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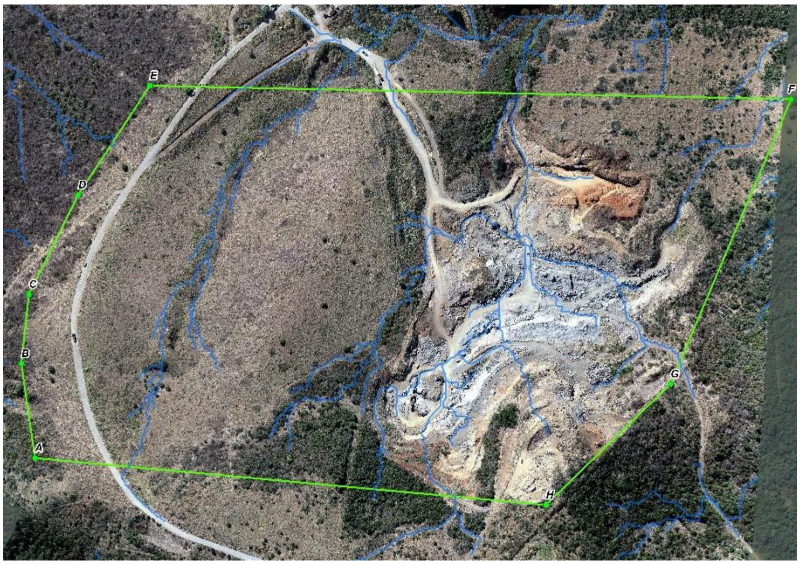
Wansley Siyakhula (Pty) Ltd Mining Rights Area Storm Water Management Plan

Report

Version – 1.3

03 September 2020



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Wansley Siyakhula (Pty) Ltd

3 September 2020

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EXECUTIVE SUMMARY

Spatial Science Solutions was indirectly appointed by Wansley Siyakhula (Pty) Ltd to conduct a surface water assessment focussed on the impacts of the extension of the mining rights area and blasting practices at their Wansley Siyakhula (Pty) Ltd mining plant in the Eastern Cape Province of South Africa, situated approximately 10km North-East of the town of East London on portion 1 of the Farm 652 registrational district East London.

The climate data used in this study were obtained from the WR2012 database (WRC Surface Water Resources of South Africa). In addition, the 24-hour peak rainfall depths, for various return periods were obtained using the Design Rainfall Estimation software (Smithers, 2002).

The National Environmental Management Water Act (NEMWA) classifies wastes from the dolerite mining industry as general waste. General waste is defined as waste that does not pose an immediate hazard or threat to health or to the environment (NEMWA, 2014). Therefore, it can be concluded that the extended mining area can be unlined.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMINOLOGY

Berm: A wall designed and constructed to change the direction of a natural surface water flow path.

Catchment: That area from which any surface runoff will naturally drain to a specified point.

Clean water: Natural runoff water from a catchment area that has not been contaminated through contact with known pollutants.

Dirty water: Water that has been, or could potentially become, contaminated through contact with known pollutants.

Dirty water system: Any systems designed to collect, convey, contain, store or dispose of dirty water.

Drainage channel: An artificial flow path designed to convey water.

Hydrology: The study of natural water cycles that include rainfall, evaporation and transpiration and resulting surface flows.

Mean Annual Runoff (MAR): The average amount of water running over the land surface during a given year.

WRSM: Water Resources Simulation Model

Stormwater dam (SWD): Storage dams designed to prevent environmental pollution by containing and storing storm water runoff for safe disposal through evaporation or by any other environmentally responsible process.

Process Water Dam (PWD): Specialised storage dams designed to store water for operational and process purposes.

Runoff: Water that falls as rainfall and is not lost through evaporation, transpiration or deep percolation into the ground. This water either does not penetrate soils but flows directly across the soil surface, or re-emerges from local soils to flow on the surface along natural flow paths or watercourses.

Watercourse: Watercourse refers to a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which water flows and any collection of water which the Minister may by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its beds and banks (National Water Act 1998 (Act 36 of 1998)).

1 INTRODUCTION

Spatial Science Solutions was appointed by Wansley Siyakhula (Pty) Ltd to conduct a surface water assessment that focusses on the Storm Water Management Plan (SWMP) to support of the proposed extension of the open pit dolerite mining area. The Wansley Siyakhula (Pty) Ltd mine is situated in the Eastern Cape Province of South Africa, situated approximately 10km North-East of the town of East London on portion 1 of the Farm 652 registrational district East London

The Wansley Siyakhula (Pty) Ltd project area is at an average altitude of approximately 130m and located in the Albany Coastal Belt region. The Mean Annual Precipitation (MAP) is estimated at 782 mm, while Mean Annual Symons Pan Evaporation (MAE) of 1362 mm is expected.

The existing Mining area covers 5.2149 ha and it is proposed that this area be expanded by a further 32.6426 ha to a total surface area of 37.8575 ha.

2 METHODOLOGY

The study is based on a desktop assessment of the hydrology of area of interest and study of previous reports, data and literature pertaining to the area.

All the data was sourced and the site accessed using remotely sensed data and data obtained from the client.

Runoff from catchments was analysed using accepted techniques to downscale quaternary catchment data. Generally-accepted algorithms and methodologies were used to determine design floods at various points in the area and to estimate flood levels.

Software used in the study includes the following:

- ArcMap 10.4 for Geographic Information Systems (GIS) work and mapping, and
- Results of WRSM as published in WR2012 (Water Resources of South Africa), used for base line runoff data.

Climate data was obtained from the South African Weather Service (SAWS) and/or databases of WR2012. The SWMP was conducted in accordance with the DWA BPG G1: Storm Water Management (National Water Act, 1998 (Act No 36 of 1998), 1999).

3 SITE DESCRIPTION

The Wansley Siyakhula (Pty) Ltd mine is situated at an average altitude of approximately 130 m above mean sea level. The site is situated in a relatively hilly area with the slope varying towards two main drainage lines in an Eastern direction.

Wansley Siyakhula falls within the summer rainfall region and is characterised by mild temperatures the region generally warm and temperate. Rain falls in the form of extended showers. The MAP for the area is 782 mm/year. The winters are associated with less rain but with significant rain. The mine is located in quaternary catchment R30F. Smaller rivers and streams receive only ephemeral flow after significant rainfall events. Two non-perennial streams flow west to east from the site with the catchment being relatively small and contained within the site. The drainage line to the north run through two dams and joins the southern drainage line in a third dam. The flow is then directed to the Quenera river by anon-perennial stream.

The site is covered by grassland on the higher slopes with scattered indigenous trees. Towards the drainage lines larger trees can be found with thick wooded areas in the drainage lines. These wooded areas contain protected indigenous trees such Yellow wood.

