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Hydrological Assessment and Stormwater Management Plan for the Proposed Shaft 18 Complex at Impala Platinum, Rustenburg

I001-59

Report No. 1

September 2013

Impala Platinum (Pty) Ltd

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HYDROLOGICAL ASSESSMENT AND STORMWATER MANAGEMENT PLAN FOR THE PROPOSED SHAFT 18 COMPLEX AT IMPALA PLATINUM, RUSTENBURG

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ABBREVIATIONS AND ACRONYMS

AMSL	Above Mean Sea Level
DDF	Depth Duration Frequency
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
IWULA	Integrated Water Use License Application
MAP	Mean Annual Precipitation
RLMA&SI	Regional L-Moment Algorithm and Scale Invariance
RP	Return Period
SANRAL	South African National Road Agency Limited
SAWS	South African Weather Service
TC	Time of Concentration
TR-55	Technical Report 55
TSF	Tailings Storage Facility
WRC	Water Research Commission
WR2005	Water Resources 2005

HYDROLOGICAL ASSESSMENT AND STORMWATER MANAGEMENT PLAN FOR THE PROPOSED SHAFT 18 COMPLEX AT IMPALA PLATINUM, RUSTENBURG

1 INTRODUCTION

1.1 BACKGROUND

Impala Platinum Limited (Impala) operates a platinum mining and processing operation near Rustenburg in the North West Province. The operation has an approved environmental impact assessment (EIA) and environmental management programme (EMP) report that has been amended numerous times to incorporate a range of expansion projects. Impala now plans to develop the shaft 18 complex including associated linear infrastructure, a central sewage treatment plant, as well as a sewage pipeline from shaft 17 (existing) to the central sewage treatment plant.

The proposed infrastructure is all located within Impala's existing converted mining rights areas. The additional infrastructure will be authorised through an environmental assessment process, which comprises two phases: the scoping phase and EIA/EMP phase. This specialist report supports the EIA/EMP with regards to the surface water environment, fluvial flood risk and stormwater management. It is also the intention that this report will be used as part of the Integrated Water Use Licence Application (IWULA).

It should be noted that SLR Africa did not undertake the conceptual design of the stormwater management plan. This conceptual design was planned and sized by TWP (Pty) Ltd and incorporated into this report by SLR Africa as necessary. The reader is consequently directed to the TWP report and associated designs.

1.2 SITE LOCATION

The Impala site covers an area of approximately 333km^2, and is located within the North West Province of South Africa, at Grid Coordinates 25.5º S and 27.2º E. The nearest town to the mine, is Rustenburg which lies approximately 3km south of the Impala lease area.

The shaft 18 complex is located in the centre of the Impala lease area and covers an area of 1.08 km^2. Figure 1.1 presents the sites locality, mine lease area as well as the location of the shaft 18 complex.

The site was visited by Luke Wiles on the 26 April 2013.

1.3 PROJECT INFORMATION

The proposed shaft 18 complex is intended to replace production from older shafts that are reaching the end of their life. The proposed development of the additional shaft plans to include infrastructure as detailed in the EIA/EMP.

A service corridor for linear infrastructure proposed to link the shaft 18 complex with the rest of the mine operation and will include:

- Powerlines;
- Roads;
- Rail Lines; and
- Pipelines.

In addition to the above, the scope of this project includes an additional central sewage treatment plant as well as a sewage pipeline linking the existing shaft 17 to this central sewage treatment plant.

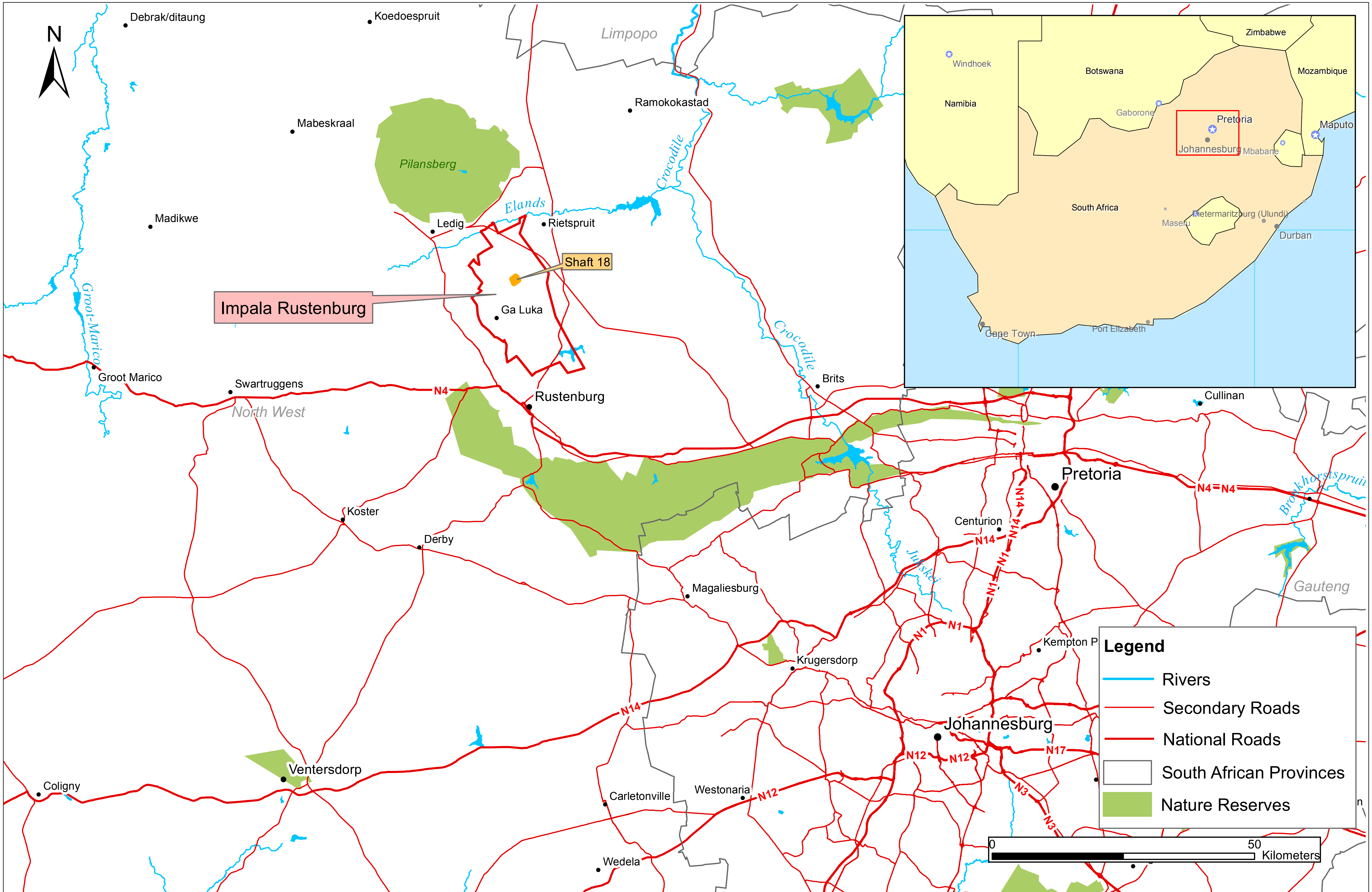


Figure 1.1 Regional Setting of the Impala Rustenburg Operation

2 BASELINE INFORMATION

2.1 TOPOGRAPHY AND LAND COVER

The topography of the Impala lease area is relatively flat, with slopes ranging primarily between 1% and 10%. The same is true for the site at the shaft 18 complex, with slopes below 10%. Elevations over the shaft site approximate 1085m AMSL. Land cover on the proposed shaft site is currently predominantly natural bushveld. The proposed shaft infrastructure will, however, replace much of this landcover with hardstanding areas.

Both the topography and land cover of the site are regarded as important considerations in the determination of runoff generated during flood events.

FIGURE 2.1: LANDCOVER AT THE PROPOSED SHAFT 18 SITE

2.2 GEOLOGY AND SOILS

According to the WR2005 geology dataset, the site is predominantly underlain by Pyramid Gabbro geology which is igneous in nature. Overlying the igneous rocks are soils defined as a variation of Loamy Sands to Clays. The soil texture is further classified as Loamy Sands to Sandy Loams (25%) and Sandy Clay Loams to Clay (70%). The remaining 5% is made up of other soil types.

2.3 HYDROLOGY

The proposed shaft site is located near a watershed. In terms of surface drainage at (or near to) the site, the stream network as per the 1:50,000 topographical map sheets was extracted and used in the generation of Figure 2.2 to give a good indication of the nature of the river systems in the greater area. According to this stream network, there are number of non-perennial streams near to the site. Of these non-perennial rivers, only one unnamed tributary intersects the site boundary of the shaft 18 complex. The non-perennial watercourse intersecting the shaft 18 complex, joins a secondary unnamed non-perennial watercourse which subsequently flows north to join the Leragane River. The Leragane then drains to the Elands River situated to the further to the north. This drainage area is associated with quaternary catchment A22F.

