substation (MTS) on the proposed development site for Mulilo. The proposed development is envisaged for the farm Vetlaagte 4, Hanover Registration Division in the De Aar area in the Emthanjeni Local Municipality area under the Pixley ka Seme District Municipality in the Northern Cape.

Detailed topographical survey data is not yet available for this project phase. The work for this report is based upon publicly available elevation data, prepared from satellite imagery, and presented by the Copernicus (UE) Earth Observation Programme.

2. Purpose of this Report

The purpose of this report is to provide an oversight of the hydrological setting of the project, and to provide the scope of work for further hydrological assessment and the development of the STORM WATER MANAGEMENT PLAN for the site.

Image 1: Focus Areas

The report will focus on the alternative sites (with approximate 10 ha footprint each) as derived from the preliminary field work of other specialists.

3. Context of the SWMP in accordance with legal requirements

The direct applicable guiding legislation is:

- National Environmental Management Act (Act 107 of 1998)
- National Water Act ((Act 36 of 1998)
  - Conservation of Agricultural Resources Act (Act 43 of 1983)

No specific Regulations guiding storm water management could be found, thus sound rational engineering principles must be followed in the planning, design, construction, and operation of the MTS site.

Aspects of importance are:

- Hydrological characteristics including flood volumes, possible flood line challenges and general flow patterns expected on site (Topography and climatological drivers).
- Water quality due to site activities.
- Mitigating the hydrologic impact of the development.

4. Storm Water Management Plan

4.1 Purpose

The purpose of the Storm Water Management Plan (SWMP) is:

- To provide guidance to align all phases of development and the eventual operation to the relevant Acts of Law.
- To provide guidance for rational thinking in concept development and design.
- To minimise risk of on site and / or downstream damage due to hydrological impact. This includes exposure to runoff associated with normal rain, as well as during more extreme flood events.
- To minimise the risk of on site and / or downstream contamination through storm water due to products and waste on site.
- It needs to consider the impact of rain on the site, the impact of water entering the site from higher ground and the impact of water leaving the site.

The SWMP Report is not a design report; guidance is given in it for compliance by the eventual design-implementation- and operational teams.

4.2 Technical Parameters

Following is a discussion of the various aspects impacting on the SWMP for a specific site, with elements highlighted for a conclusive discussion of the SWMP.

As indicated by the title of it, the plan deals with storm water. Generally, in South Africa, and specifically so in the project area, it is dry for most of any given year. In years with normal rainfall, the precipitation is low, and evidence of extreme flood conditions may not be visible in vegetation, soil, and landscape. The impact that storm water may have on the site is often not visible before it happens. The frequency of occurrence of intensity of rainfall to the extremes of

1:100-year flood conditions cannot be forecasted. It happens randomly, and operators can easily be caught unprepared.

It is important to point out and to understand that diligence in stormwater management is essential and a full-time task, even during dry periods. Any lack of care may lead to the slow degrading of the site, rendering it susceptible to severe damage in the event of unexpected flooding, and subsequent potential damage to equipment on site due to gradual erosion due to normal rainfall events, or by unexpected huge damage due to random extreme flood events.

4.2.1 Geographical Orientation

Image 2 below illustrates the geographical setting of the project area.

Image 2: Regional Setting

The Vetlaagte site is situated in the Hanover Registration Division in the De Aar area in the Emthanjeni Local Municipality area under the Pixley ka Seme District Municipality in the Northern Cape. The coordinates at the approximate centre of the site are 30.70^0 South and 24.10^0 East at approximately 1260 m above sea level.

The Vetlaagte site is situated approximately 4.6 km north-east of the N10 route, with access via gravel road from De Aar, approximately 6 km to the west.

4.2.2 Topography

The Vetlaagte site is situated in the bigger quaternary catchment D62D. It is sloping from the southern high ground (1,484 m elevation) to the point of exit of the Brak River from quaternary catchment D62D in the north (1172 m elevation). This represents a slope of approximately 312 vertical metre over 95 km, thus 0,328%. The development site sub-catchment itself also slopes from south to north, falling 185 m over 37.2 km, representing a slope of approximately 0.495 %.