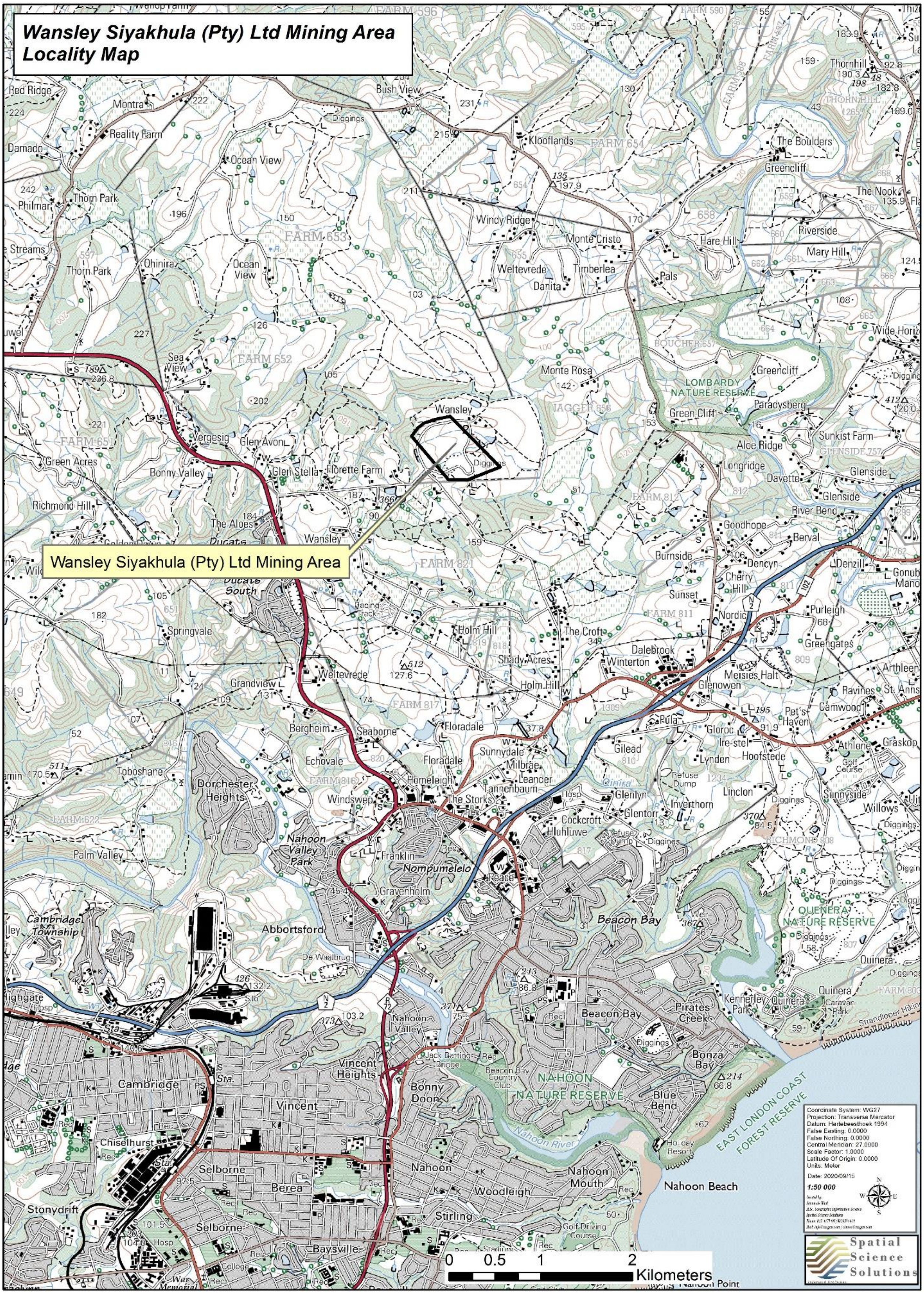

Figure 3.1 Site Locality Map

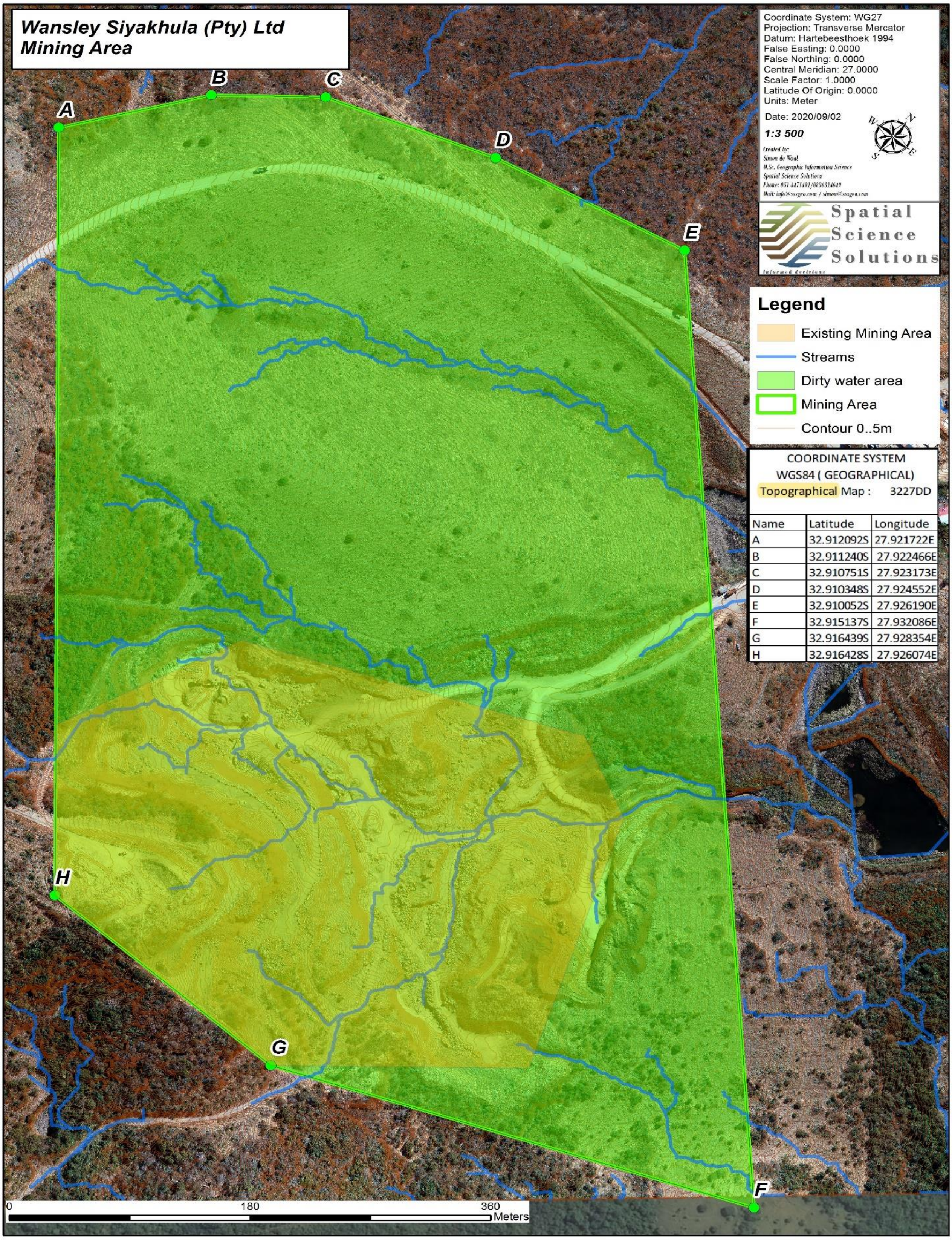

Figure 3.2 Site Map

4 HYDROLOGY

1. MAP and MAE

The climate data used in this study was obtained from the Water Resources of South Africa, 2012 Study (WR2012), and Water Research Commission Report. The MAP calculated for this area is 782mm while the MAE is 1362 mm. Figure 4.1 Mean Annual Rainfall in mm/month

Month	Rainfall (mm)
Oct	83.85283
Nov	101.0941
Dec	82.17188
Jan	90.15638
Feb	86.07892
Mar	103.1418
Apr	61.85866
May	36.21352
Jun	23.33786
Jul	30.1928
Aug	41.56953
Sep	62.20395

Figure 4.1 Mean Annual Rainfall

2. Peak Rainfall

The 24-hour peak rainfall depths were obtained for the site in order to calculate the design flood peaks. These values were obtained using the Design Rainfall Estimation software (Smithers, 2000). This software analyses gauged rain data in South Africa and tabulates peak rainfall depths for various storm durations and return periods. The closest reliable rainfall station to the Wansley Siyakhula mining area is the East London station, which has rainfall and evaporation data records from 1920 to 2009. The 5min to 24-hour design rainfall depths used are shown in Table 4.2:

Duratio	Return Period (years)																	
m/h/d)	2	2L	2U	5	5L	5U	10	10L	10U	20	20L	20U	50	50L	50U	100	100L	100U
5 m	5.7	3.6	7.8	8.4	5.3	11.6	10.6	6.6	14.5	12.8	8	17.7	16.2	10.1	22.6	19.1	11.8	26.8
30 m	17.7	14.6	20.7	26.1	21.5	30.6	32.7	26.9	38.3	39.7	32.6	46.8	50.3	40.9	59.6	59.2	48	70.7
1 h	25.1	21.9	28.3	37.2	32.4	41.8	46.5	40.4	52.3	56.5	49	63.9	71.5	61.5	81.4	84.3	72.1	96.6
2 h	35.8	32.9	38.6	52.9	48.7	57.1	66.1	60.8	71.4	80.4	73.7	87.2	101.7	92.4	111.1	119.8	108.4	131.8
6 h	56.6	49.4	63.7	83.7	73.1	94.2	104.7	91.3	117.8	127.3	110.6	143.9	161	138.8	183.4	189.7	162.8	217.5
10 h	70.1	59.7	80.4	103.6	88.3	118.9	129.6	110.2	148.7	157.7	133.6	181.7	199.3	167.6	231.5	235	196.6	274.5
24 h	101	82.5	119.9	149.5	122	177.2	187	152.4	221.6	227.4	184.7	270.8	287.5	231.7	345	338.9	271.8	409.1

Table 4.1 Design Rainfall Values

3. Mean Annual Runoff (MAR)

The runoff data for the quaternary catchment R3A was extracted from the WR2012 database. The calculated MAR (for rivers in the region) can be seen in Figure 4.2.

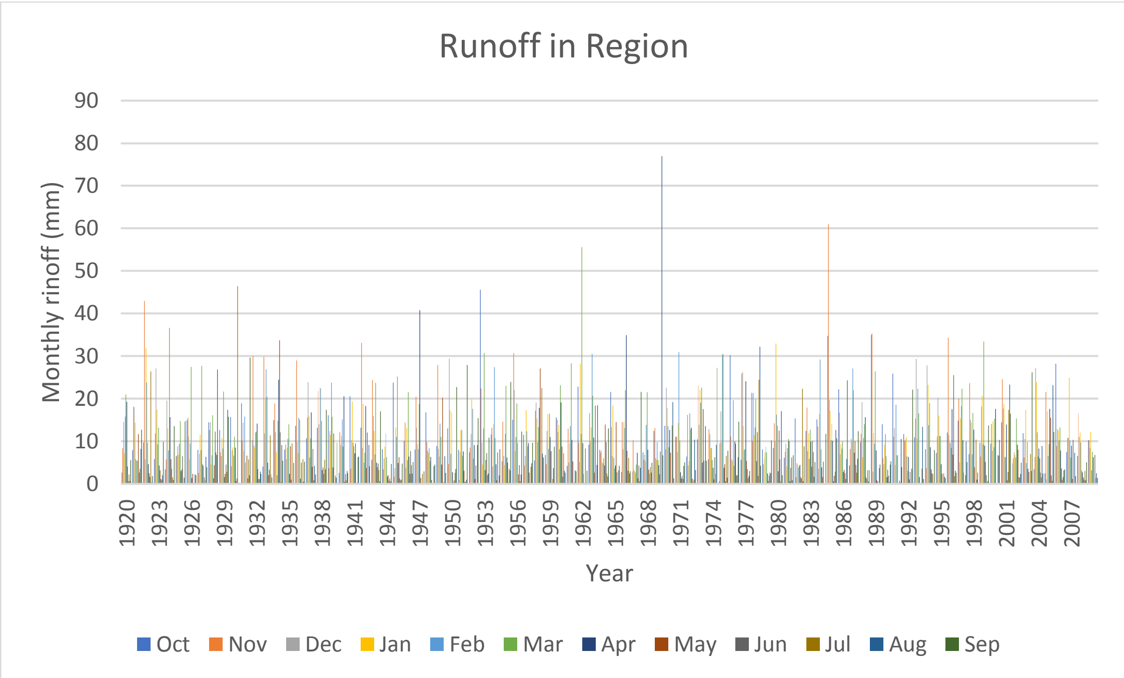

Figure 4.2 Runoff in Regional Rivers

This indicates an MAR equivalent to 113.4 mm of runoff over a wide area. It was, however, considered that on a more local scale, higher values of runoff could be expected.

