STORMWATER MANAGEMENT PLAN: PROPOSED MAKGANYANE IRON ORE MINE

Tsantsabane Municipality, Northern Cape, South Africa

10/07/2025

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Report Name	**STORMWATER MANAGEMENT PLAN: PROPOSED MAKGANYANE IRON ORE MINE**
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Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

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1 Introduction

1.1 Background

The Biodiversity Company was commissioned to conduct a Stormwater Management Plan (SWMP) for the proposed Makganyane Iron Ore Mine. The project comprises of 1549 ha and is located on Portion 2 (A Portion of Portion 1), Remainder Portion, Remainder Portion of Portion 1 and Portion 3 of the Farm Makganyene No 667, approximately 24 km north-west of Postmasburg in the Tsantsabane Municipality, Northern Cape (Figure 1-1).

The objective of the SWMP is to limit any potential impacts of the proposed mine and associated activities on the surface water resources. The National Water Act (Act No. 36 of 1998) was used as the guidance document to meet this objective.

The preamble to the NWA recognises that the ultimate aim of water resource management is to achieve sustainable use of water for the benefit of all users and that the protection of the quality water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users. The purpose of the Act is stated, in Section 2 as, inter alia:

- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Protecting aquatic and associated ecosystems and their biological diversity;
- Reducing and preventing pollution and degradation of water resources; and
- Meeting international obligations.

The NWA presents strategies to facilitate sound management of water resources, provides for the protection of water resources, and regulates use of water by means of Catchment Management Agencies, Water User Associations, Advisory Committees and International Water Management.

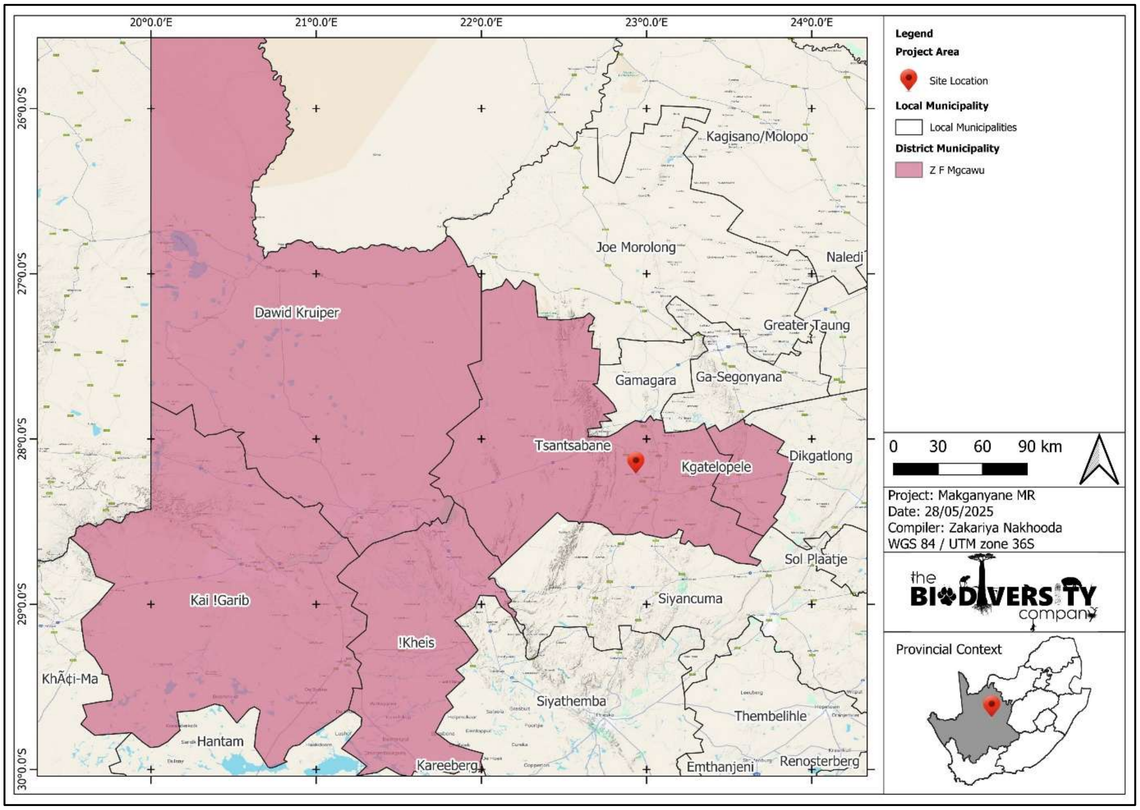

Figure 1-1 Locality Setting

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable:

- It is assumed that all information received from the client is relevant and correct;
- The project description was based on information provided by the client, and any alterations to the area and/or missing data pertaining to the development would have affected the area surveyed and hence the results of this assessment;
- Contour data was provided by the client was utilised;
- The results of this study were largely based on the outcomes of a standardised hydrological assessment and historic information of the catchment;
- The stormwater infrastructure presented should only be used for indicative and environmental planning purposes, and not for detailed engineering designs, unless signed off by a suitably qualified and registered engineer;
- It has been assumed that all runoff from within the Pit areas will flow towards the lowest point within the Pits towards a sump;
- The design capacity of the Pit sump/s takes cognisance of surface runoff and decant, with the larger volume being utilised (surface runoff) as the assumption made is that the sump/s would be kept as empty;
- Sizing of only the proposed retention facilities was undertaken as part of this exercise; and
- Data presented in the hydrological model attempts to represent current catchment conditions, for which the most recently available climate data as well as Google Earth satellite imagery was utilised.

2 Project Description

The project description was taken from the Final Scoping report compiled by Greenmined Environmental (Pty) Ltd (2025).

The Applicant, Assmang (Pty) Ltd, applied for a mining right (MR), environmental authorisation (EA), and waste licence (WL) to mine Hematite, Magnetite, Goethite, Limonite, Siderite, Pyrolusite, Psilomelane, Rhodochrosite, Manganite, Braunite, Hausmannite, Manganese ore, Iron ore, and Diamonds (general) from 1 549.61 ha that extends over Portion 2 (portion of Portion 1), Remainder Portion, Remainder Portion of Portion 1 and Portion 3 of the farm Makganyene No 667 in the Tsantsabane Local Municipality of the Northern Cape (Figure 2-1).