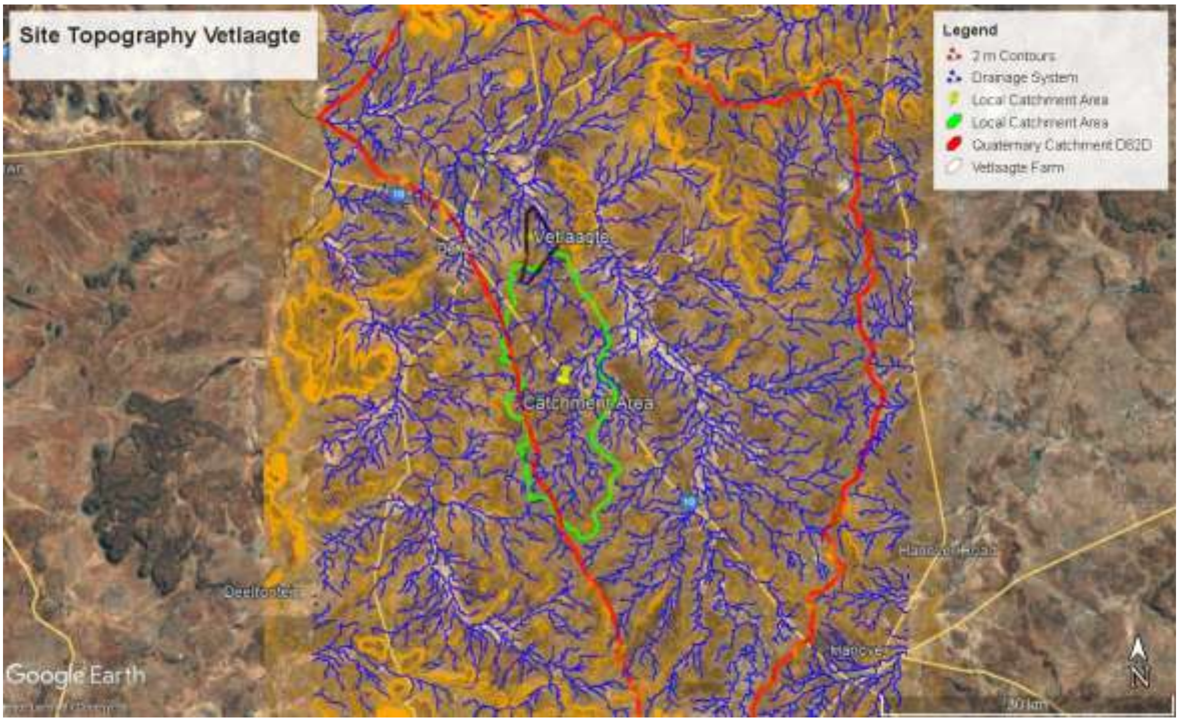

Image 3: Site Topography

The larger area consists of extremely irregular plains with moderate relief, with high drainage density of 2 to 3.5 km/km2 and high stream frequency of 6 to 10.5 stream/km2, (Kruger, 1983).

4.2.3 Surface Conditions

Sections 4.2.3.1 – 4.2.4 give an oversight of the assorted topics as prepared by an external specialist, Mr Piet Nel of the Agricultural Research Council.

4.2.3.1 Soil

Unconsolidated aeolian sandy superficial deposits of Tertiary to Recent age are found on the property. The red sand is freely drained high base status soils, usually deeper than 300 mm. Dunes are present with occasional outcrops of metamorphosed sediments, volcanics and intrusives of the Wilgenhoutsdrif and Koras Groups and the Groblershoop Formation. The aeolian red sands (fine medium sand) are mostly underlain by silcretes and calcretes of the Cenozoic Kalahari Group.

According to Land type Survey Staff (1986) for land type Ag 6, the soil is predominantly from the Hutton soil form (Hu34), with a very shallow soil depth of between 100 to 350 mm.

The clay content in the topsoil is between 6 to 12 % and between 7 and 15 % in the subsoil (Land type Survey Staff, 1986). The soil has a relatively low water holding capacity, probably between 15 to 25 mm/m, but the actual water available in the profile would be much lower, due to the very shallow soil depth of between 100 to 350 mm. The infiltration rate of the relatively sandy soil would be low, in the range of 10 to 15 mm/h, due to sodic character of the soil.

4.2.3.2 Erosion

Based on the slope gradient and soil erodibility index the water erosion susceptibility class is Class 5 for the broader area, but from satellite images it is clear that for the specific farm, the erosion is more problematic, and Class 6 is more realistic: Moderating sloping land with soils of very high erodibility hazard (Arc-ISCW, 2004).