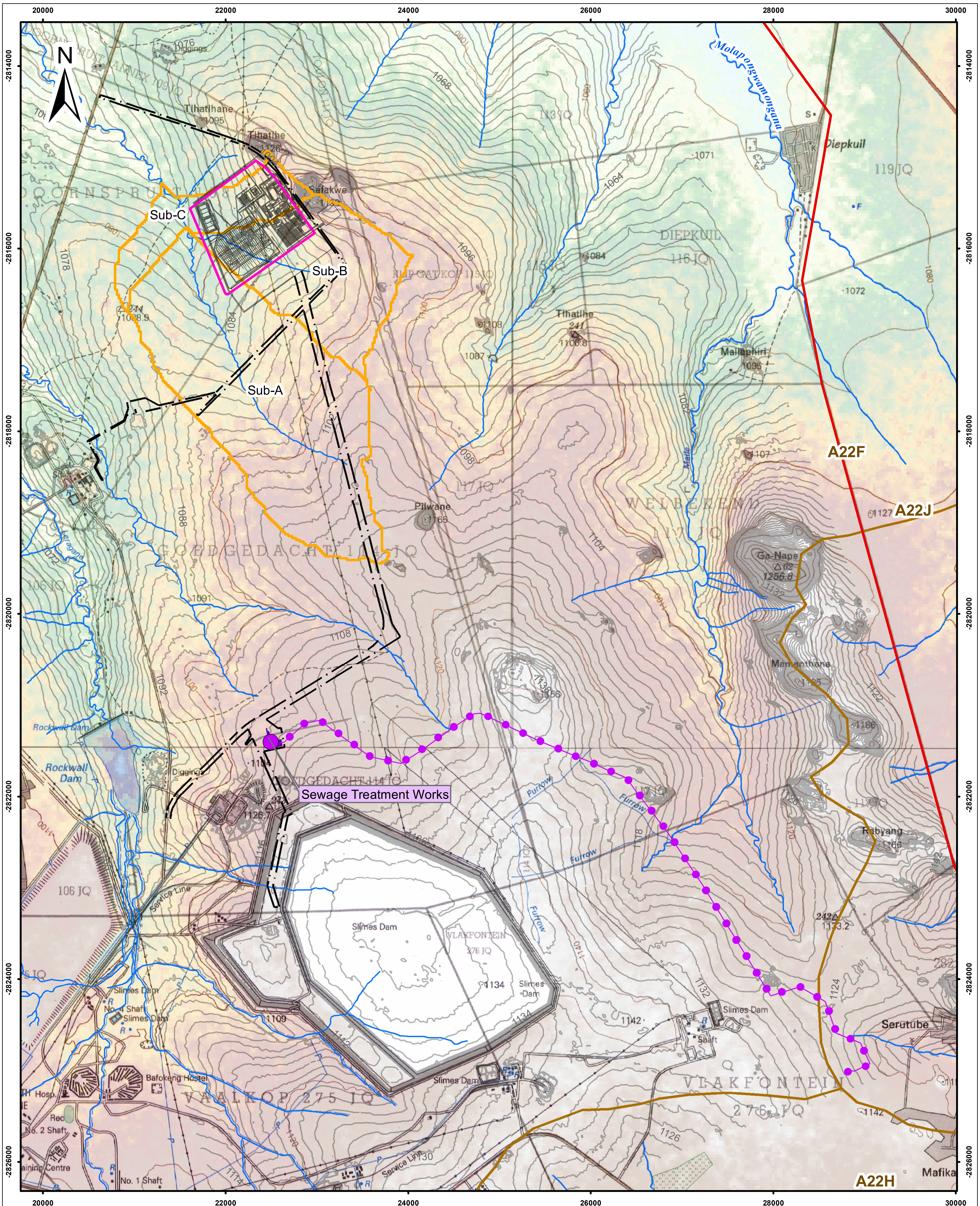
The Mean Annual Runoff (MAR) for the catchment associated with the anticipated area of containment for the shaft 18 complex was estimated using rainfall-runoff response parameters from WR2005. The rainfall-runoff response of the catchment was assumed to be the same as the regional rainfall-runoff response as determined for the quaternary catchment in which the mine falls. Using the WR2005 quaternary catchments dataset, and an estimated 0.79km^2 of runoff being contained at the shaft 18 complex, it is expected that approximately 0.0067 million m^3 of the quaternary catchments 14.4 million m^3 Mean Annual Runoff (MAR), will be held back. This accounts for 0.047% of the MAR for quaternary catchment A22F. The effect of the linear infrastructure associated with the development of the shaft 18 complex and shaft 17 sewage pipeline on MAR is expected to be limited.

2.4 CLIMATE

The annual average rainfall for the Rustenburg region is approximately 600 mm, mainly occurring as a result of thunderstorms between October and March, peaking in January. Hail can be expected, on an average 4 times a year. Average daily maximum temperatures are about 32^{o}C in January and 22^{o}C in July. Average daily minima are about 18^{o}C in January and 4^{o}C in July. Winds are mainly light to moderate and blow from the north-easterly sector except for short periods during thunder storms or weather changes when they have a southerly component. More site specific rainfall and evaporation information is available in the following sections, as these are important considerations of a hydrological assessment.

2.5 RAINFALL AND EVAPORATION

Rainfall and evaporation data for the shaft 18 complex was considered from various sources including weather stations managed by both the South African Weather Services (SAWS) and the Department of Water Affairs (DWA).



Legend

- Shaft 18
- Linear Infrastructure Associated with Shaft 18
- Shaft 17 Sewage Pipeline
- Rivers
- 2m Contours
- Subcatchments
- Quarternary Catchments

This map uses ASTER data.
ASTER is a product of METI and NASA

0 — 2 Kilometers

Scale: 1:30,000 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

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Figure 2.2

Hydrology and Topography

SLR

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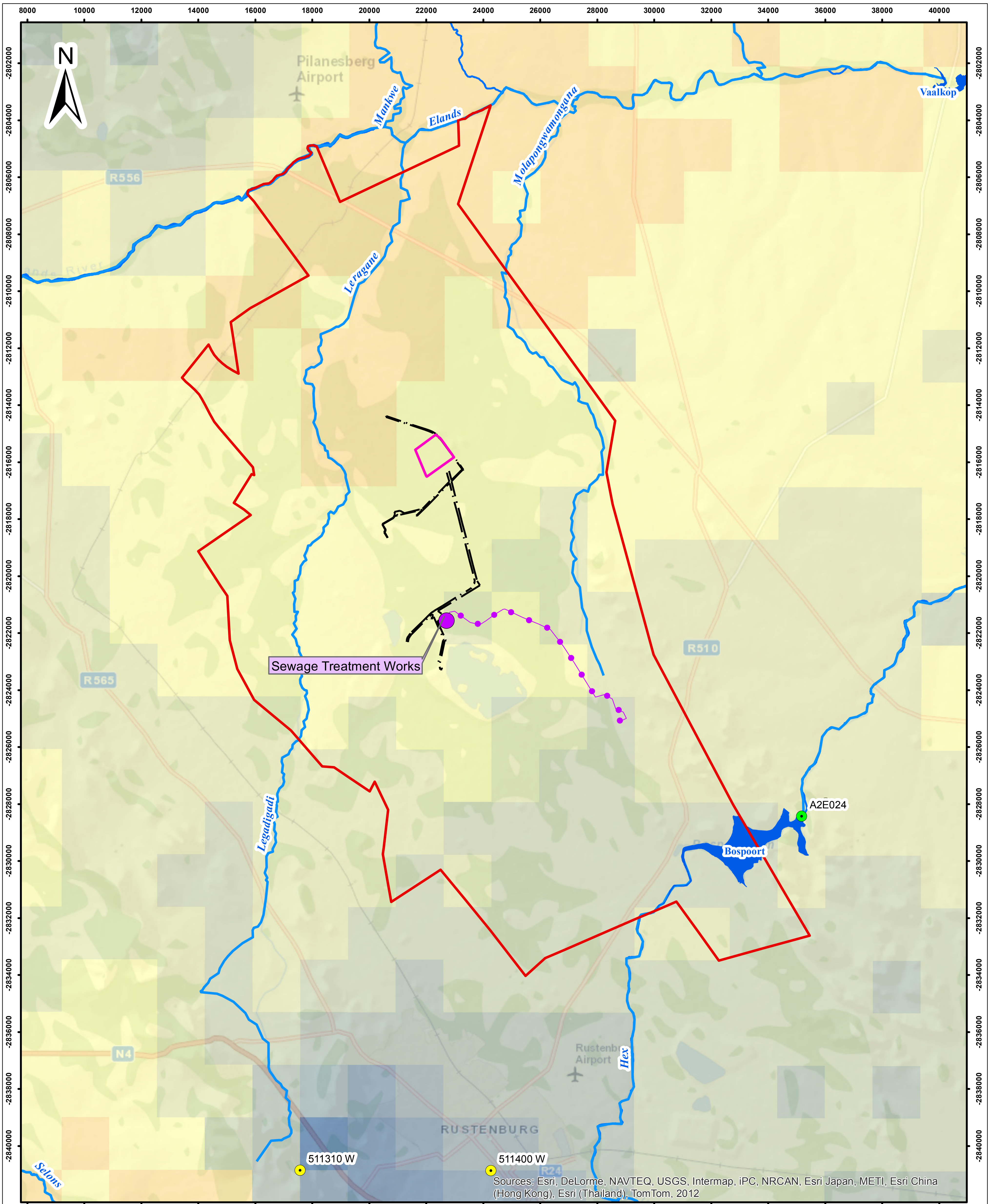
Mean annual precipitation (MAP) for the site was sourced from the Rustenburg-POL weather station (511400W), 25km south of the centroid of the shaft complex. The Boschpoort weather station (A2E024) is 16km east of the Impala site, and 18km south east of the proposed shaft 18 complex. The Rustenburg-POL weather station has been used in past Impala environmental investigations and provides a reliable daily record length of 87 years, with an average MAP of 665mm. The Boschpoort weather station is, however, closer to the site and provides a record length of 30 years, with an average MAP of 604mm.

