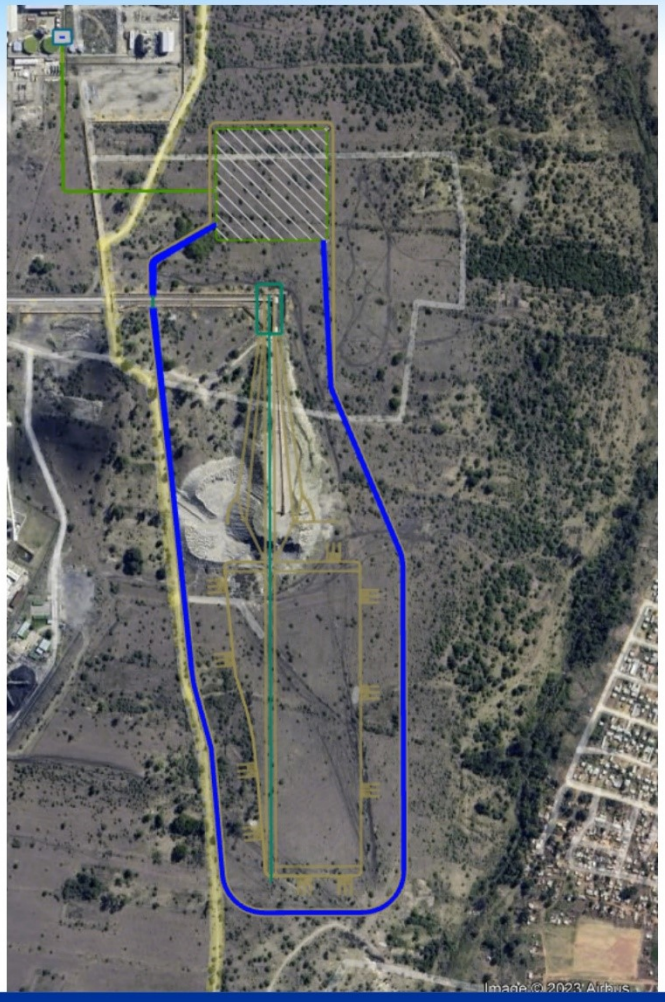

Financial Provisioning and Closure Cost for K4 - Pollution Control Dam and Related Infrastructure

JULY 2023

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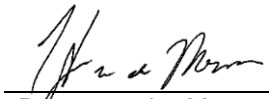

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	25 July 2023	Update Context	Yes	HGvdM	Engineer

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EXECUTIVE SUMMARY

Introduction

This project rehabilitation and costing is additional to the existing provisioning of the whole mine of Karee shaft K4, Sibanye-Stillwater Marikana Operations.

This project consist of the diversion berms and canals around the Waste Rock Dump towards the new Pollution Control Dam and a pipeline from the Pollution Control Dam towards the plant.

Rehabilitation plan

The Waste Rock Dump will be rehabilitated by reduction of slopes and full vegetation of the slopes. No or minimal erosion will be result of the Waste Rock Dump rehabilitation.

Due to the Waste Rock Dump rehabilitation the diversion berms and canals towards the Pollution Control Dam and the pipeline to the plant can be demolished and the area rehabilitated to a pre-mining state at the closure of the mine.

Methodology

The diversion berms will be used to shape and form the flow canals to the pre-mining topographical state.

The pollution control dam infrastructure and lining will be removed and the basin backfilled from the existing embankment material as well as imported selected material in order to shape the area to a pre-mining topographical state. Contour walls can be constructed where required although the area is very flat and with vegetation this should not be required.

The pipeline will be demolished, and the plinths removed.

The affected area will be prepared and vegetated with local species.

Financial Provisioning

The 2022 regulations (Greecy, 2022) require that for new developments the cost related to the disturbance and closure that will occur in the first year of operations with latent cost after closure must be included in the Financial Provisioning cost.