Should the relevant authorisations be granted, and the project proceeds the principal mining activities will entail the following:

- Site establishment and infrastructure development;
- Strip and stockpile of topsoil and overburden to access the ore (excavation);
- Opencast mining (including drilling and blasting);
- Transport, stockpile and crushing of run of mine ore (RoM);
- Transport of crushed ore to Beeshoek Mine; and
- Slope, landscape and rehabilitate the affected areas upon closure of the mine.

The preliminary layout of the mining area (Figure 6) is expected to include at least the following:

- Internal roads;
- Office complex (±1 ha):
    - Ablution facilities,
    - Diesel depot,
    - Equipment workshop,
    - Office containers,
    - Parking area,
    - Planning / meeting site rooms,
    - Security access control,
    - Water reservoir,
    - Wash bays.
- Stockpile Area (±15 ha):
    - Crushing plant,
    - Weigh bridge and Operations Hut,
- Excavations (±36 ha):
    - Pit 1
    - Pit 2
- Waste rock dump (±64 ha);
- Water storage dam/s (for dewatering of the pits).

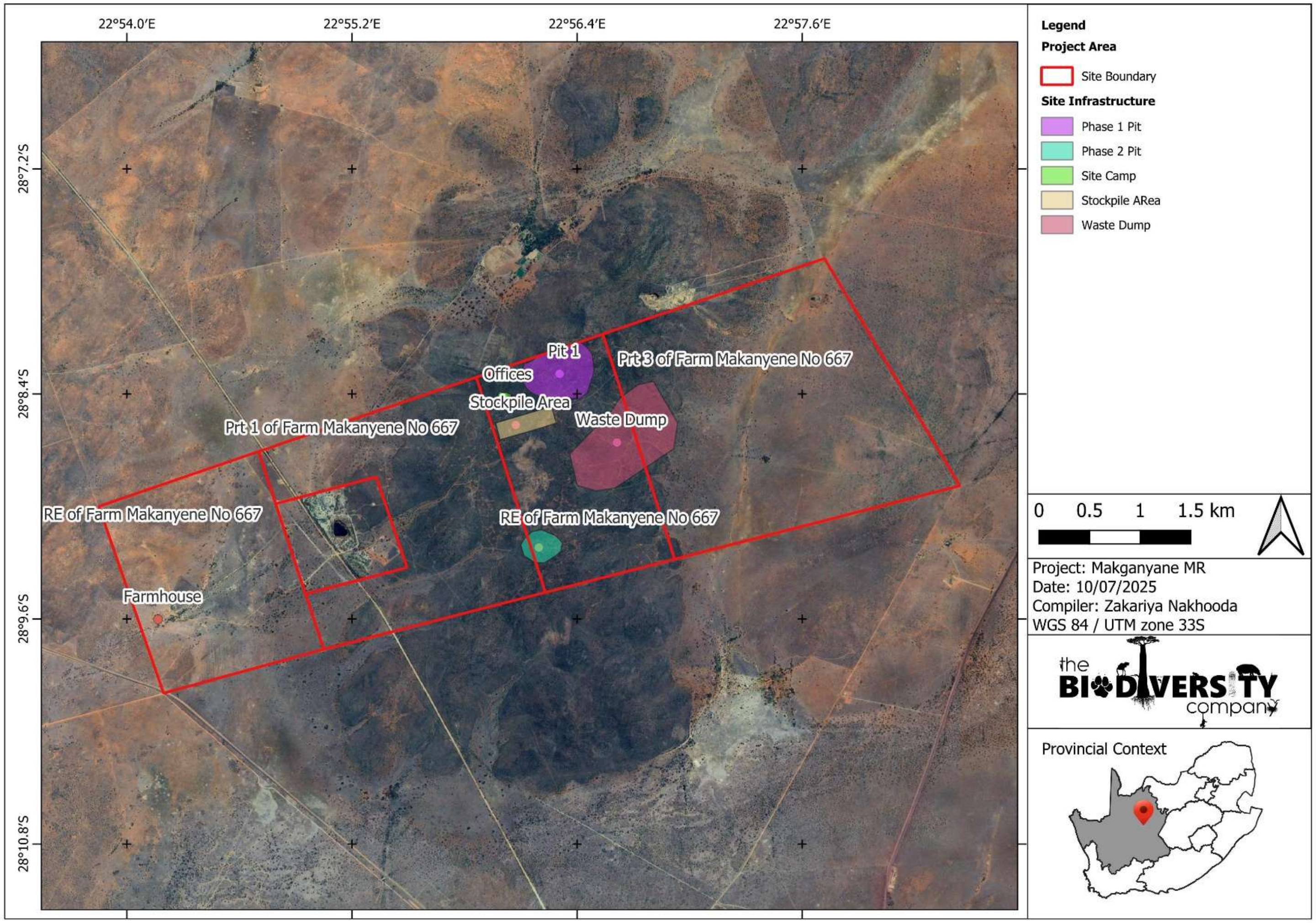

Figure 2-1 Site Setting

3 Methodology

The objective of the SWMP is to prevent contamination of receiving watercourses from 'dirty' surface water runoff generated at the site, through the appropriate separation and/or containment of 'clean' and 'dirty' storm water. The following scope of work was conducted as part of the assessment:

- Desktop Review;
- Site Walkover;
- Conceptual Storm Water Management Planning, and
- Numerical Modelling.

These aspects are elaborated on further in the sections that follow.

3.1 Desktop Review

A conceptual understanding of the sites was developed which involved the identification of potential clean areas and their isolation from likely dirty areas. The development of the SWMP considered the following guidelines:

- Department of Water and Sanitation (DWS) Government Notice No.704 (GN704) (June 1999). The two main principal conditions of GN 704 applicable to this project are:
    - Regulation 4 – Describes the restriction on the locality of infrastructure or mining related activities. The infrastructure or mining related activities should be located outside the 1:100-year floodline extent or a 100m horizontal distance from a watercourse;
    - Regulation 6 - describes the capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained, and operated to ensure the conveyance of flows of a 1:50-year recurrence event. Clean and dirty water systems should not spill into each other more frequently than once in 50 years. Any dirty water dam should have a minimum freeboard of 0.8m above the full supply level.
    - Regulation 7 - describes the measures which must be taken to protect water resources. All dirty water or substances that may cause pollution should be prevented from entering a water resource (by spillage, seepage, erosion, etc.), and ensure that water used in any process is recycled as far as practicable.
- DWAF (now DWS) Best Practice Guidelines (BPGs):
- BPG G1 – Storm Water Management (August 2006); and
- BPG A4 – Pollution Control Dams (August 2007).