Figure 2.3 presents an illustration of the distribution of MAP over the site. As presented in the figure, annual rainfall increases from north to south across the site. It is consequently noted that the Rustenburg-POL weather station has a MAP above that of the site, while the Boschpoort weather station is seen as being more representative of average site conditions. Furthermore, the Rustenburg-POL weather station does not have any evaporative data. Consequently, the Boschpoort weather station was used for both rainfall and evaporative data. Table 2.1 presents the monthly rainfall and evaporation of the Boschpoort weather station.

TABLE 2.1: MONTHLY RAINFALL AND EVAPORATIVE ESTIMATES

Month	Mean Monthly Rainfall (mm)	Mean Monthly Evaporation - Lake (mm)
Jan	107	162
Feb	99	143
Mar	73	130
Apr	40	99
May	13	83
Jun	6	64
Jul	2	70
Aug	4	95
Sep	11	129
Oct	62	155
Nov	91	158
Dec	98	163
Total	604	1453



Legend

- Lease Area
- Shaft 18
- Linear Infrastructure Associated with Shaft 18
- Shaft 17 Sewage Pipeline
- Rivers

Weather Station

- DWAF
- SAWS

Mean Annual Precipitation (mm)

- 681 - 700
- 661 - 680
- 641 - 660
- 621 - 640
- 601 - 620
- 581 - 600
- 561 - 580
- 551 - 560

0 2 4 Kilometers

Scale: 1:130,000 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

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Figure 2.3

Mean Annual Precipitation and Local Weather Stations

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2.5.1 DESIGN RAINFALL DEPTHS

Design rainfall depths for various return periods (RP) and storm durations were sourced from the Design Rainfall Estimation Software for South Africa, developed by the University of Natal in 2002 as part of a WRC project K5/1060 (Smithers and Schulze, 2002). This method uses a Regional L-Moment Algorithm in conjunction with a Scale Invariance (RLMA&SI) approach to provide site specific estimates of depth-duration-frequency (DDF) rainfall, based on surrounding observed records. This method of DDF rainfall estimation is considered more robust than previous single site methods. The Water Research Commission (WRC) Report No. K5/1060 provides further detail on the verification and validation of the method.

The rainfall depth estimates from this technique have been compared to the DDF estimates for Boschpoort weather station using the HRU methodology. The HRU methodology is a simplistic methodology which enables the estimation of depth-duration-frequency rainfall. The methodology uses the MAP for the site (604mm) and a site location factor in order to determine the DDF estimate.

TABLE 2.2: 24-HOUR STORM DEPTHS

Return Period (Years)	24-hour Rainfall Depth (mm)	
	Smithers & Schulze (2002)	HRU
1 in 2	67	49
1 in 5	91	64
1 in 10	108	79
1 in 20	125	97
1 in 50	150	127
1 in 100	170	157
1 in 200	191	193

In this project, the Smithers and Schulze technique was selected due to the following reasons:

- Estimates are based on localised observed data
- Estimates are specific to the site location
- Estimates are more conservative (with the exception of the 1 in 200 year event)

3 CATCHMENT HYDROLOGY – PEAK FLOW ESTIMATES

3.1 METHODOLOGY

Natural subcatchments were delineated for the shaft site according to Figure 2.2, using site survey data (2m contours). The Rational Method was then applied in order to calculate flood peaks for the delineated subcatchments. This method was selected to be appropriate since by using it, a combined approach could be implemented whereby flow in the headwaters of the subcatchment could be calculated assuming dominant overland flow regime, while in the lower reaches, flow could be calculated with channel flow as the dominant regime. Furthermore, a spreadsheet based implementation of the Rational method allows for the inclusion of RLMA&SI depth-duration-frequency (DDF) estimates.

3.2 MODEL INPUTS

The spreadsheet implementation of the rational method as applied in this project, is based upon the approach adopted in the Drainage Manual (SANRAL, 2006).

While the Rational method is a simplistic method of peak flow estimation, a modification to the method, which includes a composite estimation of the runoff coefficient, allows for the influence of slope, soil permeability, vegetation and land cover (e.g. residential houses or heavy industry) to be considered. Furthermore, the time of concentration is explicitly calculated, enabling a more realistic estimation of the DDF design rainfall event.

3.2.1 CATCHMENT CHARACTERISTICS

Subcatchments modelled in this study, are illustrated in Figure 2.2. The modelled area of subcatchment C includes the upstream areas of subcatchments A and B.

For each of the subcatchments modelled, catchment parameters were determined such that the Rational Method could be implemented. The runoff coefficient was subsequently estimated by assessing datasets detailing the relevant subcatchment characteristics as listed in Table 3.1. The Rational Method as applied in the project also takes into account the return period of the rainfall event, such that a greater proportion of incident rainfall is transformed into runoff for higher return periods. This simulates the saturation of soils that would occur as a result of higher rainfall events.

The landcover of the catchments to be modelled was noted to be largely natural, and consequently a generic proportion of 20% light bush and farmlands and 80% grasslands was used for all catchments.
Soils were also generic with a mix of 10% permeable, 80% semi-permeable and 10% impermeable.

TABLE 3.1: RECOMMENDED VALUES FOR RUNOFF FACTOR (SANRAL, 2006)

Rural (C_1)					Urban (C_2)	
Component	Classification	Mean annual rainfall (mm) < 600	600 - 900	> 900	Use	Factor
Surface slope (C_s)	Vleis and pans (<3%)	0,01	0,03	0,05	*Lawns*	
	Flat areas (3 to 10%)	0,06	0,08	0,11	- Sandy, flat (<2%)	0,05 - 0,10
	Hilly (10 to 30%)	0,12	0,16	0,20	- Sandy, steep (>7%)	0,15 – 0,20
	Steep areas (>30%)	0,22	0,26	0,30	- Heavy soil, flat (<2%)	0,13 – 0,17
					- Heavy soil, steep (>7%)	0,25 – 0,35
Permeability (C_p)	Very permeable	0,03	0,04	0,05	*Residential areas*	
	Permeable	0,06	0,08	0,10	- Houses	0,30 – 0,50
	Semi-permeable	0,12	0,16	0,20	- Flats	0,50 – 0,70
	Impermeable	0,21	0,26	0,30		
					Industry	
Vegetation (C_v)					- Light industry	0,50 – 0,80
	Thick bush and plantation	0,03	0,04	0,05	- Heavy industry	0,60 – 0,90
	Light bush and farm lands	0,07	0,11	0,15	*Business*	
					- City centre	0,70 – 0,95
	Grasslands	0,17	0,21	0,25	- Suburban	0,50 – 0,70
	No vegetation	0,26	0,28	0,30	- Streets	0,70 – 0,95
					- Maximum flood	1,00

3.2.2 DEPTH-DURATION-FREQUENCY RAINFALL

Design rainfall depths associated with each catchment were required to be determined through a depth-duration-frequency approach. This approach requires that both *duration* and *frequency* of rainfall be determined in order to arrive at a design rainfall *depth*. Frequency direcly relates to the return period (RP) of the event. *Duration* is defined through the estimation of the critical storm duration for each subcatchment, estimated by calculating the time of concentration (TC) for individual subcatchments. TC was calculated through the application of the TR-55 methodology. This methodology improves on other empirical estimates of TC, through the division of a catchment into 3 primary flow processes of sheet flow, shallow concentrated flow and open channel flow. This subdivision enables the application of an empirical method particular to a specific flow process, in contrast to the single primary flow approaches which have traditionally been used in the past.