The estimated financial provisioning to rehabilitate the relevant area is estimated at **R20 340 184** including Preliminary & General, Contingencies and VAT. This cost must be added to the existing Financial Provisioning of the Karee K4 shaft.

Information gaps

This EIA study was very comprehensive, and no information gaps are identified for this project.

CONTENTS

FIGURES

TABLES

ACRONYMS

Acronym	Long Form
BoQ	Bill of quantities
c/c	centre to centre
CCT	Condenser Cooling Tower
cm	centimeter
DWS	Department of Water and Sanitation
EIA	Environmental impact assessment
ECSA	Engineering Council of South Africa
FoS	Factor of safety
Fr	Froude number
g	Gravitational acceleration, 9.81 m/s²
HEC-RAS	Hydrologic Engineering Centre's River Analysis System (software)
km	kilometer
km^2	square kilometer
kN/m³	kiloNewton per cubic meter
kN	kiloNewton
kNm	kiloNewton meter
LHOS	Long Hole Open Stoping
LoM	Life of Mine
m	meter
m/s	meter per second
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
m^3/s	cubic meter per second
MAP	Mean annual precipitation
masl	meters above sea level
mm	millimeter
mm/a	millimeter/annum
MPa	MegaPascal
NEMA	National Environmental Management Act

Acronym	Long Form
N/A	not applicable
PGM	Platinum Group Metals
ROM	Run Of Mine
RMF	Regional maximum flood
RAW	Return Air Way
s	second
SANRAL	The South African National Roads Agency
VAT	Value Added Tax
WRYM	Water Resource Yield
ZAR	South African Rand

1 Introduction

1.1 Background

Sibanye-Stillwater is the owner of the K4 Shaft that forms part of the Marikana Operations located near Marikana town, North-West Province. The Marikana Operations is divided into two entities consisting of Western Platinum (Pty) Ltd and Eastern Platinum (Pty) Ltd. The K4 Shaft falls under the Western Platinum (Pty) Ltd.

The shaft was placed under care and maintenance for a period of **6 years** but is being made ready to be fully operational in the year **2024.** The current Waste Rock dump on the property of the shaft has been established and licensed by the previous owner. Sibanye-Stillwater is planning to extend the Life of Mine (LOM) with approximately 30 years and the existing waste rock dump will be utilised. The size of the waste rock dump will not exceed the approved footprint as authorised in the Western Platinum Limited – Environmental Management Programme.

Additional infrastructure that needs to be implemented in order to chieve the full operation of the shaft, include the construction of:

- A lined V-drain around the current waste rock dump. The V-drain is considered as catchment berms on either side of the waste rock dump and is located on a ridge.
- A Pollution Control Dam (PCD) that will be lined and completed with a recovery sump for the recycling of stormwater runoff for the mining operations.
- A pipeline from the K4 Shaft to the PCD.
- An emergency spillway to manage the overflow.

1.2 Declaration of interest

I, Hermanus Gideon van der Merwe, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;

- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
- Signature as part of this document layout.

1.3 Report layout

This report will follow the requirements of Regulations No. R1147[1] promulgated under NEMA and will address the infrastructure at the K4 shaft. This report further references the GN704 Storm water Assessment (Lourens, 2019).

The annual rehabilitation plan will be addressed in the same report as the final rehabilitation and closure plan, as stated in Appendix 1 of the NEMA (R1147) regulations.
The Karee K4 shaft is located on the western limb of the Bushveld complex near Brits and Rustenburg in the North-West Province, South Africa.

This report will focus on the canal and berms around the Waste Rock Stockpile, the Pollution Control Dam for the stockpile and the pump line from the Pollution Control Dam to the Plant of the Karee K4 shaft which is situated at:

- 25° 40’ 8.10” S
- 27° 28’ 2.98” E

The locality of the Karee K4 shaft in relation to South Africa is shown in **Figure 1-1**.