These documents support Section 26 of the National Water Act (Act No. 36 of 1998), which regulates any activity that may have an impact on a water resource, and the conservation and protection of this water resource. The main principles adopted in these documents include:

- Confine or divert any unpolluted water to a 'clean' water system, and polluted water to a 'dirty' water system.
- 'Clean' and 'dirty' water systems should be designed and constructed to prevent cross-contamination between the 'clean' and 'dirty' water systems.
- 'Clean' and 'dirty' water systems should contain the 1:50-year storm event and should not lie within the 1:100-year flood line or within a horizontal distance of 100m from any watercourse.

- Any dam or tailings dam that forms part of a "dirty" water system should have a minimum freeboard of 0.8m above full supply level; and
- Appropriate maintenance and management of storm water related infrastructure should be undertaken.

This document defines the allowable Pollution Control Dam (PCD) spillage frequency as being a spill every 50 years on average. This is equivalent to stating that a PCD should be designed such that there is less than a 1 in 50 chance of a spill occurring in any given year.

3.2 Site Walkover

A site walkover was undertaken on the 2nd April 2025 to ground-truth the conditions at the site and confirm the information gathered during the desktop review. The various aspects of the site and surrounding areas were analysed, such as the site layout, site infrastructure, water practices, drainage patterns, land use, land cover and soils.

3.3 Conceptual SWMP

Based on the information gathered during the desktop review and site walkover, a conceptual SWMP was developed for the site. Catchments were discretised based on topographical fall, associated activities and key areas of concern were identified. The discretisation of the catchments factored in existing storm water infrastructure, overall functionality and the most practical and feasible implementation of the final conceptual SWMP.

Based on the discretised catchments, the required storm water management drainage and storage elements (including channels and storage containment areas) were defined to ensure appropriate storm water management according to relevant management principles and best practice guidelines.

3.4 Numerical Modelling

The PCSWMM storm water drainage model was used to size the storm water management infrastructure. PCSWMM is a hydrological rainfall-runoff numerical simulation model suitable for application to both rural and urban environments. PCSWMM can be used to determine the design requirements for various drainage elements, as well as analyse the performance of existing drainage systems. PCSWMM requires a number of input parameters for each of the elements, including:

- Design and daily rainfall.
- Catchment characteristics including catchment area, overland flow length, slope, impervious areas, surface cover and soil characteristics.
- Proposed design characteristics of the drainage infrastructure, including the channels, pipes and dams.

4 Catchment Hydrological Characteristics

4.1 Quaternary Catchment

The site falls within the Quaternary Catchment D73A within the Vaal-Orange Water Management Area (WMA 4) (Figure 4-1) and the Molopo sub-WMA. The typical climatic conditions associated with rainfall and runoff volumes for the quaternary catchment are presented in Table 4-1.

Table 4-1 Quaternary Catchment Information (WRC, 2012)

Quaternary Catchment	QC Area (km^2)	MAP (mm)	MAE (mm)	MAR (mcm1)
D73A	3 238	323	2 450	-

Quaternary Catchment D73A has a Mean Annual Precipitation (MAP) of 323 mm. The monthly rainfall averages for D73A are presented in Table 4-2. The site falls within the D7C Rainfall Zone and the 7A evaporation zone with a Mean Annual Evaporation (MAE) of 2 450 mm. Monthly evaporation averages for D73A are presented in Table 4-3.

Table 4-2 Monthly Rainfall Averages (WRC, 2012)

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
48	56	61	34	16	6	4	6	7	19	27	37

Table 4-3 Monthly Evaporation Averages (WRC, 2012)

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
364	427	460	260	120	43	27	49	53	147	206	281

A comparison between the mean monthly rainfall and evaporation is presented in Figure 4-2. The overall trends indicate greater evaporation than rainfall for all months of the year.