With TC, and thereby the design rainfall duration calculated, subcatchment specific critical storm depths for return periods of interest were derived from the output of the RLMA&SI method as implemented in the Design Rainfall for South Africa software (Smithers and Schulze, 2002). The RLMA&SI methodology provides an average estimate, lower estimate and upper estimate. The application of the average estimates are most easy to validate (in that they are neither of the two extremes) and that the average RLMA&SI estimates exceeded the HRU estimates (up to the 1 in 50 year event), it was decided that the average RLMA&SI estimate would be used.

Table 3.2 presents the inputs derived for application as part of the Rational Method.

TABLE 3.2: SUBCATCHMENT CHARACTERISTICS

Description	Shaft 18 complex		
	A	B	C
Subcatchment Area (km^2)	5.1	2.3	8.5
Runoff Coefficient for the 1 in 50 year event	0.34	0.34	0.34
Time of Concentration (min)	103	62	110
Rainfall Intensity (mm/h) for the 1 in 50 year event	135	130	138

3.3 PEAK FLOW ESTIMATES

The calculated rainfall depths were subsequently converted into rainfall intensities (mm/hr), which through the inclusion of a subcatchment specific runoff coefficient, and subcatchment area (km^2) enabled the application of the Rational Method:

Rational Method

$Q_T = 0.278\ C\ I\ A$

Where:

- Q_T = Peak Flow (m^3/s for specific return period)
- C= Runoff Coefficient (%)
- I = Rainfall Intensity (mm/hr)
- A = Area (km^2)

The resulting peak flows are presented in Table 3.3 and Figure 3.1.

TABLE 3.3: DESIGN PEAK FLOWS

Catchment	Peak Flow (m^3/s) associated with RP						
	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200
Sub-A	20.46	30.01	38.32	48.27	65.41	83.23	112.22
Sub-B	9.02	13.22	16.88	21.28	28.83	36.69	49.44
Sub-C	35.03	51.40	65.63	82.63	111.99	142.50	192.18

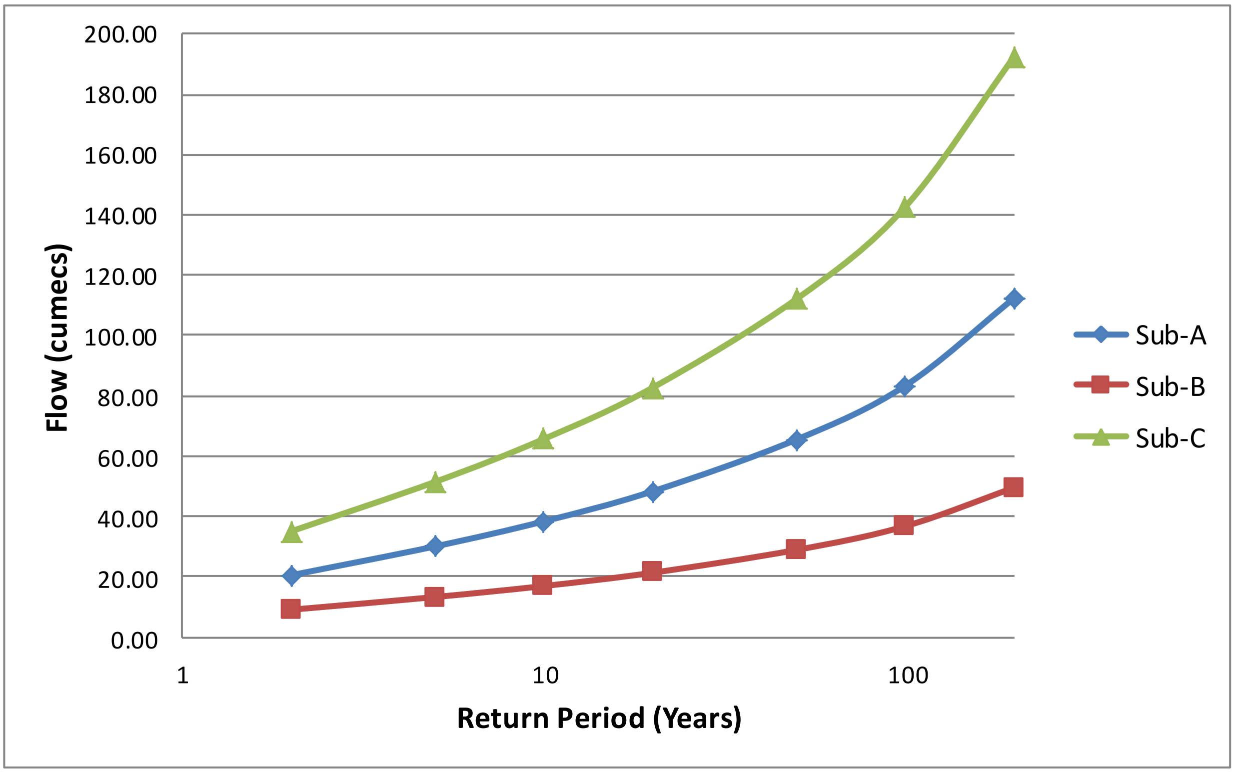


FIGURE 3.1: DESIGN PEAK FLOWS FOR THE CATCHMENTS OF INTEREST

It should be noted that the development of the shaft 18 complex will change the baseline conditions presented in Table 3.3 since the area of the subcatchments will be reduced due to the containment of dirty water generating areas. This change is primarily associated with subcatchments B and C.

4 STORMWATER MANAGEMENT PLAN

The aim of the stormwater management plan (SWMP) is to fulfil the requirements of the National Water Act (Act 36 of 1998) and more particularly, Government Notice 704 (Government Gazette 20118 of June 1999) (hereafter referred to as GN704), which deals with the separation of clean and dirty water. This conceptual stormwater management plan will form a necessary part of the IWULA, submitted to the Department of Water Affairs (DWA).

The proposed SWMP is currently being developed by TWP. SLR Africa provided some input into the conceptual layout of stormwater management infrastructure to ensure alignment with the principals presented in GN704. The details of the designs (channels and berms) however, cannot be confirmed at this stage. The reader is thereby directed to the appropriate TWP report and associated figures and designs to be finalised during the detailed phase of the project.

4.1 DWAF GOVERNMENT NOTICE 704

GN704 was published to provide regulations on the use of water for mining and related activities aimed at the protection of water resources. There are important definitions in the regulation, which require understanding, and these are discussed below.

4.1.1 IMPORTANT DEFINITIONS

Some important definitions from GN704 appropriate to this project include:

- **Clean water system:** This includes any dam, other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of unpolluted water.
- **Dam:** This includes any settling dam, slurry dam, evaporation dam, catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste (i.e. polluted water)
- **Dirty area:** This refers to any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource (i.e. polluted water)
- **Dirty water system:** This includes any dam, other form of impoundment, canal, works, pipeline, residue deposit and any other structure or facility constructed for the retention or conveyance of water containing waste.

4.1.2 APPLICABLE CONDITIONS

The four main principle conditions of GN704 applicable to this project are:

- *Condition 4* which defines the area in which mine workings or associated structures may be located with reference to a watercourse and associated flooding. The 50 year floodline and 100 year flood line are used for defining suitable locations for mine workings (prospecting, underground mining or excavations) and associated structures respectively. Where the floodline is less than 100 metres away from the watercourse, then a minimum watercourse buffer distance of 100 metres is required for both mine workings and associated structures.

- *Condition 5* which indicates that no residue or substance which causes or is likely to cause pollution of a water resource may be used in the construction of any dams, impoundments or embankments or any other infrastructure.