[1] National Environmental management Act, 1998 (Act 107 of 1998), Government Notice Regulation 1147 dated 20 November 2015

Figure 1-1: Locality of Karee K4 shaft (Google Earth)

2 Details of author and experience

Hermanus Gideon (Deon) van der Merwe is registered as a Professional Engineer with ECSA, Registration number 960070 and is the Director of the company Hydrological Environmental Engineering Solutions (Pty) Ltd situated at: 18 Lemonwood street, Centurion, 0157, SOUTH AFRICA T:+27(0) 82 895 1538

Deon has 27-years' experience in a wide field. Deon specialises in the design and project management of projects comprising dams, SWMPs, rehabilitation plans, canals, gabion structures and concrete structures. He also has experience in the management and maintenance of pump schemes and general management. He has successfully completed many water-related projects for the mining sector but has undertaken work for an array of other clients in other various sectors.

Deon served as the area manager/deputy regional director of the Tugela-Vaal Government Water Scheme on behalf of the then Department of Water Affairs (DWA), he was the deputy chief engineer for open channel systems and manager of the hydraulic laboratory at the DWA. He is thus aware of the challenges South Africa faces in terms of water resources management. He started his career at the Department of Agriculture and at exiting was the Principal Engineer – Soil Conservation for the North-West Province.

His most recent project experience includes the cost closure methods and rehabilitation plans for, Jwaneng Diamond Mine, Thorncliffe Chrome Mine and Mogalakwena Platinum Mine. Deon is also the Approved Professional Person for the Dam Safety Evaluation of the 29 m high earth embankment Imvutshane Dam. Recent detail design work includes a Parshall flume for Mogalakwena Mine and an oil separator for Thorncliffe Mine.

Other large projects include the civil design of the 55 m high ACR Itare Dam components, the detail design for the rehabilitation of the 37 m high Mothusi Dam at Letseng Mine, EPC tender design of the ± 90 m high Arror ECRD, 3 130 m³/s diversion tunnels, dam intake structure and cofferdams for the 1000 MW Hydroelectric Power Sounda Gorge Project, serving as the Civil Design Engineer for a 40 m high Concrete Gravity Dam and Powerhouse on the Orange River in South Africa for a installed capacity of 22 MW, Assistant Civil Design Engineer for the water infrastructure tender design of the 40 MW Kabompo Gorge Hydroelectric scheme in Zambia, the Assistant Design Engineer for the feasibility investigations and option analysis for the uMkhomazi transfer scheme, Design Engineer on the river diversion tender design for Neckartal Dam, Design Engineer for the review on the river diversion of the Mphanda Nkuwa

Hydroelectric Project, Member of the project team for the Safety Evaluation of the Category III Bivane (Paris) Dam, Locumue (Mozambique) Dams, the Category II Doornpoort, Wilge River, 3rd Recovery, the Approved Professional Person for the Category II Raw Water Reservoirs at Lethabo Power Station and Imvutshane Dam and detail design and draughting of a 4 km concrete-lined canal for AngloGold Ashanti's West Complex (R6 million).

Deon's full *Curriculum Vitae* is attached as **Annexure A.**

3 Details of Applicant

Details of the applicant is shown in **Table 3-1**.

Table 3-1: Details of Applicant

Name	SIBANYE-STILLWATER WESTERN PLATINUM (PTY) LTD K4 SHAFT
Postal Address	Private bag X508 Marikana 0284
Contact Details	Tel: 014 571 2000 • Fax 014 571 2037

4 Project Context

4.1 Project background

Sibanye-Stillwater is the owner of the K4 Shaft that forms part of the Marikana Operations located near Marikana town, North-West Province. The Marikana Operations is divided into two entities consisting of Western Platinum (Pty) Ltd and Eastern Platinum (Pty) Ltd. The K4 Shaft falls under the Western Platinum (Pty) Ltd.

The shaft was placed under care and maintenance for a period of **6 years** but are being made ready to be fully operational in the year **2024.** The current Waste Rock dump on the property of the shaft has been established and licensed by the previous owner. Sibanye-Stillwater is planning to extend the Life of Mine (LOM) with approximately 30 years and the existing waste rock dump will be utilised. The size of the waste rock dump will not exceed the approved footprint as authorised in the Western Platinum Limited – Environmental Management Programme.