4. Downstream Water Users

There are significant surface water users downstream of Wansley Siyakhula. This include farming practices and town. Due to the small catchment areas associated with Wansley Siyakhula mining operation there will be no significant effect on downstream water users if dirty water is contained within the mining area. The catchment area for the two drainage lines running through the mining area are 0.141 km^2 and 0.236 km^2 respectively as seen in figure 4.3. There are also no significant water users on the non-perennial river before joining the Quenera River.

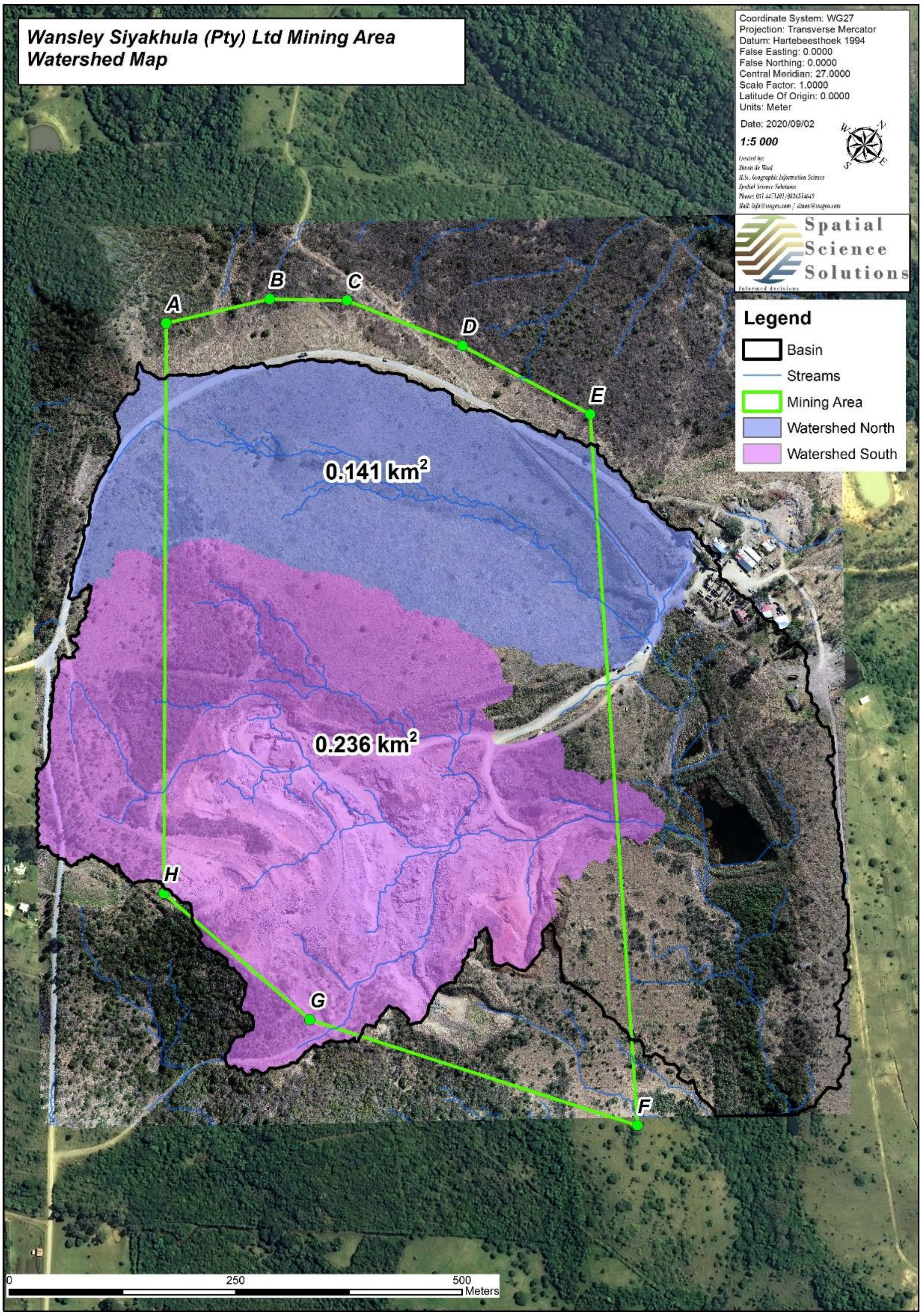

Figure 4.3 Watershed Map

5 CONCEPTUAL STORM WATER MANAGEMENT PLAN

A SWMP is a statutory requirement for mining and related activities in South Africa and is defined by General Notice 704 and Regulation 77 of the National Water Act (Act 36 of 1988). No water use licences in terms of this act will be granted without an approved SWMP. The purpose of a SWMP is to prevent the pollution of water resources in and around mining areas, or areas where mining related activity occurs. Regulations define a methodological approach to preventing and/or containing pollution on mining sites, set design standards and specify measures that must be taken to monitor and evaluate the efficacy of pollution control measures that are implemented.

The basic principles of a SWMP include:

- Separation of clean and dirty water - clean water should, as far as possible, be kept separate from dirty water. Water from clean water areas should be diverted away from dirty water areas and should be allowed to pass through to downstream users. Dirty water must be contained and captured on site.
- The design standard stipulated by GN704 is not that a 1 in 50-year flood should be captured, but that the dam may not spill more than once every 50 years. Design storage volumes are a function of peak storage requirements that often correspond to abnormally wet conditions that continue for an extended period of time, and not to a specific flood event.
- Containment of dirty water - reasonable measures must be taken to ensure that dirty water is contained. All dirty water must be captured and transported in lined channels (capable of containing 1:50-year design floods) to prevent the seepage of contaminated water into groundwater resources. Dirty water runoff must be stored in a dirty water dam, where reasonable precautions are taken to prevent leaks or seepage.
- Reuse and recycling of dirty water - regulations stipulate a clear hierarchy of water use. Firstly, recycle any captured dirty water and minimise the import and use of clean water resources. Excess water released from a dirty water area must be treated to a standard agreed to by the regulator, Department of Water Affairs (DWA), and any plan to treat and release excess water must be approved and licensed.
- Preventing the pollution of water resources - exposure between water and potential pollutants should be reduced to a minimum. Special precautions may be required to

prevent the transport of pollutants in water. Oil traps should be specified below workshops, fuel depots and vehicle wash-bays to prevent the flow of hydrocarbons into dirty water dams. Silt traps may be constructed where surface runoff is likely to lead to the transport of suspended sediments and the like.