[1] Million Cubic Metres

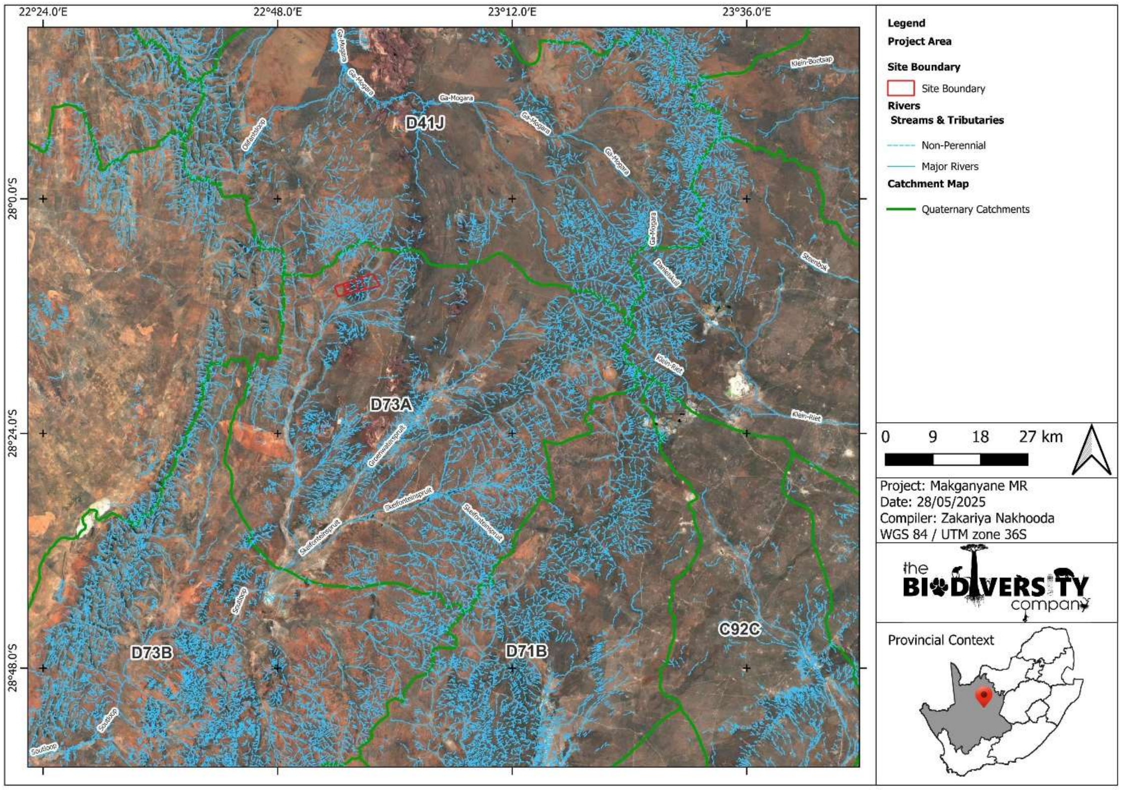

Figure 4-1 Hydrological Setting

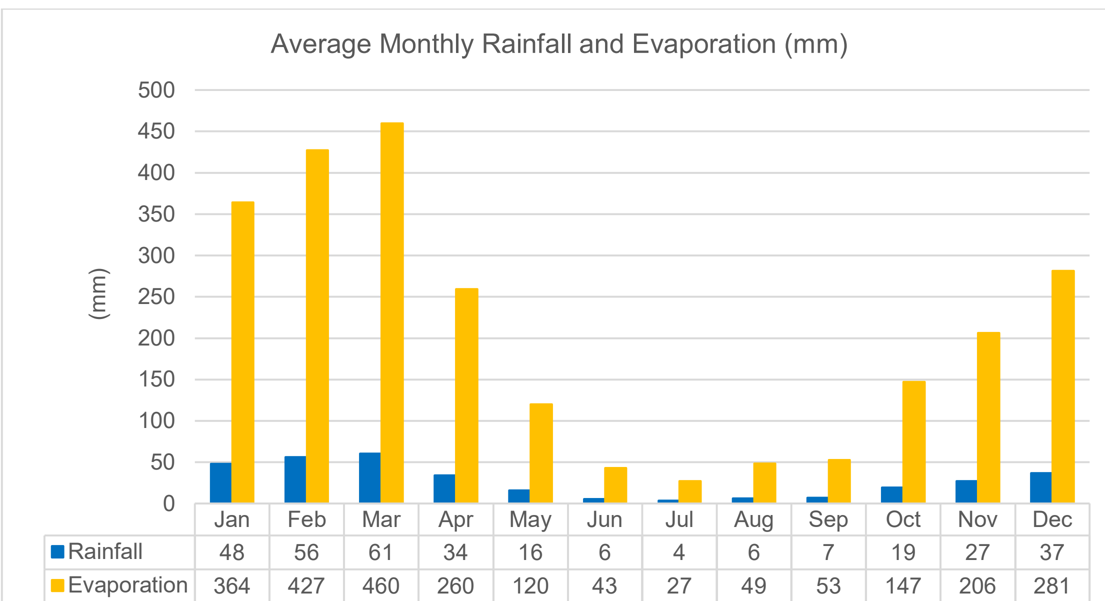

Figure 4-2 Average Monthly Rainfall and Evaporation for QC D73A

4.2 Site Specific Design Rainfall

Design rainfall is a probabilistic representation of rainfall intensity (depth of rainfall over a time period) at a certain location for a given duration and average recurrence interval. The design rainfall depths for the centroid of the site were extracted using the Design Rainfall Estimation software for South Africa (Smithers and Schulze, 2002). The rainfall data utilised to determine the design rainfall depths was extracted from the Rainfall Utility Tool (Table 4-4).

Table 4-4 Rainfall Station Utilised to Determine Design Rainfall Depths

Name	ID	Distance to Site (km)	Record (years)	Altitude (mamsl)	MAP (mm)
Aucampus	0320828_W	12.7	57	1 289	304
Lohatla	0321032_W	16.6	36	1 365	368
Mangore	0321159_W	18.0	34	1 438	377
Postmasburg	0321110_W	23.1	75	1 325	323
Wolhaarkop	0320654_W	28.5	68	1 222	285
Smythe	0356712_W	30.8	86	1 210	337

The output rainfall at each site includes a ninety percent upper, standard and lower bounds for all design rainfall values. For this assessment, the ninety percent upper value (bold value in Table 4-5) was used in the modelling to determine the indicative floodline. The rationale for the use of the upper bound is as follows:

- To consider any potential increases in the rainfall that may occur due to effects of climate change; and
- The type of infrastructure located at the proposed Mine.

The 24-hr design rainfall depths for the different return periods are illustrated in Table 4-5 and the value used is highlighted in **bold**.

Table 4-5 Design Rainfall Depths

Recurrence Interval (years)	1:2-year	1:5-year	1:10-year	1:20-year	1:50-year	1:100-year
Rainfall depth (mm)	55.8	79.0	95.3	111.9	**134.9**	153.2

4.3 Topography and Drainage

4.3.1 Topography

A Digital Elevation Model (DEM) has been created to identify lower lying regions as well as potential convex topographical features which could point towards preferential flow paths. The proposed Mine site ranges from 1 244 in the south-western region to 1 376 meters above sea level within the vicinity of Pit 1, which can be considered the highest point at the site. The lower lying areas (generally represented in dark blue) represent the area that will have the highest potential to be characterised as watercourses (Figure 4-3).