The prevalence of the very sandy soil and the low annual rainfall of less than 200 mm results in low plant biomass production and low soil organic material, rendering the land susceptible to wind erosion. The wind erodibility index is Class 2a. In this Class, sand is strongly dominant, which makes it susceptible to wind erosion. There is a possibility that the shifting sands could damage electric components of the MTS infrastructure.

4.2.3.3 Land Capability

The eight-class land capability are interpretive groupings of land units with similar potentials and continuing limitations or hazards. The area falls in Land Capability Class (vii). The class has very severe limitations that make it unsuited to cultivation and that restrict its use largely to grazing and wildlife (ARC-ISCW, 2004).

4.2.3.4 Vegetation

The area consists of Bushman land Arid Grassland (NKb3) vegetation and is dominated by white grasses (Stripagrostis species) giving this vegetation type the character of semi desert ‘steppe’. In places low shrubs of Salsola change the vegetation structure (Mucina and Rutherford (2006). The sparing vegetation cover would not protect the soil against erosion during high intensity rainfall events.

4.2.4 Climate

The climate data of the area is obtained from the Kenhardt weather station (No. 0251/261 S).

Table 1: Climate Data

Month	Average Rainfall (mm)	Average Daily Temperature 14:00 (^oC)	Daily Max. Temp (^oC)	Daily Min. Temp (^oC)
Jan	15	33.5	35.7	19.1
Feb	29	32.1	35.4	18.5
Mar	31	30.1	31.9	16.4
Apr	17	26.0	27.7	11.8
May	11	21.4	23.1	6.6
Jun	6	18.6	20.2	3.3
Jul	5	18.6	19.7	2.5
Aug	4	20.3	22.2	4.3
Sep	5	24.3	25.7	7.5
Oct	8	27.1	29.3	11.3
Nov	9	30.6	31.8	14.6
Dec	11	31.8	34.6	17.7
Year	**151**			

The long-term average annual rainfall is 151 mm for the weather station, of which 147 mm, or 75%, falls from October to March. Temperatures vary from an average daily monthly maximum and minimum of 34.6ºC and 10.8ºC for January to 20.7ºC and -3.6ºC for June, respectively.

4.2.5 Hydrological Setting

4.2.5.1 Hydrological Characteristics

Refer to Image 3:

The site is situated in the D62D quaternary catchment area (White Polygon). This area is drained from the south to the north by the non-perennial Brak River. The Brak River continues to flow in a north-western direction where it meets up with the Orange River, approximately 175 km from site. The proposed development area is also drained form the south to the north, through an unnamed non-perennial drainage line.

The 1:100 flood line of this local drainage line was conducted under a separate assignment. It was found that the proposed development MTS on the farm Vetlaagte is not affected by the associated flood lines.