- Reducing dirty water areas - special attention should be paid to early rehabilitation of mining and other dirty water areas to reduce the dirty water footprint area to an absolute minimum. This will reduce the total volumes of dirty water and simplify the final measures to be taken at mine closure. Part of any SWMP will include processes that identify and implement opportunities to reduce the dirty water footprint areas. A benefit of smaller dirty water footprint areas is that possible polluted runoff is reduced, fewer drains are required and stormwater dams can often be smaller. (Smaller surface area equates to cheaper and more effective storm water management)

1. Concerns and Limitations in Developing a Conceptual SWMP

Potentially polluted runoff from the mining area must (in terms of GN704) be captured and contained in a dirty water dam. This larger mining area will require a larger or additional dirty water dams and storm water management is likely to become both more complex and more expensive.

The National Environmental Management Water Act (NEMWA) classifies wastes from the dolerite mining industry as general waste. General waste is defined as waste that does not pose an immediate hazard or threat to health or to the environment (NEMWA, 2014). Therefore, it can be concluded that the extended mining area can be unlined. Simulations used to compile this report have assumed that no lining is provided within the mining area and that a large proportion of rainfall that infiltrates into the area will seep into underlying soils and not report to the dirty water dams.

2. Simulation of Runoff and Flow from Study Area

In order to predict inflows into the dirty water dams required for the proposed development and simulate storage in the dirty water dams it was necessary to simulate likely flows from different areas where runoff reports to the dirty water dams. These simulations were simplified by defining three categories of runoff area and determining likely runoff or flow from those areas. Simulations are done separately for each of the main drainage Lines using the rational method.

The Rational Method is a hydrological method used to predict peak runoff with the equation being shown below.

$$Q_T = \frac{CIA}{3.6}$$

Where:

QT = Peak Flow (m3/s for specific return period);

C = Runoff Coefficient (%);

I = Rainfall Intensity (mm/hr); and

A = Area (km2).

The runoff coefficient C is based on a number of different physical characteristics of the site. These include the vegetation type and the slope drainage properties of the soil. The percentage of land used for residential or industrial development or under paved roads is also taken into account. The Rational Method is suitable for small catchments and is a method used extensively around the world.

Northern drainage line:

This area will predominantly be part of the mining area. Some rainfall is intercepted and will evaporate off wet surface material, or from temporary ponds that form on the surface. The majority of rainfall will infiltrate into stockpiled material or waste material where water is temporarily stored in voids before seeping into underlying soils or leaching out from the base. The following flow was simulated:

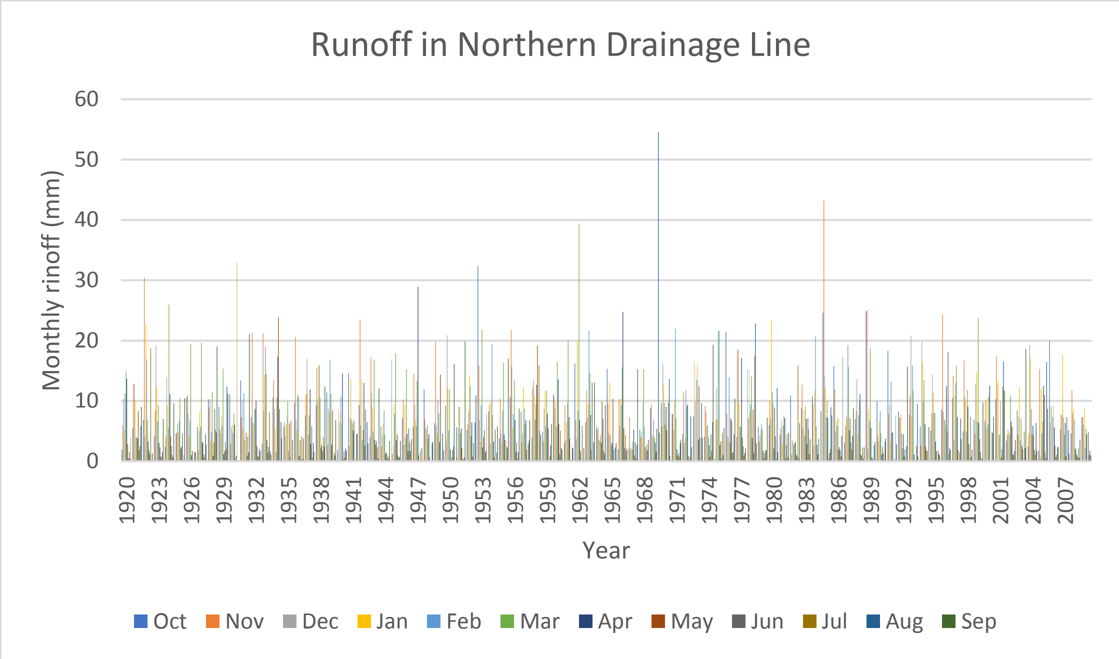

Figure 5.1 Flow from Northern drainage line

Southern drainage line:

This area will predominantly be part of the mining area. Some rainfall is intercepted and will evaporate off wet surface material, or from temporary ponds that form on the surface. The majority of rainfall will infiltrate into stockpiled material or waste material where water is temporarily stored in voids before seeping into underlying soils or leaching out from the base. follows:

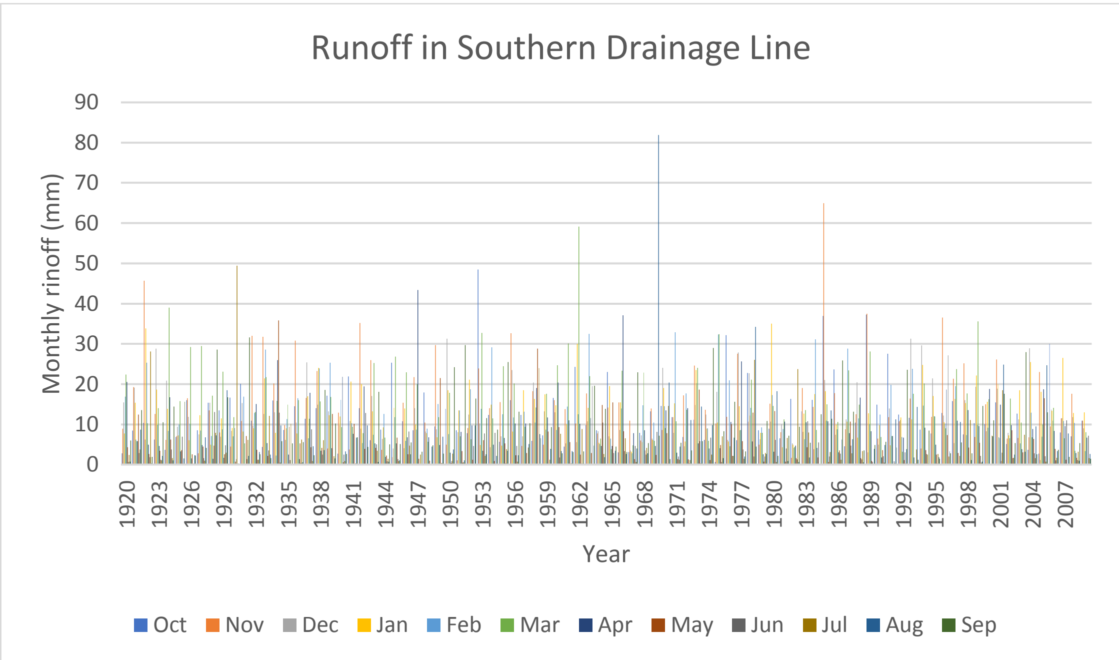

Figure 5.2 Flow from Southern drainage line

Natural Runoff:

Areas exist where runoff is likely to duplicate the runoff expected from natural, undisturbed catchment areas.

3. Delineation of Clean and Dirty Water Catchments

Clean and dirty water areas were mapped out, based on topography and mine infrastructure. The entire mining area was considered to be a dirty area. Runoff from a catchment upstream of the stockpile was considered to be clean, as indicated. All clean water must be diverted around the dirty water areas, as per the GN 704, to ensure that clean water never mixes with dirty water.

4. Storm Water Dam Simulation

The storm water dam must meet GN704 design criteria to be considered as a Stormwater Water Containment Dam. To ensure that the storm water dam in the project area will not spill more than once, on average, in 50 years, an Excel-based simulation was utilised. The basis of this calculation takes a simple hydrological water balance of:

The rainfall and evaporation inputs were obtained from WR2012. Monthly storages were simulated for a period of 91 years, as 91 years of data was available. Withdrawals from the dam that would be used for dust suppression where assumed. Figure 5.3 shows the results of the simulation, which indicates a dirty stormwater dam storage requirement of 4100 m^3. Figure 5.4 shows the results of the simulation, which indicates a dirty stormwater dam storage requirement of 1900 m3.

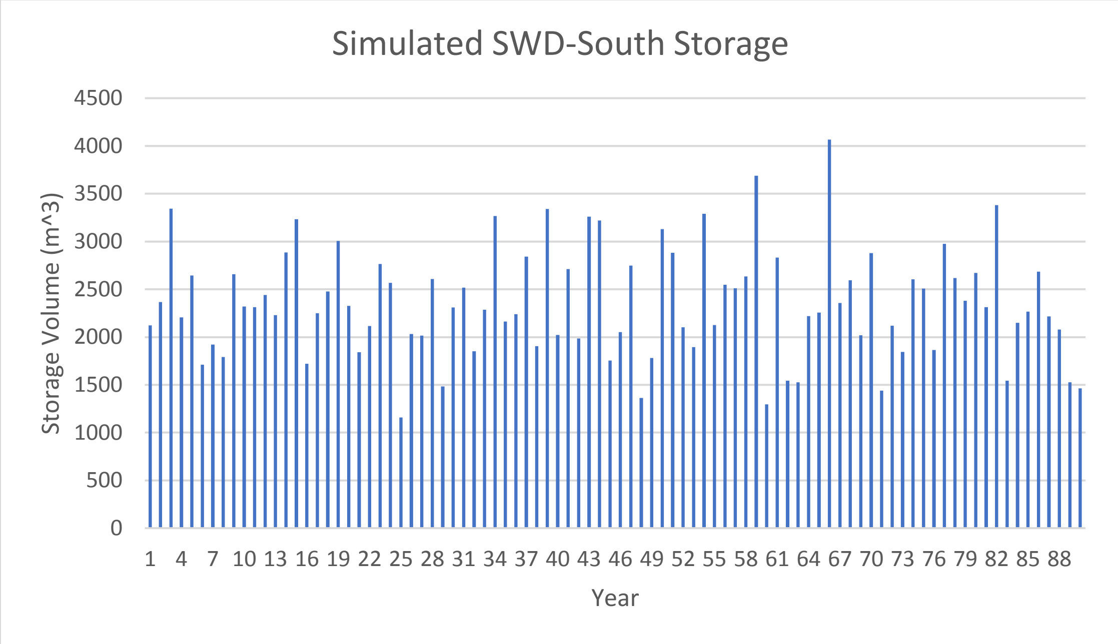

Figure 5.3 Simulated storage capacity for southern SWD.

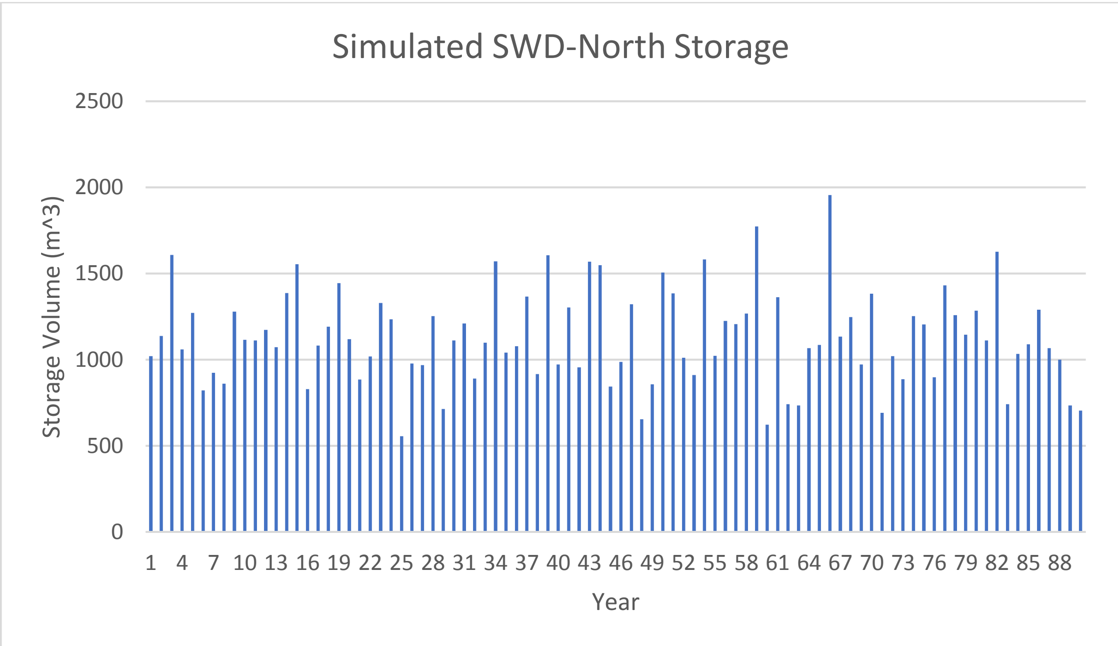

Figure 5.4 Simulated storage capacity for Northern SWD.