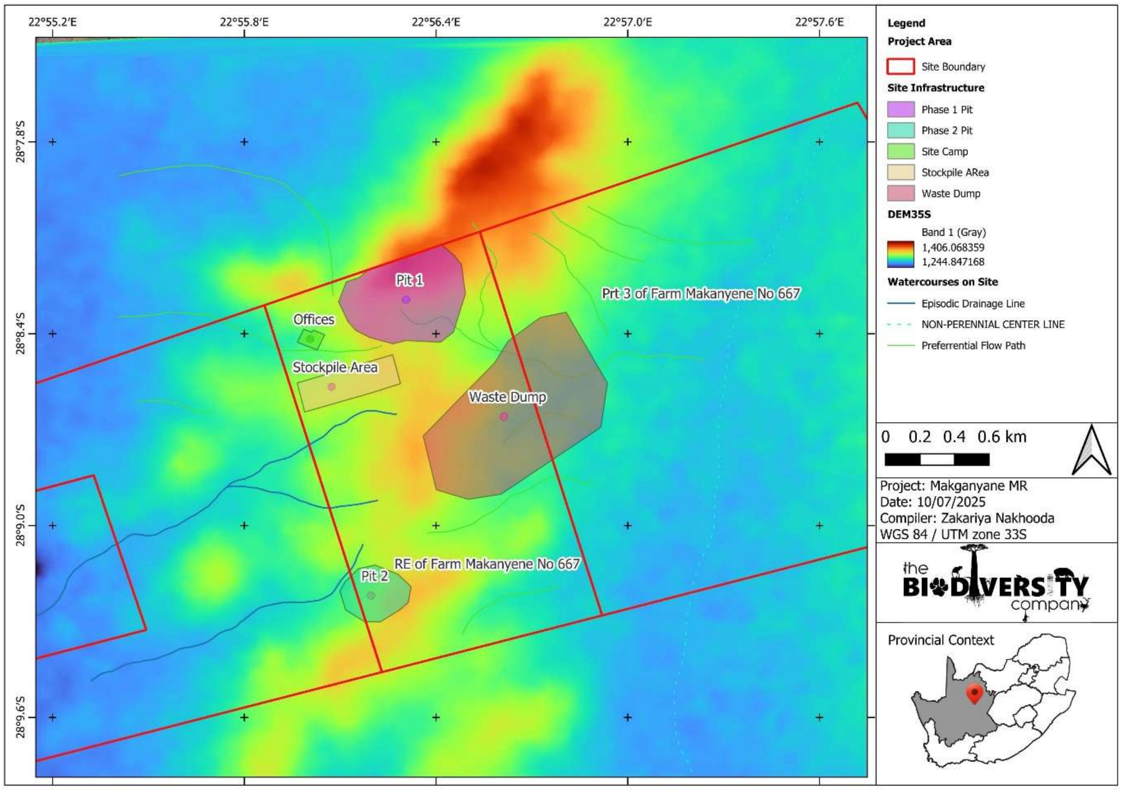

Figure 4-3 Digital Elevation Model

4.3.2 Drainage

The proposed Mine site is drained by a non-perennial tributary located towards the east of the mining area as well as smaller non-perennial drainage lines and preferential flow paths (Figure 3-4 and 3-5). The non-perennial tributary passes through the project area (away from proposed mine workings) in a southerly direction before eventually joining the Soutloop River some 57km downstream. These watercourses are predominantly dry, apart from runoff generated during and immediately after significant rainfall events.

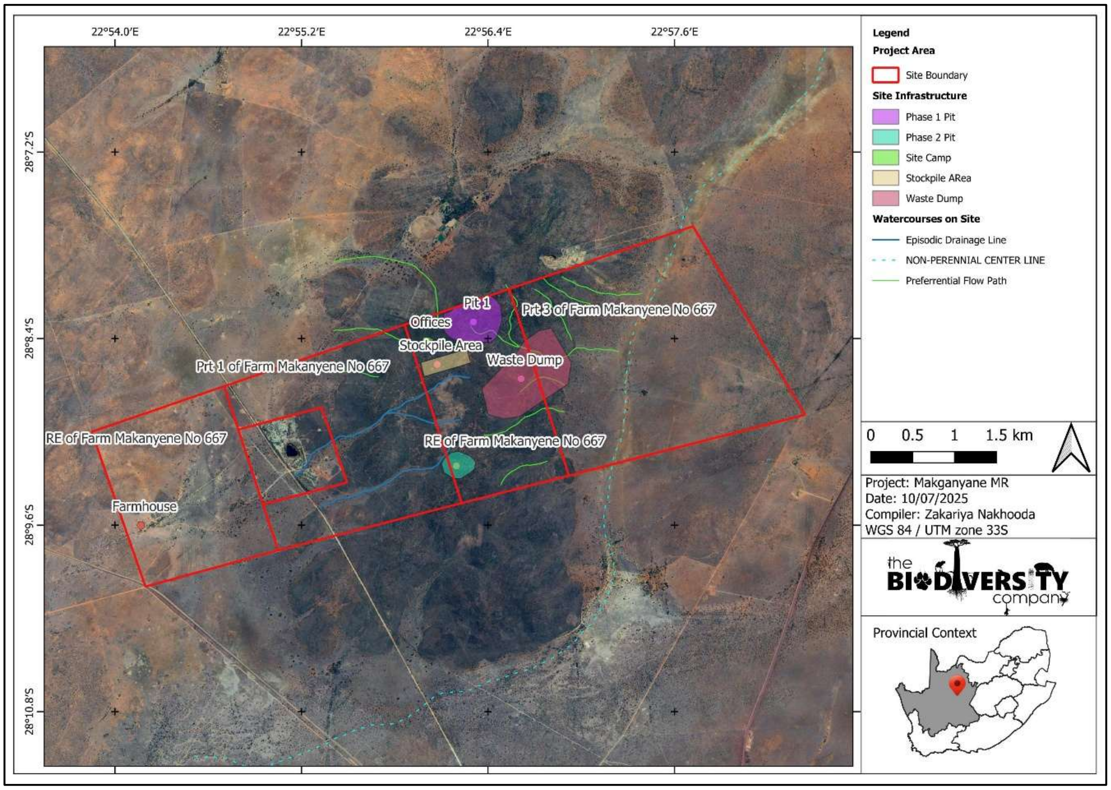

Figure 4-4 Drainage Setting of the Proposed Mine Site

5 Site Assessment

A site visit was undertaken by TBC in April 2025 to assess the current stormwater infrastructure at the site as well as any potential impacts to the surrounding watercourses, and identify potential risks that may result from the proposed Mine. Images of the assessed sites together with a description is provide in Table 5-1.

Table 5-1 Photos of the Sites Assessed (April 2025)

Plate 1: Stockpile Area – The area lies on relatively flat terrain with the surface water draining towards the preferential flow path located along the northern boundary as show on Figure 4-4.


Plate 2: Pit 1- The Pit 1 site is located on the slope of a hill as can be seen above. The Pit 1 area naturally drains towards the preferential flow path as show on Figure 4-4.


Plate 3: Waste Dump - The area lies on relatively flat terrain with elevation increasing towards the east. The surface water draining towards the preferential flow paths located along the northern boundary and within the area as show on Figure 4-4.


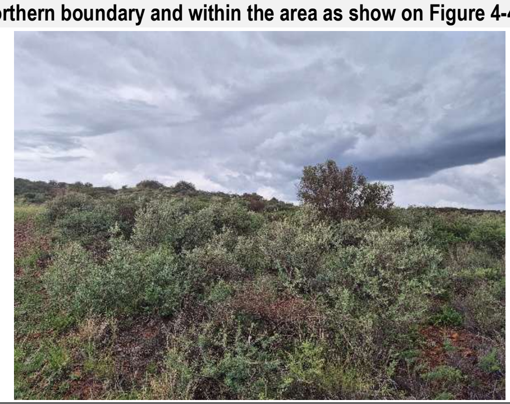

Plate 4: Pit 2 - The Pit 2 site is located on the slope of a hill as can be seen above. The Pit 2 area naturally drains towards the Episodic Drainage Line as show on Figure 4-4.