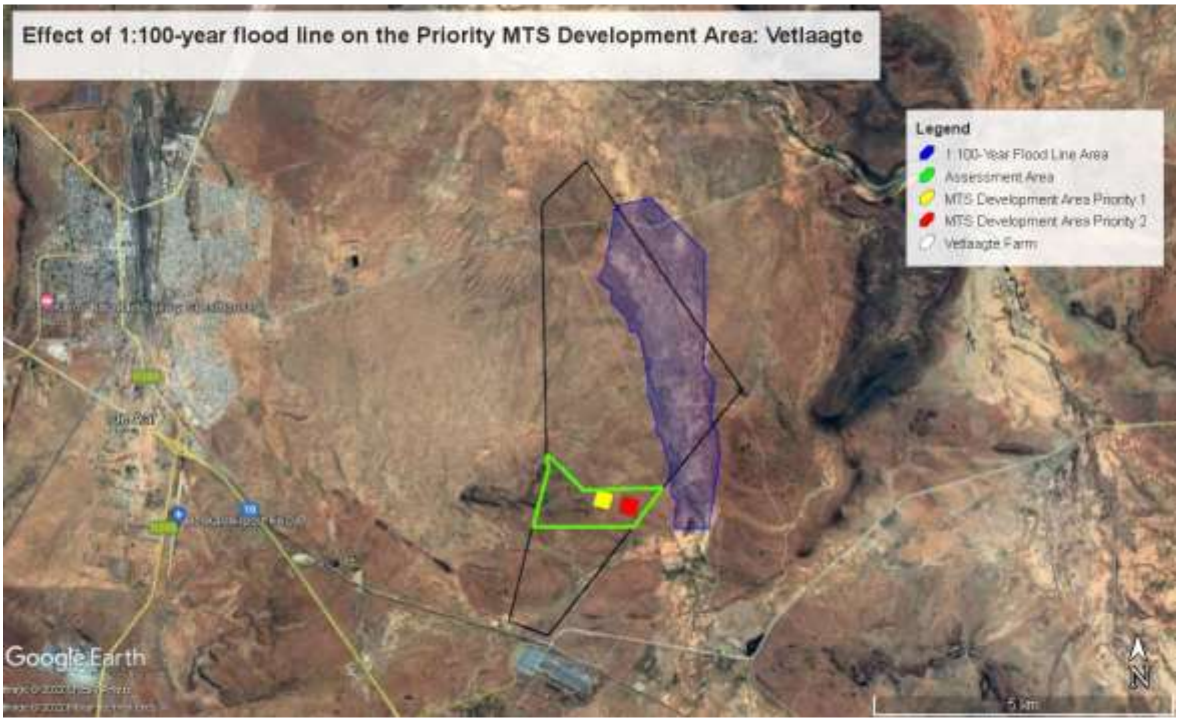

Image 4: 1:100 Floodline in relation to Priority MTS Development Areas

4.2.5.2 Hydrological Considerations

Three aspects of flow require consideration:

Drainage through the defined drainage channel from higher ground in the catchment area and from the site itself:

- If present, this requires the establishment of flood-lines and the exclusion of the area included in the 1:100-year flood-lines. There are no draining lines with impact on this site requiring this. No formal flood-line provisions apply.

Surface flow and channels with limited impact reaching the site from higher ground:

- The cause of this is outside the development site on higher ground and will have a definite impact on the development on site, with the severity of it depending on the various hydrological parameters and the specific foreseen development on the site. This flow must either be re-directed or managed on site.
- This impact on the site is low, due to the relatively small contributing areas. It is recommended that on this site this flow is contained within acceptable design parameters on site and disposed of at suitable places.

Surface flow generated on site:

- Due to direct rainfall on site, sheet flow will occur, leading to the smallest of flow channels, interlinking to bigger until it leads onto drainage lines of the magnitude that ~~it~~ must be managed.

Flow speed of down flowing water:

- A definite relationship exists between the flow speed of water and erosion. In general terms, the capacity to transport solid particles (thus to erode) of water is exponential to the flow- speed. A slight increase in flow speed thus gives rise to a proportionally bigger erosion risk.
- The flow speed of surface flood water is of importance because of:
  - the potential damage to the development.
  - the potential downstream impact due to altering the natural flow pattern.
- The flow speed of flood water is a function of:
  - Climate, and specifically precipitation and the intensity of it.
  - Slope of the flow path of water: Through the correct design of discharge channels on site, the flow speed of water can be manipulated. A longer flow path with a more gradual slope may slow down downflow. Care must be taken not to slow down the water to the point that suspended solids may in turn be deposited in the channels. This will cause blockages that will require additional maintenance to clean and to dispose of the material.
  - Vegetation on site: Vegetation forms a physical obstacle that dissipates energy from flowing water and have a slowing effect.
  - Site development with the possible increase of bare surfaces that allow quicker runoff, and thus higher flow speeds.

5. Site Specific Stormwater Management Plan

5.1. Background

A storm water management plan is developed for a site to manage and mitigate the effect of flood water on the site, the infrastructure on it, and the operation of the infrastructure. It is necessary to differentiate between two different flood impacts, namely that of:

- Substantial downflow of water from a substantial catchment area, where the topography concentrates water to canal type flow. These drainage lines are clearly identifiable, and flood lines can be established in accordance with established methodology and procedures. The flood lines are referred to in terms of the rainfall event that gives rise to a specific flood event. For example, the 1:100-year flood lines are based upon a rainfall event of intensity that it statistically occurs once in a hundred years.
- Smaller areas with less developed drainage. It is characterized by plate flow of water over topographically weaker defined areas, with accumulation of flow in ditches and dongas. Water flows down until it accumulates into definable drainage channels.;

It follows that the storm water management plan must take into account the possible impact of both the flood regimes as described above.