5. Flood Runoff

According to GN 704, the design standard is that a 1 in 50-year flood should be captured by on-site dirty water dams, and that the dirty water dams may not spill more often than once in 50 year, on average.

Design storage volumes are a function of peak storage requirements that often correspond to abnormally wet conditions that continue for an extended period of time. The volume of water that seems likely to flow into the storage facility during an extreme flood event is, however significant. These floods report to storm water drainage systems and are directed to the storm water dams. The volume of water contained in the flood hydrograph is estimated at 2610 m^3 and will report to the Southern storm water dam. The estimated volume for the northern drainage line is 1255 m^3 and will report to the Northern storm water dam.

For the southern dam a dam simulation based on simulated monthly inflows indicates the need for a dirty water dam that is capable of storing in the order of 4100 m^3. The total storm water dam storage requirement is estimated as 75% of simulated storage, plus 2610 m^3 that would accommodate the 1:50 year flood. A total storm water dam storage capacity of 5685 m^3 is recommended.

For the northern dam, a dam simulation based on simulated monthly inflows indicates the need for a dirty water dam that is capable of storing in the order of 1900 m^3. The total storm water dam storage requirement is estimated as 75% of simulated storage, plus 1255 m^3 that would accommodate the 1:50 year flood. A total storm water dam storage capacity of 2680 m^3 is recommended.

6. Proposed Storm Water Infrastructure

As per the clean water diversions, dirty water containment systems have been designed to ensure possible dirty water generated on the site is contained. From the Watershed Map (figure 4.3) it can be seen that the mining area basically contain the sub catchment areas where potentially dirty water runoff water is generated. The planned mining sequence from the mine engineer are show in in the figures (figure 8-1, figure 8-2). This will ensure that all contaminated water will be directed towards the two main drainage lines directing water to the valley area of the mine and into the respective storm water dams.

8.0 MINING SEQUENCE

The recommended mining sequence is presented in the schematics shown in Figure 8-1 and Figure 8-2, with the mining direction extending from the southern boundary towards the northern boundary with increasing depth.

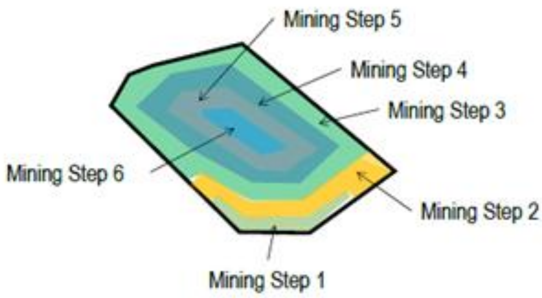

Figure 8-1 Schematic plan showing the recommended mining sequence for Wansley Quarry

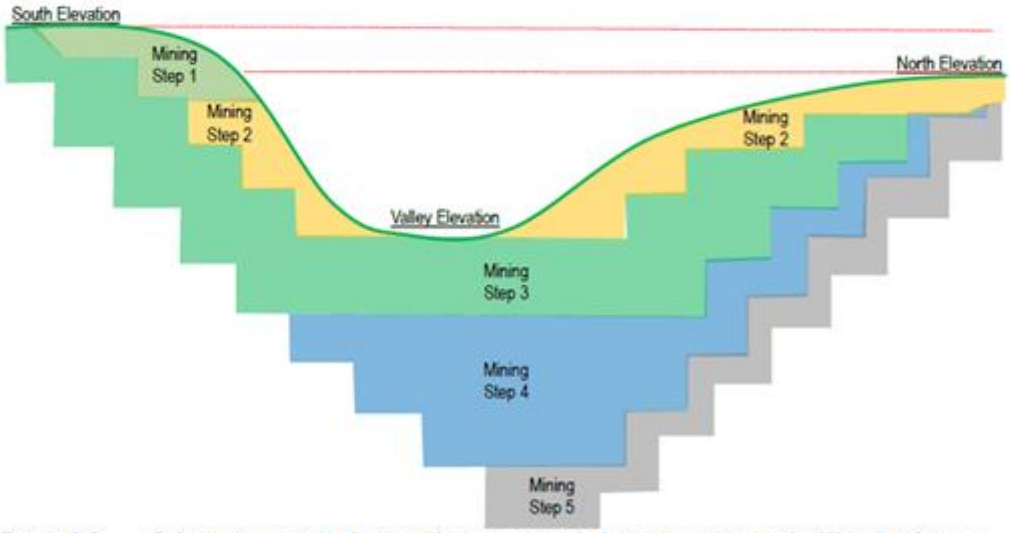

Figure 8-2 Schematic section showing the recommended mining sequence for Wansley Quarry

The main assumption in the storm water diversion layout is that all water generated in the dirty area will be able to drain under gravity, to the area allocated for the storm water containment facility. The proposed works are expected to level out much of the site, while site drainage is expected to facilitate the drainage of all areas into the proposed storm water diversions.

Figure 3.5 represents a typical storm water containment berm and channel. The berm component will be constructed from the material excavated from the channel and supplemented by topsoil stockpiling if required. The side slopes for all berms and channels will be kept constant at 1 vertical: 2 horizontals. The channel component has been sized using Manning's equation for trapezoidal channels to meet the requirements of the 1 in 50-year flood. The collected water should be channelled to neighbouring storm water dam. For clean water the collected water should be channelled to neighbouring clean stream. All berms were standardised to similar dimensions, for conceptual drainage channel sizing see Figure 5.4:

a = Channel Depth

b = Channel base breadth

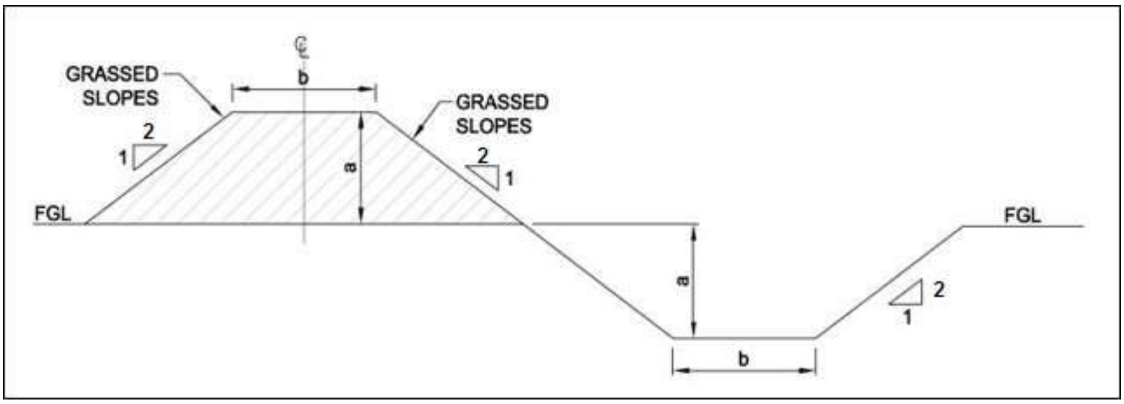

Figure 5.5 Typical berm and channel for storm water systems

Diversion	**a (m)**	**b (m)**	**Average Slope (m/m)**
Dirty Water	1	1.6	0.002

Table 5.1 presents the dimensions for each of the berms and channels associated with the dirty water area.