Plate 5: Image of the Episodic Drainage Line located within the site

6 Stormwater Management Plan

6.1 Topography and Site Layout

The site layout used in the numerical modelling was obtained from aerial imagery and verified during the site walkover. Contour data was provided by the client (Figure 4-3) and was used to define the current topographical surface of the site as well as delineate the clean and dirty contributing catchment areas.

A conceptual SWMP is presented in (Figure 6-1). It should be noted that the majority of the site is considered clean as there are no mining works anticipated, apart from the areas identified in Figure 6-1. The area between the Pit 1 and Waste Dump was included for modelling purposes so as to separate clean and dirty water in line with GN704 Regulations.

A moderately dirty area was added as this area is anticipated for the passing of vehicles required for the mining operations. There may be spillages off the back of trucks, mining residue and dust during transport of rock waste.

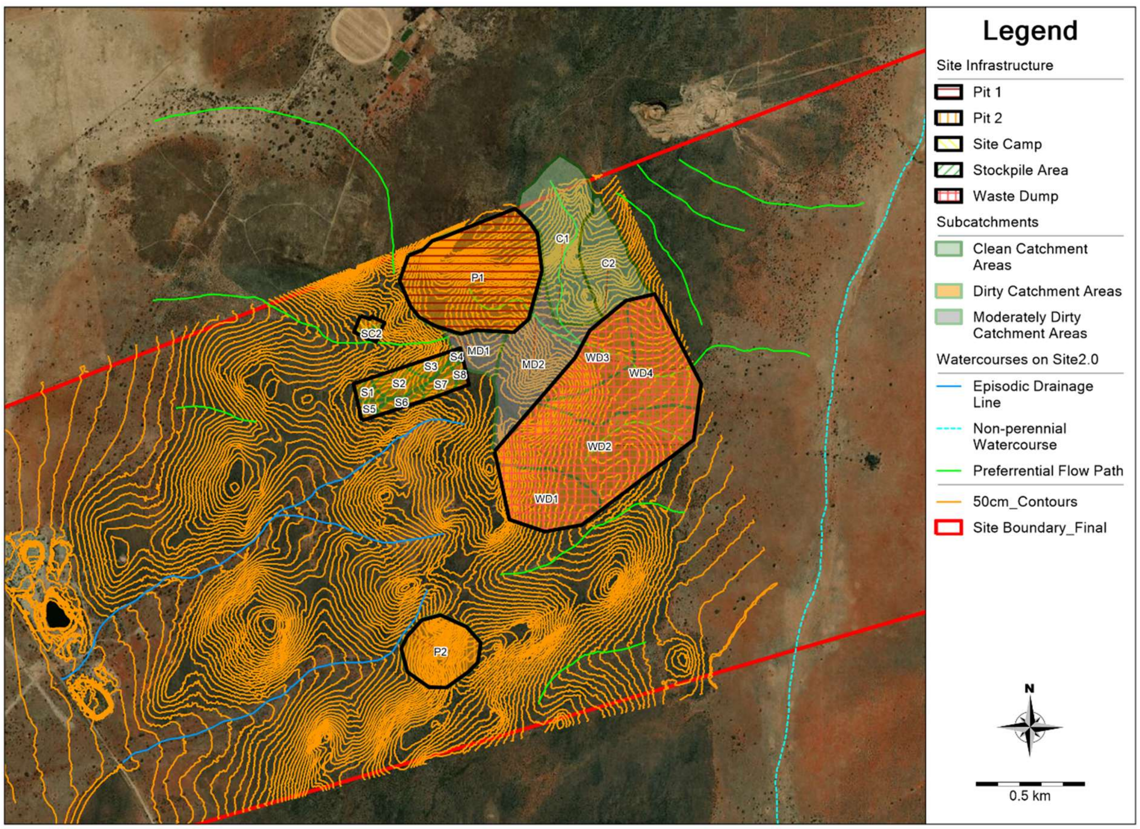

Figure 6-1 Delineated Catchment Areas

7 Numerical Modelling

To determine the required sizing of the storm water management infrastructure, storm event modelling using the PCSWMM model was undertaken. The numerical modelling was based on the proposed infrastructure and layout of the operations (Figure 7-1). The results of each infrastructure component are elaborated on in the sections that follow.

7.1 Design Rainfall

The design rainfall was fitted to the SCS-SA Type 3 rainfall distribution and applied to the site to determine the peak flow and volume reporting to the various infrastructure. The rainfall distribution graph is shown below (Figure 7-2):

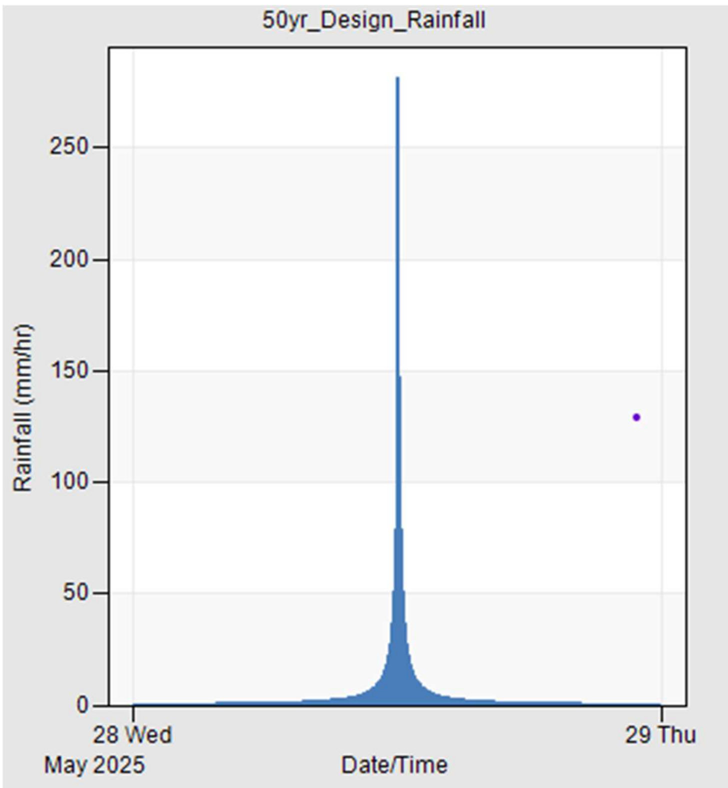

Figure 7-1 Rainfall Distribution for the Site

The 1:50-year design rainfall was fitted to the above distribution and used within the PCSWMM model.