The flood lines are established as follows:

- The project area is considered to establish the bigger drainage area in which it is situated. The various identifiable drainage lines area delineated on a contour map. A point in a drainage line is selected so that the full impact on the project area can be assessed.
- The catchment area that contributes towards the flow in a specific drainage line is delineated on a contour map. For this area, the rainfall event associated with a specific return period (in this case stipulated to be 1:100-year) is estimated (statistics from close-by weather station data) and applied through established methodology to determine the 1:100-year flood value (cubic meter per second) at a specific point.

- The calculated flood must pass through the specific geometry defined by the topography of the drainage line. Through the application of the Manning formula, the water level for various cross sections perpendicular to the drainage line is established. On any specific cross section, the intersection points of the water surface level and the land profile represents points on the flood lines on the two sides of the stream. Linking the points establish the flood lines.

For any development, apart from the effect that any formally established flood lines may have, the local on-site flow of rainwater must be accounted for thoroughly. In order to do so, the site design in terms of the lay-out of buildings, lay-down areas, parking, open spaces, storm water collection system, etc. must be based on rational principles. It is industry standard to design these on-site storm water management systems in terms of rainfall of a certain expected return period. The return period to apply should be in relation to the value and strategic importance of the development. Where the consequences of flooding of infrastructure, and the economic value of it is low, a low-risk design like for a 1:20 year rain event may be applicable. We consider the strategic value of the development of the MTS on this site of such a high impact, that we suggest compliance to a 1:100-year rainfall event.

From the above, it follows that the contour map of the project area, and specifically any interface of surface drainage on the identified development area is of essential importance, as it substantiates the topography. To obtain high resolution elevation detail for high resolution contour plans, a topographical survey is required. Although such a survey can be restricted to relevant areas, it is a high-cost item. During the feasibility phase, less accurate elevation detail that is publicly available is used. If the project obtain approval, detailed design is done before construction. At this stage, it becomes essential to conduct a detailed topographical survey of the relevant areas. With this high-resolution topographic detail available, the development of the project area, including the placement of infrastructure and buildings and the storm water collection system, should be based upon real topographical data.

Image 4 presents a view of the impact of the 1:100-year flood lines on the distinct development areas.

The Vetlaagte MTS Assessment Site is not affected by the 1:100-year flood line. This aspect does not require further attention.

At the hand of a flow analysis for the identified MTS development sites, specific requirements of the individual SWMP for each site will be developed. Specific recommendations will be made pertaining to the:

- Planning and design of the sites
- Construction phase
- Operational Phase

"***A storm water management plan is to be implemented during the construction and operation of the facility. The plan must ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion. The plan must include the implementing of appropriate design measures that will allow surface and subsurface movement of water along drainage lines so as not to impede natural surface and subsurface flows. Drainage measures must promote the dissipation of stormwater run-off."***

5.2. General Discussion Pertaining to the Hydrology of the MTS Sites

With reference to Image 5 below , the development site is subjected to the following drainage:

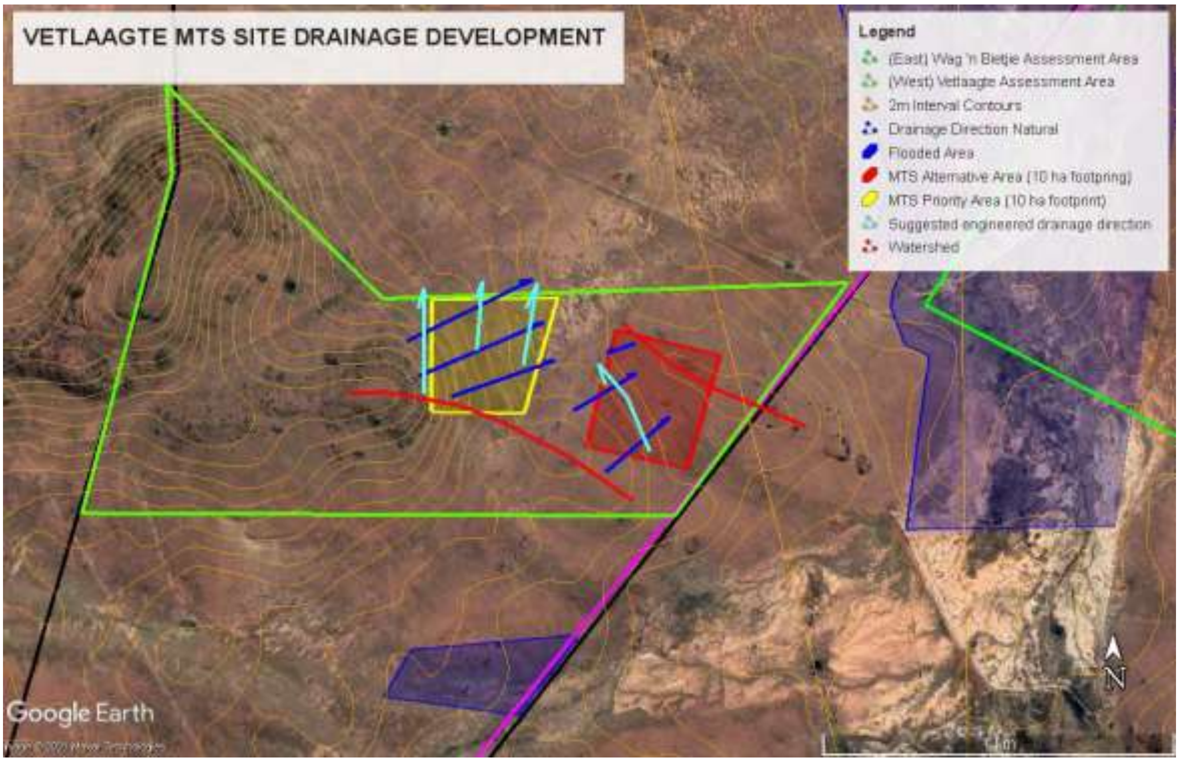

Image 5: Site Drainage Pattern as derived from "Copernicus Contours"

The yellow polygon in Image 5 represents the Alternative 1 MTS development site for Vetlaagte while the red polygon represents the Alternative 2 site.

The proposed development area in both instances is situated close to the top of the sub-catchment near the watershed (indicated by the red line). Normal drainage is indicated (dark blue line with directional heads). The site is not subjected to flooding from any higher land.

- The site is subjected to accumulated flood water originating from precipitation only on the site.
- Generally, care must be taken to protect neighbouring land and other adjacent development areas from potential damage from disposed flood water.

It is recommended that a suitable diversion canal be installed as required approximately parallel to contours to lead accumulated water out from the site. (Conceptually indicated in light blue).

5.3. Planning and Design pertaining to the Storm Water Management Plan

Reference is made in this section of various elements of on-site drainage as follows:

- Local Watersheds: Local outcrops of land that mark the highest point in a specific cross section. Water from different sides of the watershed flows in opposite directions.

- Contour following canals are canals, furrows, or any kind of water directing structure that is constructed almost parallel to a contour line, but with the allowance of a very low gradient to direct the flow of water. Due to the low slope of these canals, the flow speed of water is very low. These canals dispose of this slow flowing water into suitable downstream structures like storm water drains, directly into natural drains, or on open land, given that suitable energy dissipation is designed to prevent erosion.

- Storm water canals normally run perpendicular to contours and thus follow the natural steepest slope. Their function is to collect water from surface flow and from contour channels and to lead it out of the site to a suitable place of disposal, normally in a natural stream. Again, care must be taken to dissipate energy at the points of disposal to prevent erosion of the waterways.

5.3.1. The position in the catchment area is such that no risk is posed by flood water from a higher area.

5.3.2. There is no risk pertaining to flood-lines of definable water causes. As indicated on Image 4 the sites are suitably set out not to intervene with the 1:100-year flood lines.

5.3.3. Exposure to external surface flood water due to surface flow from higher ground:

- Surface flood water in such flat areas drains slowly and is prone to ponding. Ponding water can be harmful to infrastructure and detrimental to operations.
- By the lack of formal guidelines in this regard, it is recommended that on-site drainage structures be designed for at least a 1:100-year flood. (The application of a 1:100 years instead of a lesser event is based upon the:
  - High value of infrastructure.
  - The severe consequences in not reaching operational targets and the potential of contractual penalties and loss of income.
  - The strategic importance of power supply into the ESKOM distribution network.)
- Where practically feasible, the design and construction of cut-off trenches and outlet drains is recommended to prevent water from higher ground to flow onto the site:
  - Cut-off trench will run approximately parallel to the upper contour on site.
  - Allowance must be made in the design to approximately equal the concentration time under natural conditions to minimise the flow impact downstream.
  - Diverted flow must be disposed of into a flood channel (drainage line) in such a way that the energy is dissipated suitably to prevent erosion or the deposit of suspended material at the disposal point.