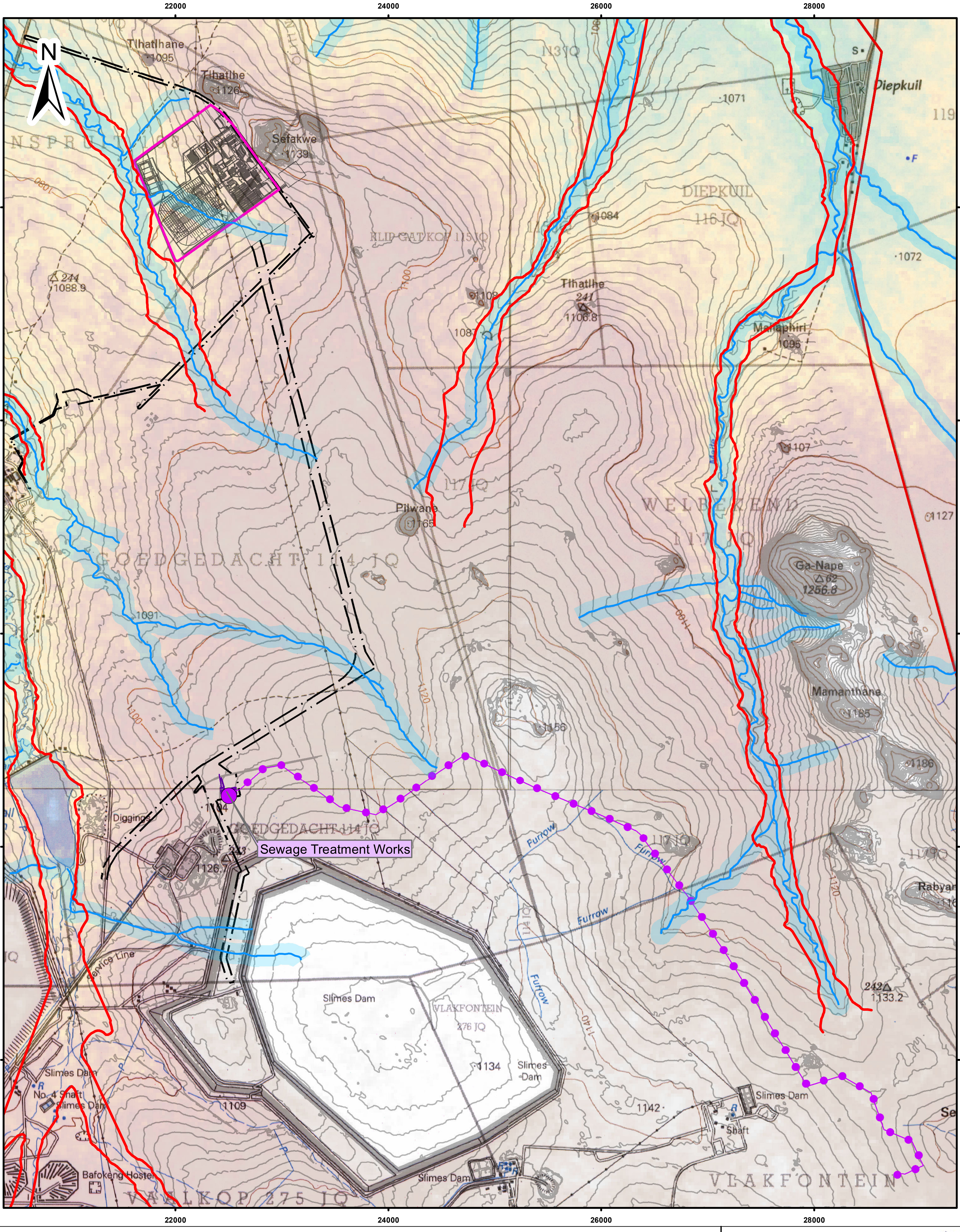
- *Condition 6* which describes the capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated such that these systems do not spill into each other more than once in 50 years

- *Condition 7* which describes the measures which must be taken to protect water resources. All dirty water or substances which cause or are likely to cause pollution of a water resource either through natural flow or by seepage are to be mitigated.

4.2 ASSESSMENT OF FLOODING POTENTIAL

SLR Africa previously completed modelling of Impala main rivers as part of a Surface Water Assessment and Floodline Modelling project. The results of this modelling have been presented in Figure 4.1. The figure also presents the 100m buffer of all 1 in 50,000 topographical map rivers near the site.

Figure 4.1 indicates the presence of a non-perennial watercourse passing through the proposed shaft 18 complex. This watercourse is associated with an approximate 1 in 50 year flood peak of 29m^3/s and a 1 in 100 year flood peak of 37m^3/s. Flood risk to the site may prove to be significant with associated mitigation required. It may therefore be necessary to include a river diversion (along with appropriate Section 21 licencing) to prevent flood water from entering the site. The location of this diversion has been presented in Figure 4.2.



Legend

- Shaft 18
- Linear Infrastructure Associated with Shaft 18
- Shaft 17 Sewage Pipeline
- Rivers
- 2m Contours
- 1in50 Year Flood Extent
- 1in100 Year Flood Extent
- 100m River Buffer

This map uses ASTER data.
ASTER is a product of METI and NASA

0 1 Kilometers

Scale: 1:16,800 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

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Figure 4.1
Flood Extents and 100m River Buffers

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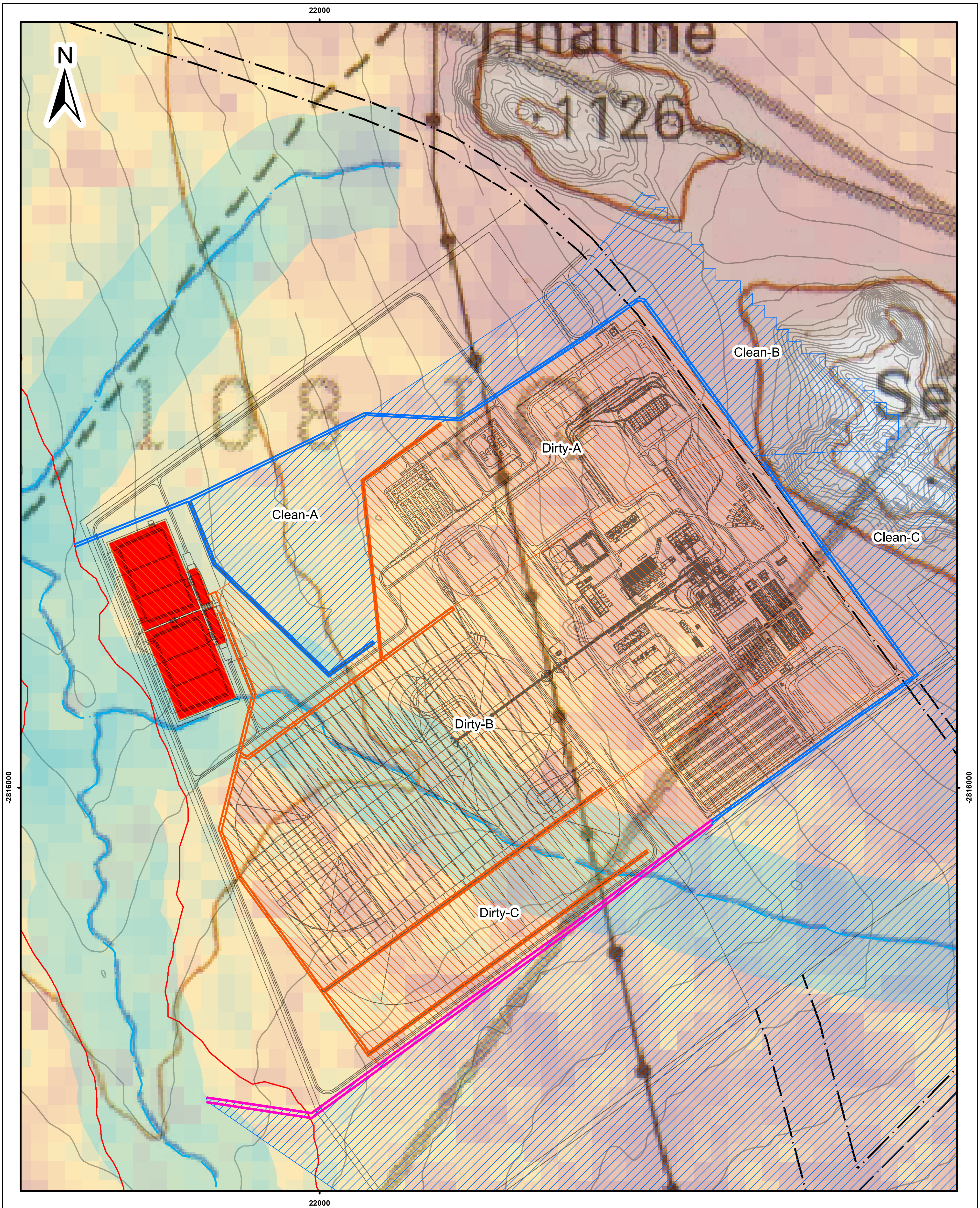
The containment facility to the north west of the site is at risk of flooding from the river crossing the site, as well as from the non-perennial watercourse to the west. Design of this facility will consequently need to consider all potential sources of flooding such that erosion of the facility embankments does not occur.

4.3 CLEAN AND DIRTY WATER AREAS

In Figure 4.2, clean and dirty catchments have been delineated for the surface works. These catchments were delineated using the TWP layout for the shaft 18 complex. Only the surface area which is anticipated to be managed by either clean or dirty water infrastructure as presented by the TWP SWMP, have been estimated. All other areas around the shaft site are not mitigated with respect to either dirty or clean water. These unmitigated areas will consequently follow natural drainage pathways, ultimately routing surface water into the nearby watercourses. As such, these areas should not contain any infrastructure or workings which would be defined as dirty, unless additional mitigation has been included.