4.2 Project infrastructure

Additional infrastructure that needs to be implemented in order to chieve the full operation of the shaft, including the construction of the infrastructure as described in **Table 4-1** and the layout as in **Figure 4-1**.

Table 4-1: Proposed infrastructure

Proposed infrastructure	Description
Surface infrastructure	
Waste Rock Stockpile – V drains (protection berms)	The total final waste rock stockpile footprint area will be 203 830 m² and this footprint has already been authorised in the WPL EMPR. Canals and berms will be 1 353 meters in length and 10,83 meters wide. The west berm (V drain) length is 550 m and east berm (V drain) Length 600 m.
Pollution Control Dam	A Class C lined pollution control dam will be constructed with a capacity of **35 203 m³** and will have a maximum height of **3 m** from the floor of the dam. It will have a spillway of at least 0.8 m depth and an effected area of 3.6 ha.
Pipelines	Transfer water from the PDC to the K4 Shaft for re-use. The pipeline will be 500m in length with a total pump capacity of 60 m³/hour. It will consist of a 110 OD HDPE line, sized to empty the dam for a 1:20 year ARI over 14 days continuous operation.

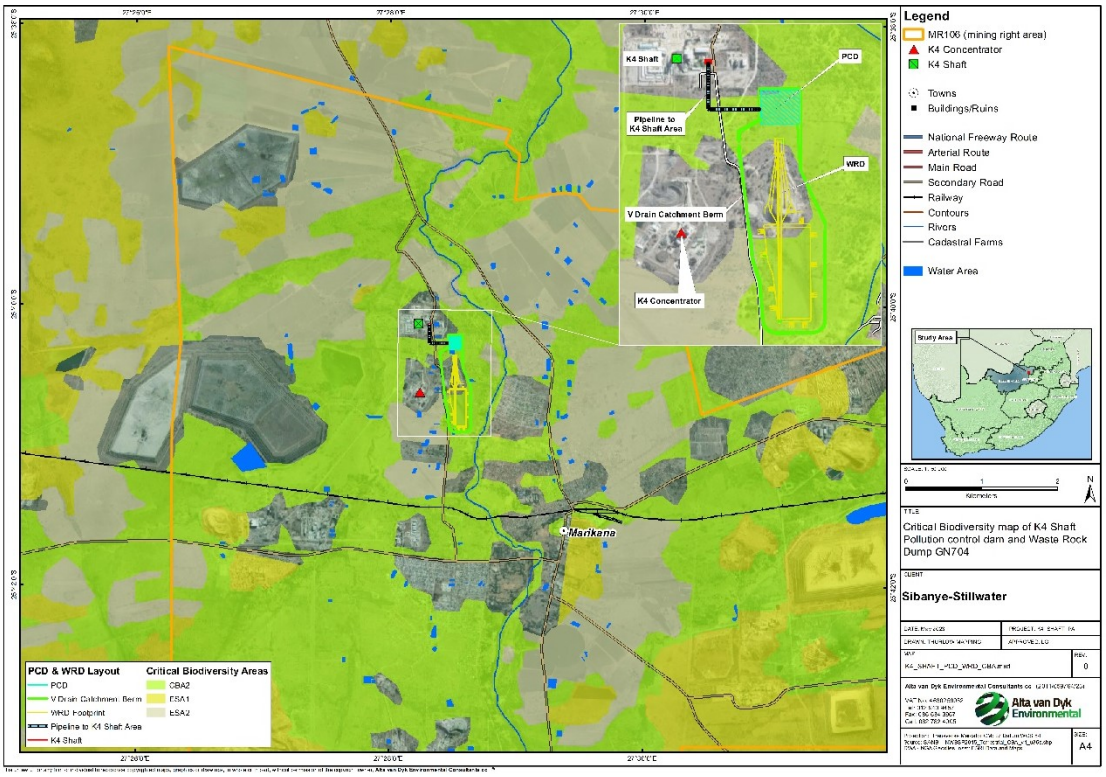

Figure 4-1: Infrastructure layout

5 Environmental Drivers and Context

5.1 Vegetation assessment (de Beer, 2022)

5.1.1 General

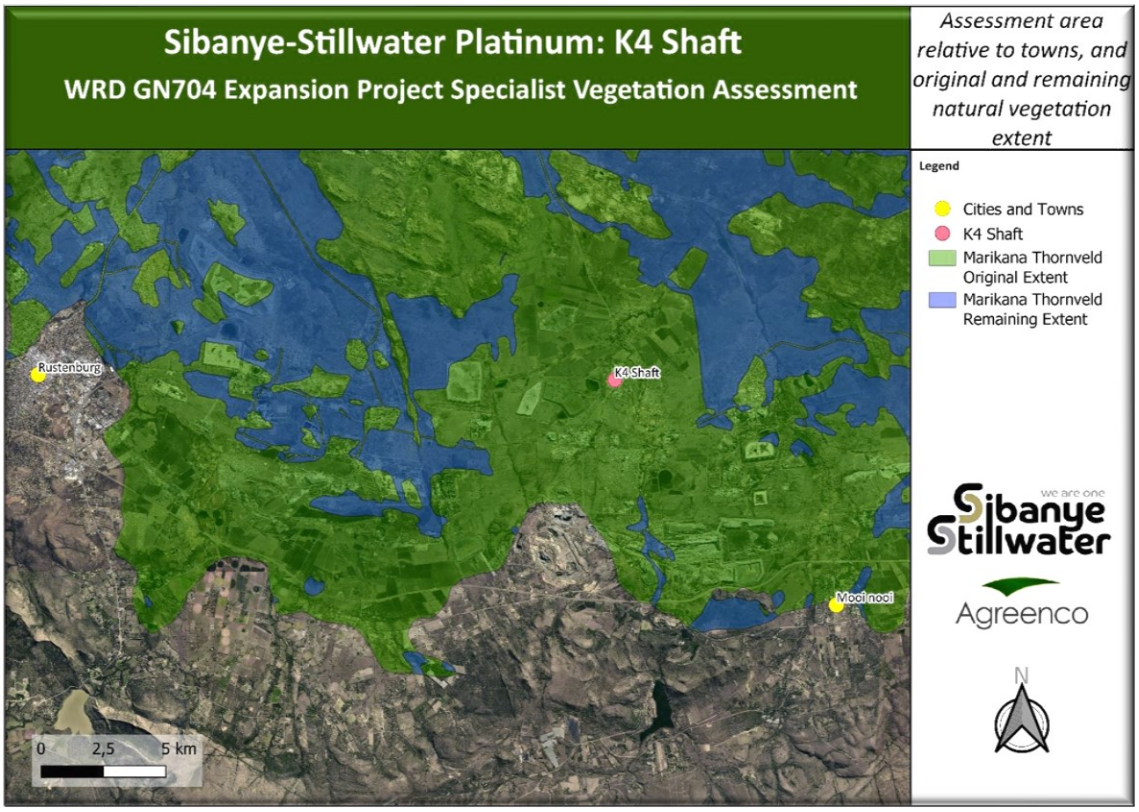

Figure 5-1: Locality of project in relation to towns and dominant veld type

The following summarised description of Marikana Thornveld vegetation applies (Mucina and Rutherford (2006)):

SVcb6 is generally characterized by valleys and slightly undulating plains and some lowland hills. It occurs in Gauteng and North-West Provinces from the Rustenburg area in the west, through Marikana and Brits to Pretoria eastwards.