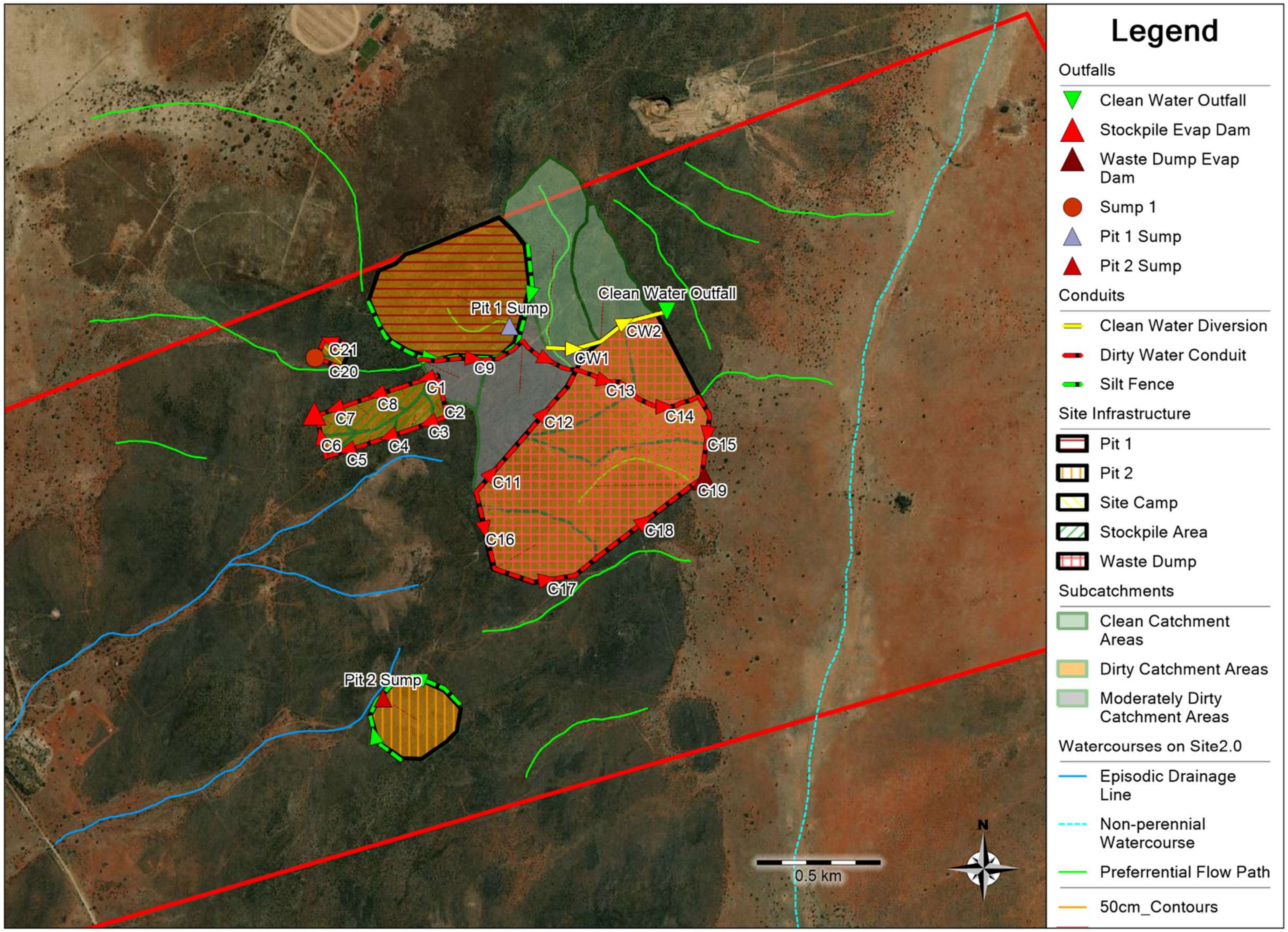

Figure 7-2 Conceptual SWMP

7.2 Modelling Outputs

The 1:50-year flood events were routed through the site to determine the flow rates and flow volumes generated from each of the catchment areas, together with the flow rates and flow volumes reporting to the channels and proposed containment facilities. The results are shown in Table 7-1 to Table 7-3 below.

Table 7-1 Sub-Catchment Results

Catchment ID	Area (ha)	Slope (%)	Runoff Volume (ML)	Peak Runoff (m^3/s)
		Clean Catchment Areas		
C1	16.4322	9.001	13.67	10.24
C2	9.2951	9.848	7.74	5.91
		Moderately Dirty Areas		
MD1	3.704	6.703	3.03	1.82
MD2	14.5145	8.763	11.63	5.72
		Pits		
P1	27.56224	12.993	25.1	15.93
P2	8.982619	14.432	8.24	5.71
		Stockpile Area		
S1	0.9823	7.929	1.33	0.77
S2	2.3796	8.492	3.21	1.85
S3	1.2965	10.484	1.75	1.01
S4	0.2986	2.841	0.4	0.23
S5	0.7328	5.723	0.99	0.57
S6	1.1395	6.892	1.54	0.88
S7	1.4268	6.626	1.93	1.11
S8	0.6886	4.376	0.93	0.53
		Site Camp Area		
SC1	0.5733	10.631	0.61	0.43
SC2	0.4317	9.484	0.46	0.32
		Waste Dump Area		
WD1	10.1515	9.937	9.21	5.61
WD2	24.5951	8.544	22.36	13.89
WD3	8.4765	8.638	7.73	5.03
WD4	17.164	7.039	15.63	9.93

Table 7-2 Flow Rate and Volumes Reporting to the Containment Facilities

Description	Avg. Flow (m^3/s)	Max. Flow (m^3/s)	Total Flow (ML)	Total Flow (m^3/s)
Clean Water Outfall	0.628	5.23	15.254	15 254
Pit 1 Sump	1.001	15.929	25.093	25 093
Pit 2 Sump	0.33	5.711	8.234	8 234

Stockpile Evap Dam	0.407	6.668	12.057	12 057
Sump 1	0.04	0.731	1.069	1 069
Waste Dump Evap Dam	2.717	35.333	67.723	67 723