5.3.4. Flood water accumulated from flow on site:

- It serves to be noted again that surface flood water in such flat areas drains slowly and is prone to ponding. Ponding water can be harmful to infrastructure and detrimental to operations.
- By the lack of formal guidelines in this regard, it is recommended that on-site drainage structures be designed for at least a 1:100-year flood.
- The layout of the MTS system and associated service roads should be such that it can accommodate a suitably designed storm water trench system.

- The on-site systems must be carefully designed using contour following canals and storm water canals as explained at the onset of this section, in order to follow natural flow patterns in such a way that:
  - Flood water within the limits of 1:100-year floods are contained.
  - Erosion is prevented.
  - Infrastructural damage is prevented.
  - All points on site are easily accessible in all weather conditions.

5.3.5. The hydrologic impact of the infrastructure to be constructed can be compared to the roofing of a large area. The associated covered area will present a 100% runoff and a shorter reaction time (time of concentration), thus tending to cause quicker (more rapid) downflow in the site. This will increase the severity of all flood events and the erosion potential which must be mitigated in the planning and design of the drainage system for the site.

5.3.6. Allowance must be made in the design to approximately equal the concentration time under natural conditions to minimise the flow impact on the drainage channel downstream.

5.3.7. To limit future maintenance cost, the on-site drainage canal slope and profile must be designed in such a way that neither erosion of the trenches nor the deposit of material occurs.

5.3.8. The on-site drainage system must deposit its flow into a relevant drainage channel in such a way that the energy is suitably dissipated to prevent erosion or the deposit of suspended material at this point.

5.3.9. It is recommended that only the essential portion of land be cleared of vegetation. Vegetation, even though sparse, serves a very important function to limit erosion through the dissipation of energy as physical objects in the flow path, and by their roots binding the soil.

5.3.10. At all points where transmission lines and associated service roads traverse streams, Water Use Licencing in terms of section 21(c) of the National Water Act is compulsory. The essence of these is to install sufficient mitigation measures to ensure that the integrity of any such downstream areas of the relevant drainage lines is not affected adversely.

5.4. Construction Phase Storm Water Management

- It is recommended that access and service roads, as well as stormwater systems are constructed at the commencement of the construction phase to ensure that suitable stormwater management measures are in place at the least additional cost.

- These permanent routes must be used also for construction purposes. In order to preserve the natural state of the surface and vegetation as far as practically possible, off-road driving should be restricted to the absolute essential.

- Space for lay-down areas for construction material and for construction facilities is restricted on site. It is not possible to give clear directions in terms of positioning it. The flowing should however be taken into account:
  - Temporary or permanent soil stockpiles should be placed in such a way to minimize the impact on surface flow.
  - High resolution site survey data must be used to design stormwater ditches to direct surface flood water past any stockpiles.

- Site clearing should be limited to the essential.

- Construction waste must be collected and stored safely for disposal in accordance with the relevant waste regulations, protocols, and product specifications. Care must be taken not to leave any waste on site that can lead to future contamination of the site or the downstream area.

- Training with regards to stormwater management of construction personnel must be undertaken as part of their induction.

5.5. Operational Phase Storm Water Management

- Training with regards to stormwater management of site personnel must be undertaken as part of their induction. Refreshment training must be undertaken periodically.

- Regular conditional inspections of all storm water infrastructure are required. Inspection data must be recorded and accumulated for tracking purposes. Regular reporting should be a scheduled management task.

- Any item that may be found to be out of order, for instance accumulation of settled sand in a trench, or erosion, must be addressed and corrected without delay to keep the storm water system in a good and fully functional condition. Record must be kept on all repairs.

- Specific attention must be given to inspection during and after any rain and/or flood event to kerb any damage that may occur.

- If any structures (for instance access roads of transmission lines) have to be erected in the 1:100-year flood line zones, Water Use Licencing is compulsory (in terms of section 21(c)) of the National Water Act. Any such licence will contain various conditions about monitoring, maintenance, repair and reporting that must be complied with. It is essential to make this a key responsibility of the relevant manager.

6. Way Forward

Prior to the detailed design stage and implementation, a physical high resolution topographical survey needs to be conducted. Based on this the development site drainage needs to be designed on this elevation basis, with the full consideration of the final infrastructure layout on site. The final infrastructural layout and drainage design mutually impact on each other and will therefore be an iterative process.

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