The mean annual precipitation in the area ranges between 600 and 700mm which falls predominantly in the summer months. This region has a somewhat temperate climate with mean maximum and minimum temperatures ranging between 35.3°C (November) and -1.4°C (July) for Rustenburg with frost occurring during winter months. The geology of SVcb6 consists mainly of mafic intrusive rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex. Shales and quartzites of the Pretoria Group of the Transvaal Supergroup, also contribute. The soils are mainly vertic or melanic clays with some dystrophic or mesotrophic plinthic catenas and some freely drained,

deep soils. The vegetation of SVcb 6 is characterized by open Acacia karroo with more dense shrubby vegetation along drainage lines, on termitaria and rocky outcrops and other habitats that are protected from fires. The important woody species that occur in this vegetation type include Acacia karroo, A. nilotica subsp. kraussiana, A. tortilis subsp. heteracantha, A. caffra, A. gerrardii, Ziziphus mucronata, Searsia lancea, S. pyroides var. pyroides, Combretum molle, Grewia flava and Diospyros lycioides subsp. guerkei. Significantly represented grasses include Elionurus muticus, Eragrostis lehmanniana var. lehmanniana, Fingerhuthia africana, Setaria sphacelata, Heteropogon contortus and Themeda triandra, with Ischaemum afrum, Aristida scabrivalvis subsp. Scabrivalvis, Hyperthelia dissoluta, Melinis nerviglumis and Pogonarthria squarrosa Herb species of importance are Hermannia depressa, Ledebouria revoluta, Ipomoea obscura, Barleria macrostegia and Vernonia oligocephala. Alien invasive plants occur localized in high densities, especially along drainage lines.

5.1.2 Impact importance

The project infrastructure in relation to the importance of the vegetation is provided in **Figure 5-2**. It is shown in **Figure 5-2** that the area of the Pollution Control Dam is not situated at an important vegetation area, and it is confirmed that the area of the Waste Rock Facility is already approved in a previous process. The V-drains (berms) fall within the Waste Rock Facility Footprint.