Legend

- Shaft 18 Infrastructure
- Linear Infrastructure Associated with Shaft 18
- Rivers
- 2m Contours
- 100m River Buffer
- 1 in 100 Year Floodline
- River Diversion
- Dirty Water Diversion
- Clean Water Diversion
- Containment Facility
- Clean Water Area
- Dirty Water Area

This map uses ASTER data.
ASTER is a product of METI and NASA

0 200 400 Meters

Scale: 1:6,000 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

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Figure 4.2

Stormwater Management Plan

SLR

SLR Consulting (Africa) (Pty) Ltd
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4.3.1 CLEAN WATER DIVERSIONS

The stormwater management plan as presented in Figure 4.2 includes typical upstream clean water diversions consisting of a berm component. Clean water diversion berms are designed to divert upstream clean water around dirty water generating areas (i.e. intercepting clean water runoff and diverting this water around mining activities). These diversions are to be sized to cater for the 1:50 year flood event with dimensions finalised during the detailed design phase of the project. Figure 4.3 illustrates a typical berm which will be used to manage clean water.

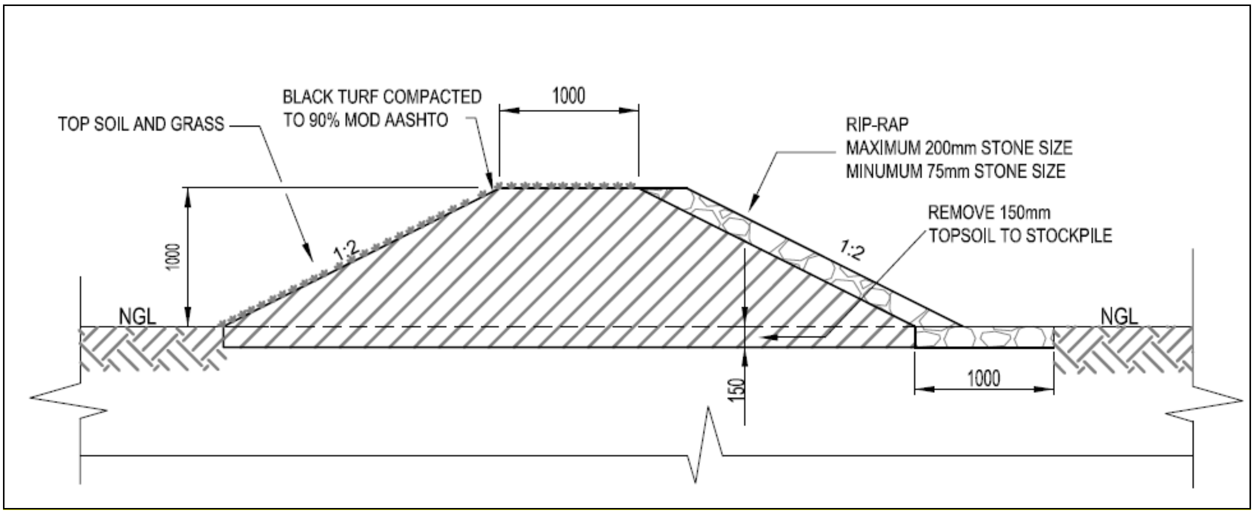


FIGURE 4.3: TYPICAL BERM FOR CLEAN STORMWATER DIVERSION SYSTEM

4.3.2 DIRTY WATER DIVERSIONS

As per the clean water diversions, dirty water containment systems have been designed to ensure dirty water generated on the site is contained. These systems will contain a channel component. Lining of the dirty water diversions has been included to prevent seepage of any pollutants into the soil profile and subsequent percolation into groundwater. These diversions are to be sized to cater for a minimum of the 1:50 year flood event with dimensions finalised during the detailed design phase of the project. Figure 4.4 illustrates a typical channel which will be used to manage dirty water.

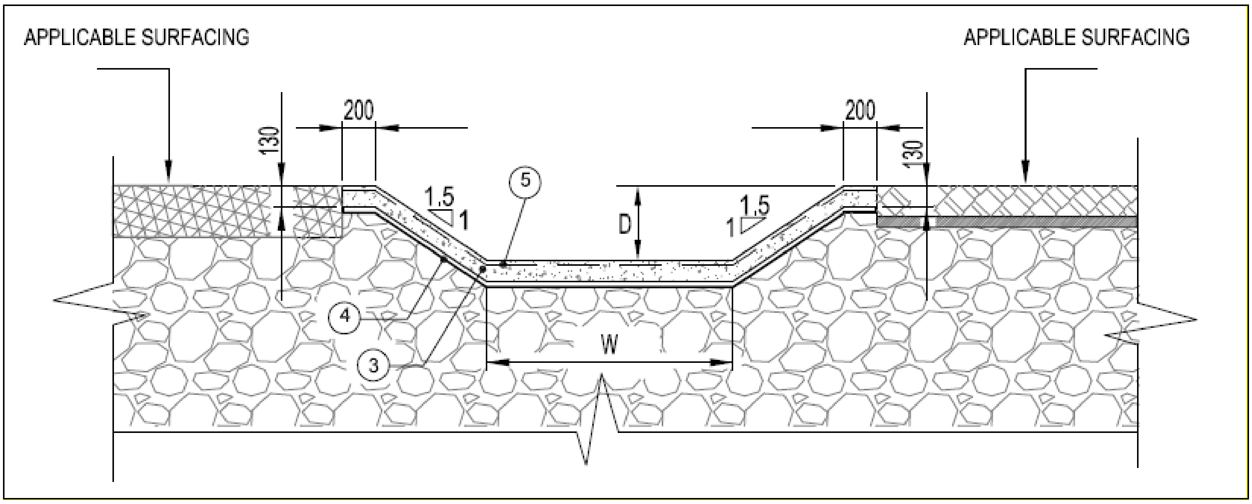


FIGURE 4.4: TYPICAL CHANNEL FOR DIRTY STORMWATER DIVERSION SYSTEM

4.3.3 DIRTY WATER CONTAINMENT

Condition 6 of GN704, deals with the capacity requirements of clean and dirty water systems, and states that clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated such that these clean and dirty water systems do not spill into each other as a result of storm events below and including the 1 in 50 year event. A minimum freeboard of 0.8 m above full supply level must also be maintained as per the requirements of GN704. Water accumulated in the containment facility during the wet season should be used as a priority in the process water circuit to ensure the capacity requirements are not compromised during periods of heavy/extended rainfall. Prevention of seepage of pollutants into the soil profile and subsequent percolation into groundwater will be achieved through the addition of lining.

As with the clean and dirty water diversions, the dirty water containment facility has been designed by TWP. The reader is thereby directed to TWP report (Ref. 110012 305 0130 10 0001 0C) where a summary of design for the containment facility at the shaft 18 complex is provided.

TABLE 4.1: DIRTY WATER CONTAINMENT FACILITY VOLUME REQUIREMENTS

	Total Volume (m^3)	Depth (m)
Shaft 18	85,000	4

Allowance has been made for the addition of process water as follows:

- Refrigeration cooling towers (1,728m^3/day)
- Precooling tower from cold well (8.64m^3/day)
- Compressor cooling (25m^3/day)
- Hot well blow down including underground excess (2,160m^3/day)

- Sewage for 4,500 people at 120 litres per person (540 m^3/day)

The sizing of the stormwater containment facilities has been based upon a minimum pumping capacity of 6,000m^3/day with a minimum availability of 95% per day. Given the required availability, a backup pump should always be available since in the event of a pumping failure, the addition of 6,000m^3/day would result in an empty containment facility reaching full capacity in 14 days. The 1 in 50 year design storm volume should always be available, including a 0.8m freeboard.

The water pumped from the containment facility, will need to be reused in mine processes, or discharged into the environment (with appropriate treatment and licensing as necessary). At this stage, it is anticipated that the water will be pumped to the main tailings return water dam.

5 EXEMPTION FROM REGULATION 704

Various forms of disturbance to natural drainage will occur as a result of the proposed shaft area. GN704 stipulates conditions for managing water on a mine. Dependant on the final mine plan, the exemptions required from this regulation are as follows:

- GN704 Condition 4a – *"Locate or place any residue deposit, dam, reservoir, together with any associated structure within 1:100 year flood-line or within a horizontal distance of 100 m of a watercourse or borehole, excluding boreholes drilled specifically to monitor the pollution of ground water, or on ground likely to become water-logged, undermined, unstable or cracked".*
  A non-perennial watercourse passes through the site and intersects the position of the proposed containment facility. A secondary non-perennial watercourse is located to the west of the site and is in close proximity to the aforementioned containment facility.
- GN704 Condition 4b – *"Carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is greatest".*
  A non-perennial watercourse passes through the site with a second non-perennial passing nearby the site to the west. Numerous infrastructure is consequently at risk of flooding.
  The underground mining operations will intersect both the 100m river buffer and neighbouring watercourses and will consequently require an exemption.

- Condition 5 – *"May not use any residue or substance which causes or is likely to cause pollution of water resource for the construction of any dam or other impoundment or any embankment, road or railway or for any other purpose which is likely to cause pollution of a water resource".*
  The construction of roads, shaft terraces and containment facilities may require the use of waste rock, with potentially leachable pollutants.