Table 7-3 Flow Rate and Volumes Reporting to Each Channel

Name	Length (m)	Slope (m/m)	Max. |Flow| (m³/s)	Max. |Velocity| (m/s)	Contributing Area (ha)
C1	217.774	0.04122	0.141	1.19	0.299
C2	108.117	0.01499	0.085	0.86	0.299
C3	159.836	0.03214	0.604	2.74	0.987
C4	182.275	0.03141	1.676	4.76	2.414
C5	174.532	0.02869	2.508	5.54	3.554
C6	169.351	0.02392	3.028	5.07	4.286
C7	159.673	0.01275	2.912	4.45	3.975
C8	199.945	0.05275	1.122	2.94	1.595
C9	442.453	0.04625	1.011	2.18	18.218
C10	255.477	0.03661	7.096	9.3	18.218
C13	256.076	0.02056	4.81	4.3	18.218
C14	287.209	0.01464	11.461	6.42	26.695
C15	342.089	0.01788	16.512	9.72	43.859
C17	448.12	0.07497	5.484	8.4	10.152
C18	490.075	0.01645	5.276	4.12	10.152
C19	44.689	0.02657	18.799	11.12	34.747
C20	110.528	0.06623	0.315	3.27	0.432
C21	203.638	0.07445	0.422	4.11	0.573
CW1	217.936	0.02171	10.135	6.32	16.432
CW2	259.899	0.00162	5.222	3.68	25.727

A typical example of a channel for consideration is indicated in Figure 7-3.

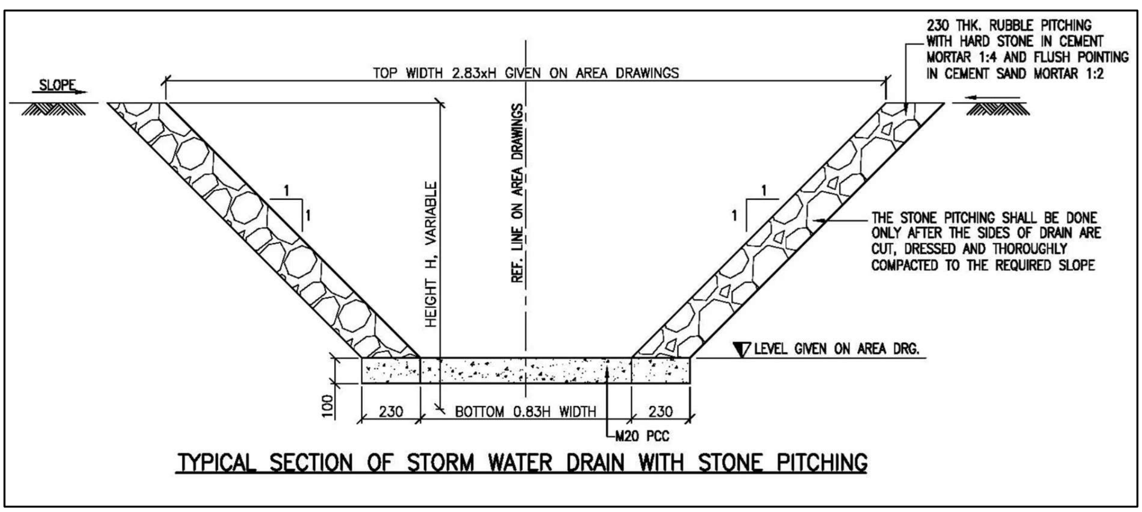

Figure 7-3 Typical Example of a Trapezoidal Channel Cross-section

8 Discussion

The proposed Mine was discretised into a total of sixteen (16) dirty, two (2) moderately dirty and two (2) clean sub-catchments based on the topographical layout of the site. The majority of the site boundary has been considered clean as operations were restricted to a few site-specific areas. These clean areas, with the exception of areas that require diversions were omitted from the SWMP as the natural flow would be away from the proposed operations. The proposed stormwater infrastructure includes the following:

- Dirty Stormwater channels around the Waste Dump, Product Stockpiles and the Office areas (site camp) represented in red on Figure 7-1;
- Two (2) evaporation dams were proposed, with one being located at the Waste Dump and the other at the Stockpile area. These dams were proposed to act as containment facilities for the dirty water emanating from the respective catchment areas. It has been assumed that the runoff from these dams will be utilised across the mining operations, specifically dust suppression;
- Regarding Pit 1 and Pit 2, sumps were proposed for these areas. The location of the sumps would be at the lowest point within the respective Pit. Thes sumps would collect runoff from within the Pits as well as any decant as a result of the mining operations. It is assumed that the sumps within the Pits will be kept as low as possible to cater for any runoff generated during rainfall events. The water contained within these sumps will be utilised across the mining operations, specifically dust suppression. Furthermore, given the nature of the works envisaged within the respective Pits, silt fences have been proposed downgradient of the respective Pits with the aim of reducing sedimentation of the nearby watercourses or drainage lines;
- Dirty stormwater channels were proposed around the Office area diverting runoff towards a Sump with an oil separator. Excess water from the sump can be considered clean after passing through the oil separator and can be allowed to flow away from the site into the nearby drainage line;
- Clean stormwater diversion channels were proposed for the area between Pit 1 and the Waste Dump with the aim of diverting clean water away from operations towards the drainage line located towards the east; and
- The proposed dimensions of the evaporation dams and sumps is at the discretion of the consulting engineer; however it is recommended that the flow volumes presented in Table 7-2 be considered.

9 Recommendations

The management of the proposed stormwater infrastructure is summarised below:

- The proposed containment facilities should be designed to incorporate a 0.8m freeboard;
- The SWMP should be revisited after any major changes to the current operations or design changes;
- It is recommended that stone pitching channels are used to transfer runoff. Stone pitching is recommended to reduce high runoff velocities in channels;
- To prevent clogging of the grated channel covers and maintain channel capacity, best practice and proper housekeeping practices must be ensured;
- All channels must be checked after any major rainfall events to ensure that there are no blockages and that the water flow will not be restricted in any way;
- Sediment that accumulates within channels and retention facilities needs to be removed directly after the storm events and appropriately disposed of to ensure design capacity is maintained; and
- It is recommended that the storm water attenuation facilities be operated empty or at a storage level low enough to accommodate storm water inflows, whilst meeting the required spillage frequency (1:50-year Return Period) and freeboard requirements.