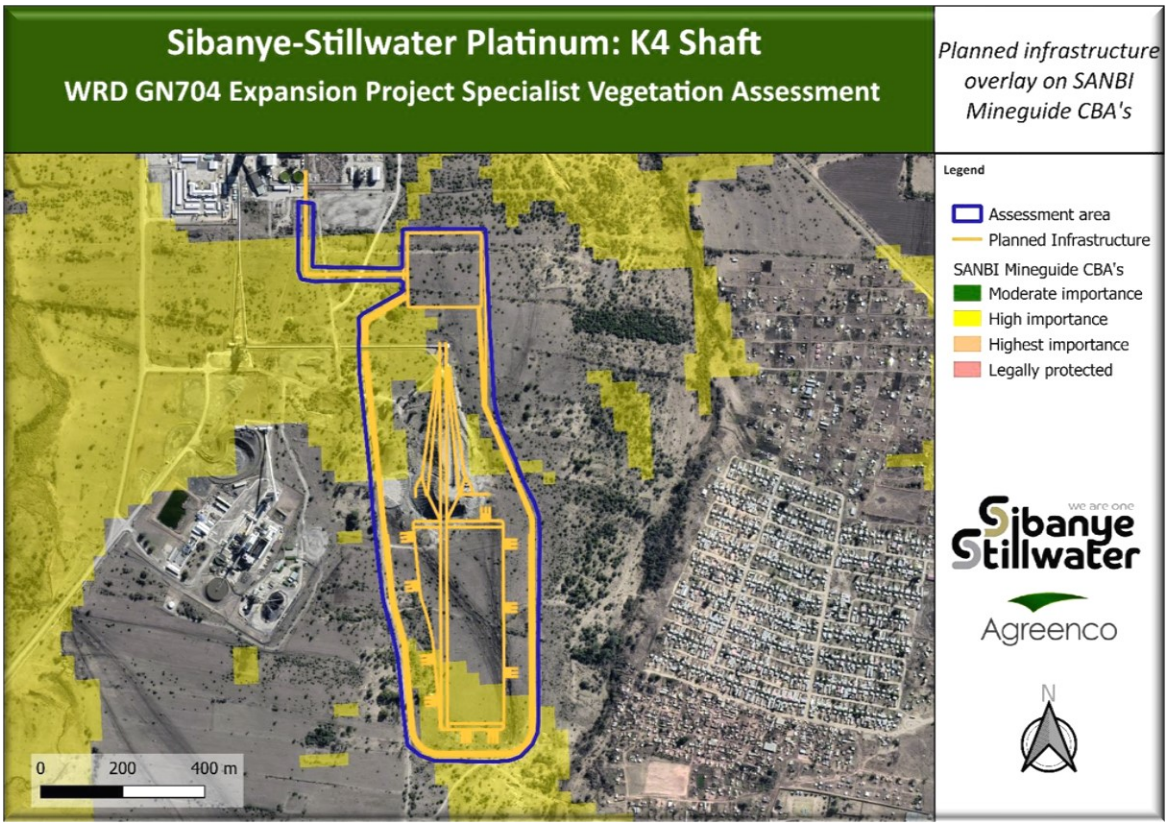

Figure 5-2: Project in relation to vegetation importance

5.2 Surface water assessment (Lourens, 2019)

The surface water assessment from Stormwater Solutions (Pty) Ltd (Lourens, 2019) address the infrastructure related to the mine excluding the Waste Rock Facility and Pollution Control Dam.

5.3 Waste classification

Due to the low contamination potential of the waste rock exemption from GN704 Regulation (4a), (4c) and 5 was obtained through licence No: 01/A21K/ABCEFGIHJ/4620 and the Waste rock material can be used as inert material. The contamination potential will be related to the migration of particles to the environment. The rehabilitation of the Waste rock dump will remove this potential.

5.4 Wetlands (Davis, 2023)

No wetlands are identified within 500m from the footprint of the PCD, canals and berms and pump line to the plant, while the Waste Rock Dump footprint is already approved (Davis, 2023).

5.5 Soil compliance (Mamera, 2023)

The soil suitability and land potential was identified and summarise as follows:
Sensitive soils identified were the Arcadia and Zondereinde soil forms with Rensburg, Rustenburg and Wasbank in the area with a land capacity class of III an IV and a land potential level 6. This area is **non-arable** and is classified as a low to medium sensitivity (Mamera, 2023).

5.6 Fauna and Flora (Burger, 2023)

A Fauna and Flora assessment was commissioned in order to assess the baseline ecological state of the area. This assessment involved the detection, identification and description of any local relevant receptors with the possible effect from the project. The conclusion from this study states:
The area has been historically altered and no significant impacts from a terrestrial ecology perspective are expected, subject to the proposed mitigation measures as escribed in the detail assessment report. This area is classified with a sensitivity rating of 'Very Low' (Burger, 2023).

5.7 Heritage assessment (van der Walt, 2023)

A heritage assessment of the project area was commissioned and the points of interest are shown in **Figure 3** with details in **Figure 4 and Figure 6**.These structural remains should be mapped before construction prior to development and a application for destruction permit can be applied for after mapping. However, continues monitoring for graves and other heritage resources should be executed during development (van der Walt, 2023).