6 RIVER CROSSINGS

It is proposed that as part of the development of the shaft 18 complex, a service corridor will be included with associated linear infrastructure, a central sewage treatment plant, as well as a sewage pipeline from shaft 17 (existing) to the central sewage treatment plant.

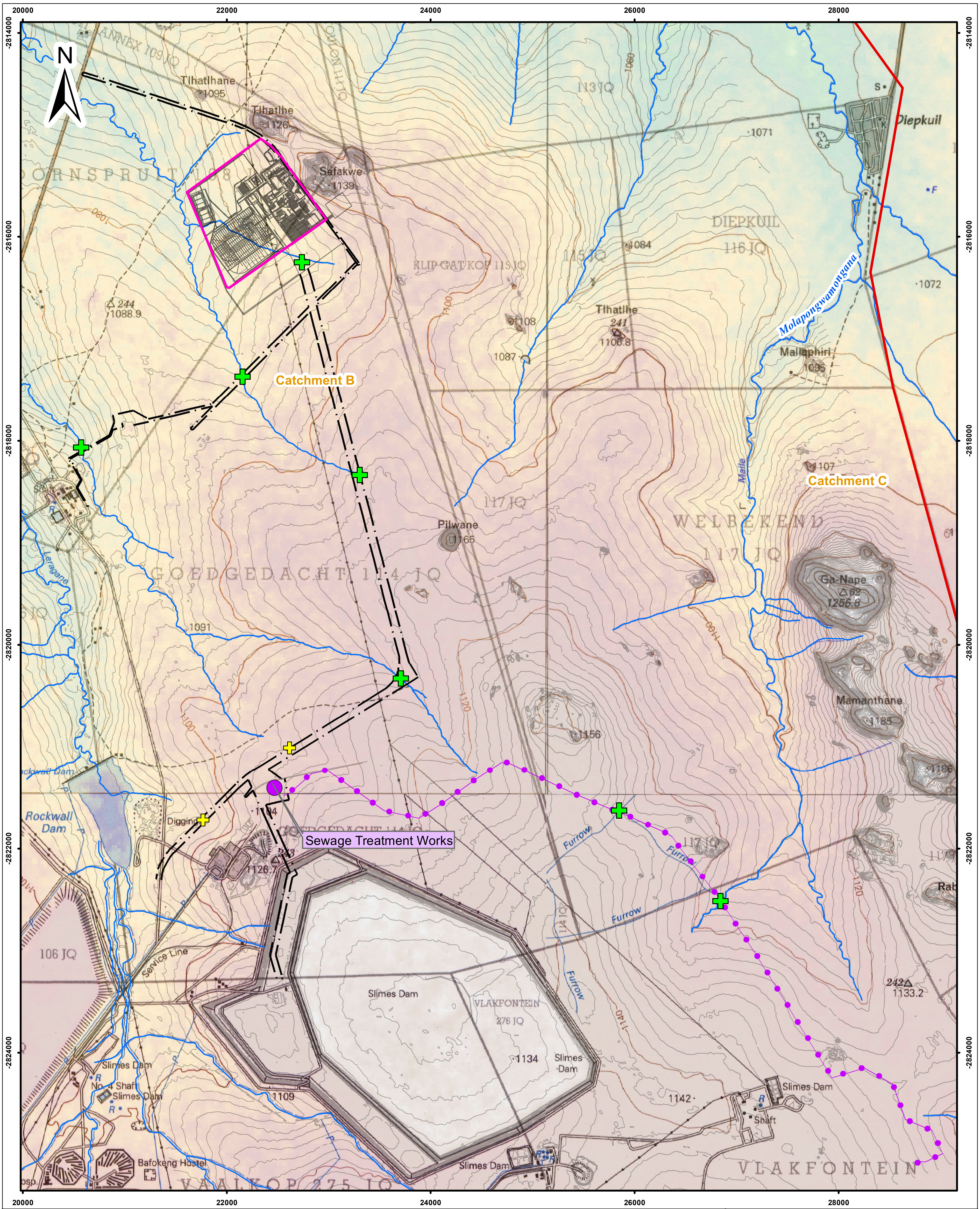
6.1 Applicable Legislation

In terms of legislation specifically applicable to a project of this nature, the following should be considered:

- The National Water Act (Act 36 of 1998) and more specifically the application for an IWULA.
    - It is understood that Impala have been issued with a license from the DWA. The new Section 21 water uses associated with shaft 18 will need to be incorporated.
- Government Notice 704 which deals with the separation of clean and dirty water systems as well as ensuring mining related infrastructure is placed outside of the 1:100 year floodline or 100m from a stream.
    - The linear infrastructure will cross numerous non-perennials hence the appropriate exemptions from GN704 should be applied for.

The service corridor and sewage pipeline will cross numerous non-perennial streams as illustrated in Figure 6.1 (defined according to the 1 in 50,000 topographical map). Two additional preferential flowpaths were also noted along the service corridor.

Although the site streams are non-perennial in nature flowing for only part of the year, effort will need to be made at the crossings to ensure the impact on the natural flow regime of the streams is limited. All stream crossings will require the inclusion of appropriately sized bridges/culverts whereby the 1 in 50 year flood is able to flow past the proposed infrastructure, unhindered. The identified preferential flowpaths while not present on the 1 in 50,000 topographical maps will be treated as streams such that the same application for Section 21 water uses will need to be made.



Legend

- Lease Area
- Shaft 18
- Linear Infrastructure Associated with Shaft 18
- Shaft 17 Sewage Pipeline
- Rivers
- 2m Contours
- Site Catchments
- River Crossing
- Preferential Flowpath

This map uses Microsoft Bing Imagery

0 500 1 000 1 500 Meters

Scale: 1:35,000 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

Impala Platinum Limited

IMPALA PLATINUM

Figure 6.1

River Crossings

SLR

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M Bollaert	I001-59	September 2013

7 STATIC WATER BALANCE

7.1 INTRODUCTION

A site wide static climatic water balance model has been developed for the proposed Impala shaft 18 complex. It covers water consumption and reticulation of the following components of the project:

- Domestic and potable water supply to the shaft and underground mining operations (drinking and operational)
- Shaft operation including cooling towers, blow down towers, change houses, sewage plant etc
- Underground operation; and
- Stormwater dam

7.2 MODEL DESCRIPTION

The static water balance presented in this report represents typical wet and dry seasons based on monthly flows for the Impala shaft 18 operation. The wet season was calculated using the six wettest months (October to March) with the dry season calculated using the six driest months (April to September). The purpose of the report is to assess the site wide water balance from an environmental or overall water use perspective. To this end, the water balance makes a number of simplifying assumptions and is not intended for use in sizing and detailed design requirements.

7.3 INPUT DATA

Various climatic data and specialist information was required as inputs to the water balance model.

7.3.1 CLIMATE

Monthly rainfall and evaporation data for the water balance were sourced from the appropriate monitoring gauges as presented in this specialist surface water report for the project.

7.3.2 SPECIALISTS

Input from a number of specialists was required for the development of this water balance. This input included the following:

- Abstraction volumes of water from underground (groundwater specialist);
- Potable water requirements for both the shaft and underground operations and the seasonal variability thereof (TWP design engineers); and
- Capacities of the stormwater dam (TWP design engineers)

7.4 MODEL SUMMARY

The water balance model schematic for the average wet and average dry seasons at the Impala shaft 18 operation are presented in Figure 7.1 and Figure 7.2 respectively.