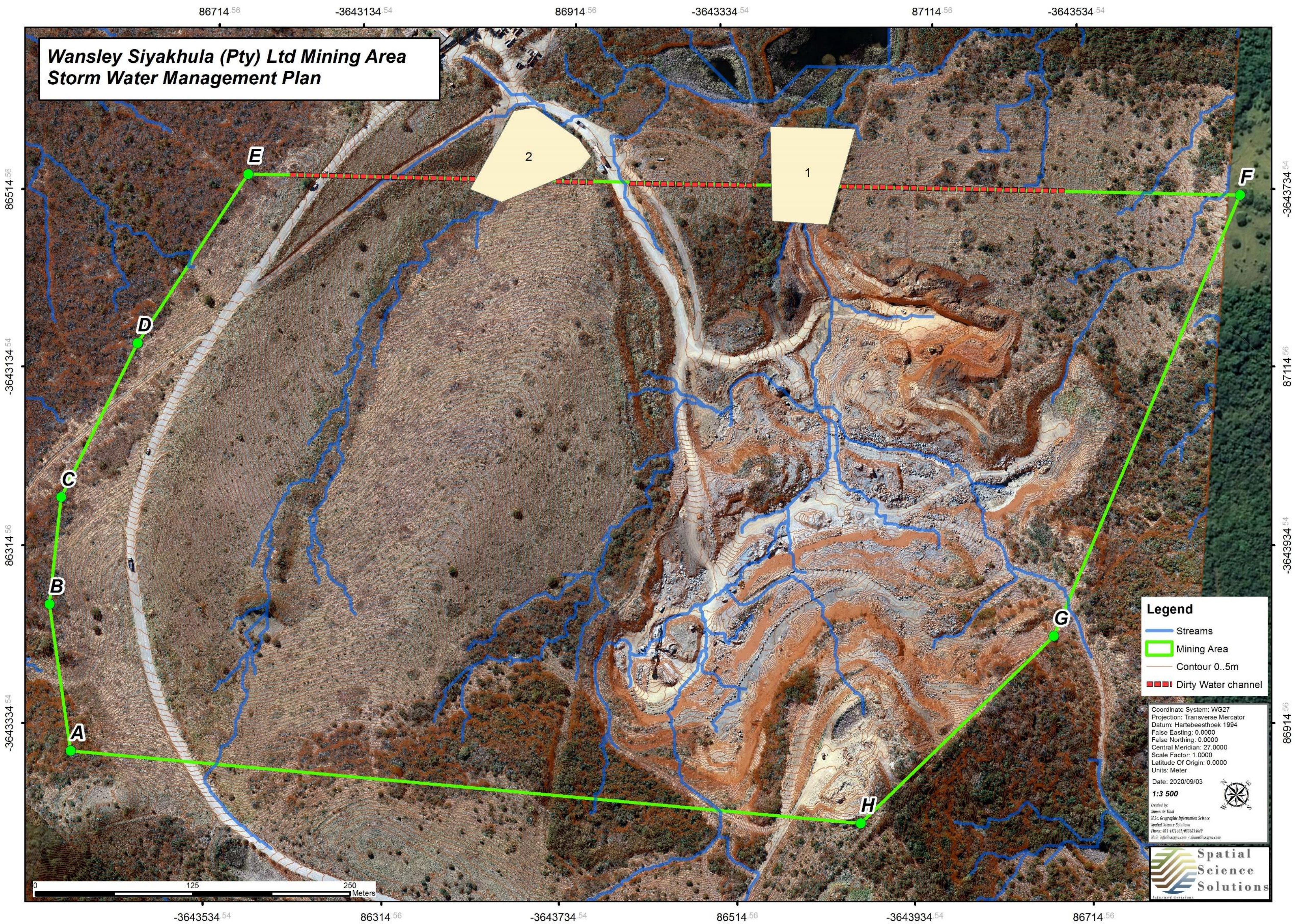

Figure 5.6 Storm Water Management Plan

6 CONCLUSION AND RECOMMENDATIONS

The study area is located in quaternary catchment area R30F, the MAP of the study area is 782mm and the MAE of the study area is 1362 mm.

There are no significant surface water users downstream of the proposed mining area development related to unreliable flow due to the containment of the water in the small catchment area. The catchment area of the two drainage lines has no significant contribution to the Quenera River where farming practices occur.

The SWMP recommends using two storm water dams for containment of storm water runoff from the mining area. Stormwater water drains are also recommended to channel storm water toward the storm water dams. It is recommended that water from the containment dams be reused for dust suppression within the mining area to ensure sufficient storage capacity during flooding events.

The National Environmental Management Water Act (NEMWA) classifies wastes from the quarry industry as general waste. General waste is defined as waste that does not pose an immediate hazard or threat to health or to the environment (NEMWA, 2014). Therefore, it can be concluded that the extended mining area can be unlined.

In accordance with Condition 7 of GN 704, it is recommended that polluting activities including storage of mining fleet, equipment wash down facilities and vehicle maintenance yards are restricted to the workshop areas and are undertaken on impermeable hard standing surfaces, which are formally drained to a dirty water drainage system at the site.

It is recommended that the mining sequence be followed in order for all runoff water within the mining area to be directed to the valley and into the respective stormwater ponds. It is recommended that stormwater water drainage channels from the mining should be constructed to divert water towards the mining area valley or stormwater pond. All fuels and chemicals stored or used on site should be contained within fit for purpose containers and stored within designated storage areas. In order to prevent pollution of the surrounding environment during an accidental spillage, the designated storage areas should be situated on an impermeable surface and should feature a perimeter bund and a drainage sump. The volume of the bund and sump should be sized to contain at least 110% of the total volume of the fuel and chemicals being stored within the designated storage area. The storage areas should feature a roof to prevent inflow of rainwater, which would require the sump to be emptied frequently.

7 REFERENCES

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