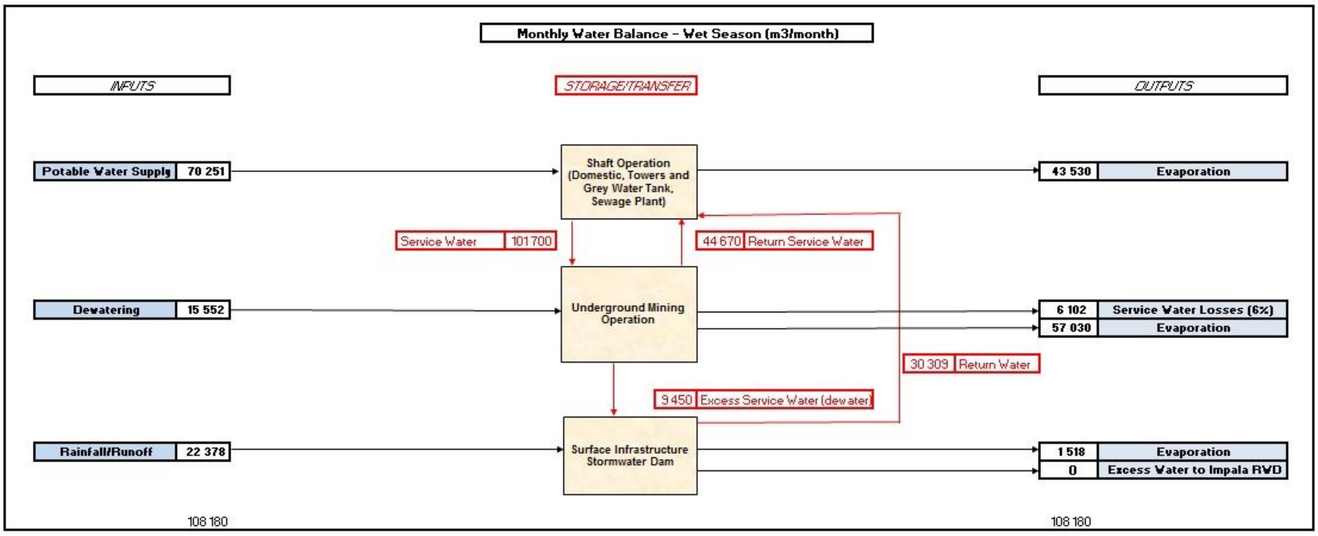

FIGURE 7.1: PROCESS WATER BALANCE MODEL FOR AVERAGE WET SEASON

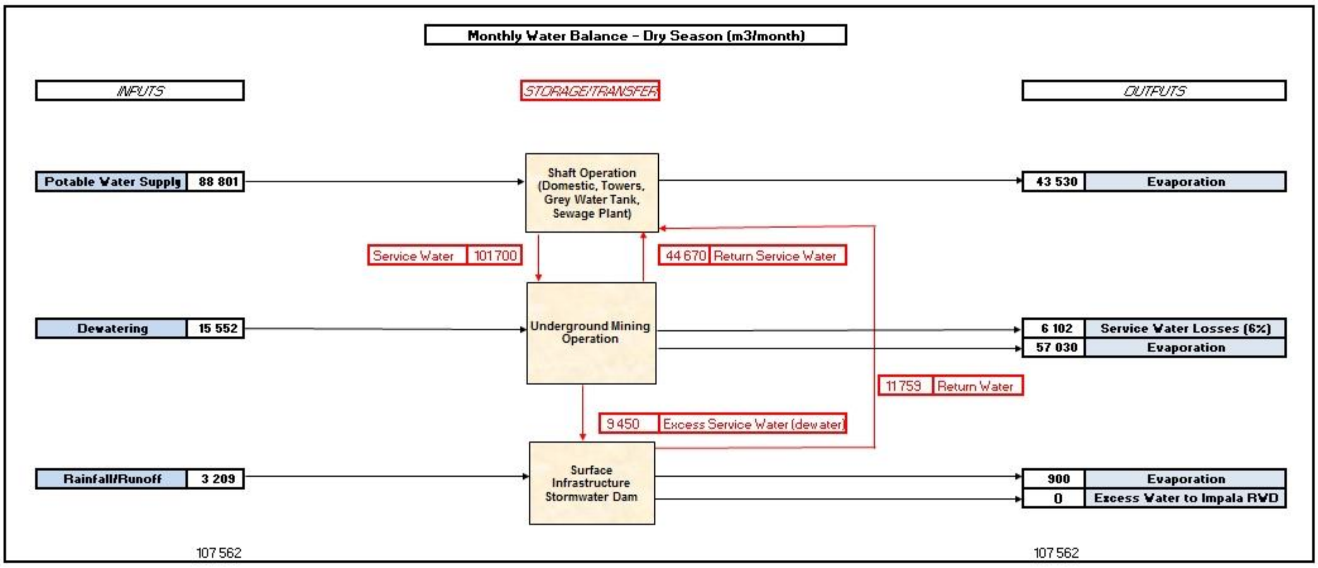

FIGURE 7.2: PROCESS WATER BALANCE MODEL FOR AVERAGE DRY SEASON

7.5 MODEL ASSUMPTIONS

- Potable water supply volumes at the proposed shaft and underground operations are based on the approximate TWP water requirements.
- There is no seasonal distinction between evaporation losses at the shaft and underground operation as per TWP approach. There is however a seasonal distinction at the stormwater dam.
- Excess water pumped from underground (dewatered volume) will be recycled into the process. No allowance has been made for the dewatered volumes to be stored in the shaft 18 stormwater dam. Excess water will therefore be pumped to the return water dam at the main TSF.
- During the summer months, stormwater runoff together with surplus underground water is anticipated to dilute return process water to sufficiently good quality for reuse.
- During the winter months however, the limited availability of stormwater may not allow for sufficient dilution of the return process water. If the salt concentrations in the return process water are too high, the water will need to be routed to the Impala return water dam.
- Evaporation from the stormwater dam has been calculated based on an assumed average operating surface area of 1 hectare (100m*100m).
- Seepage losses from the stormwater dams have been neglected as they are assumed to be lined.
- Underground service water losses have been calculated at 6%.
- Sewage water will be treated and recycled into the process.
- The water balance represents average wet and dry season conditions and does not take into account water required at the start-up of the operations.
- The Impala RWD has sufficient capacity to incorporate excess water produced (potentially high salt concentration) at the shaft 18 operation.

7.6 DISCUSSION AND RECOMMENDATIONS

The proposed project will encounter approximately 6l/s groundwater which will need to be dewatered for the safe continuation of underground mining. This water will be reused in the process water circuit.

It is recommended that the water balance be updated once more specific groundwater interception volumes are known and refined annually during the life of the project. Once the qualities of the groundwater, return process water and stormwater are known, the water balance should be updated accordingly. The seasonal distinction with regard to evaporation losses for both underground and at surface will require further investigation with balances updated accordingly. The rate of increase in salt concentrations in return process water should be monitored closely. Flow meters should be installed in the mine water circuit to provide actual data on water flows to confirm or amend predictions made in the water balance model.

8 CONCLUSION

The proposed development of the shaft 18 complex and associated linear infrastructure, the central sewage treatment plant, as well as a sewage pipeline from the existing shaft 17 complex to the central sewage treatment plant at the Impala site required a hydrological assessment which considered the existing hydrology, flooding potential, expected surface flows and the SWMP as derived by TWP.

Natural subcatchments which covered the site areas of the shaft 18 complex were delineated with peak flows subsequently derived. These subcatchments and their associated peak flows provide an estimate of likely flood peaks generated near the site, although the development of the site will alter these estimates.

Fluvial flooding potential of the shaft site was also considered. For this purpose, the 1:50 and 1:100 year flood extents as detailed in the SLR Africa project (I001-55) were used. 100m buffers of all the rivers (1:50 000 topographical dataset) in the vicinity were also included. The presence of a non-perennial watercourse passing through the site presents a significant flood risk which will require mitigation. An additional area of concern with regards to flooding and/or erosion is the placement of the containment facility for the shaft 18 complex at the confluence of two watercourses. The design of this containment facility will need to consider the presence of nearby watercourses to ensure that applicable mitigation is included to prevent eroding of the facility by flood water. A river diversion may also be necessary to prevent flood waters associated with the tributary crossing the site, from entering the site.

The sizing of the stormwater containment facility has been based upon continual pumping of 6,000m^3/day at 95% availability. An additional backup pump should therefore be made available since failure of the primary system would result in a maximum 14 day window before the containment facility reaches full capacity.

The proposed shaft 18 complex is connected to the Impala mining network via a service corridor with associated linear infrastructure. The central sewage treatment plant with an associated pipeline to the existing shaft 17 operation is also proposed north of the primary TSF. This corridor and sewage pipeline cross non-perennial rivers at seven points with an additional two preferential flowpaths being identified. The appropriate licensing and infrastructure designs (bridge or culvert) will therefore be required to ensure the disturbance to the natural flow regime is limited.

Finally, a static climatic water balance was developed for the average wet and average dry seasons at 18 shaft based on input from various specialists. Approximately 70 251m^3 and 88 801m^3 potable/domestic quality water will be required per month for the wet and dry season respectively. These wet and dry season balances will require revision once more specific information becomes available.

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9 REFERENCES

Department of Water Affairs and Forestry, 1998. *National Water Act, Act 36 of 1998*

Department of Water Affairs and Forestry, 1999. *Government Notice 704 (Government Gazette 20118 of June 1999)*

Department of Water Affairs and Forestry, 2006, "*Best Practice Guideline No. G1: Storm Water Management*" , DWAF, Pretoria, August 2006

HRU – Hydrologial Research Unit, 1978, *"A Depth-Duration-Frequency Diagram for Point Rainfall in southern Africa"*, Report 2/78, University of Witwatersrand, Johannesburg, South Africa

Middleton, B.J. and Bailey, A.K., 2009, "*Water Resources of South Africa, 2005 Study (WR2005)*, Water Research Commission, WRC Report No. TT 380/08

SANRAL. 2006, "*Drainage Manual-Fifth Edition*", The South African National Roads Agency Limited, Pretoria, 2006

Smithers, J.C. and Schulze, R.E., 2002, "*Design Rainfall and Flood Estimation in South Africa*", WRC Report No. K5/1060, Water Research Commission, Pretoria

TR-55, 1986, "*Urban Hydrology for Small Watersheds",* U.S. Soil Conservation Service Technical Release 55 (Revised Version), Department of Agriculture, Washington, USA

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