an

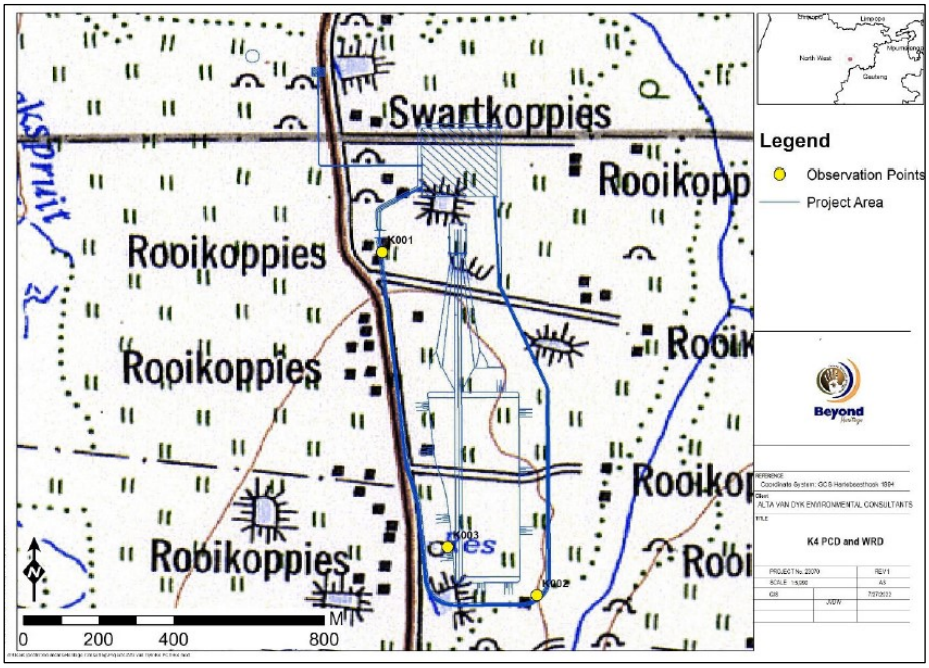

Figure 3: Points of interest for heritage at K001 to K003

Figure 4: Degrade trough at K001

Figure 7: General site view at K002

Figure 6: Stone features at K003

6 Social aspects influencing closure

Legacy Issues

Mining legacies are understood in relation to the completion of success criteria as set out by Stakeholders, in the context of the Closure Plan. When there is failure in the meeting the specific success criteria and therefore failure for effective closure it results in a negative mining legacy.

It is essential for a mine to ensure that the future public health and safety are not compromised and that the end product of mine closure results in beneficial and sustainable end-use for communities in the long term so that adverse socioeconomic impacts are minimised, and socioeconomic benefits are maximised.

Human Capital

The Mining Charter requires mines to formulate and implement a Human Resource Development and Planning (HRDP) to enable transformation and empowerment of the workforce, in particular the Historically Disadvantaged South Africans employees (HDSA), to progress to higher levels of employment in the organisation, and to be able to exploit alternative income generating opportunities outside of the organisation.

Skills and knowledge of employees and therefore the surrounding communities are restricted to the mining industry. This results in difficult implementation of skill transfer programmes as developed by the mine when closure occurs, the consequences of which are prolonged unemployment periods within the surrounding community, where there is already a limited income.

The Mine requires a skilled workforce for daily activities, and therefore offers training support and career development opportunities to its employees, in particular to the Historically Disadvantaged South African (HDSA) employees from the local labour sending areas. The Mine complies with the requirements of the Skills Development Act (No 97 of 1998) and submits Workplace Skills Plans and Annual Training Reports to the Mining Qualifications Authority (MQA).

Post-mining land use

Post closure land use is normally determined in consultation with the stakeholders (inclusive of the tribal authorities who hold the surface rights). Collective views on post-mining land use might be difficult to obtain in the cases where indigenous people have strong links with the natural environment and land and where traditional rights holds a huge social impact on the surrounding community. Finding a balanced viewpoint on the post-mining land use which will satisfy all stakeholders involved will allow for a smooth transition in the relinquishment of the mine to the appropriate third parties.

Loss of Employment

The closure phase of any mining company results in the massive downgrade of workforce as relevant positions become irrelevant with the decommissioning of mining processes. Social aspects associated with the loss of employment include:

- Poor social risks management regarding communities not being properly prepared for the loss of employment (improper implementation of assessment and counselling services, comprehensive self-employment training programmes and comprehensive training and re-employment programmes)
- Since all mining operations will one day come to an end, the Mine will equip those employees with mining-specific skills with non-mining-related portable skills to enable them to find other forms of livelihood in other sectors of the economy. Only those lower level employees working at the plant can be considered as having mining-specific skills and would therefore have been given the opportunity to acquire a non-mining-related portable skill. However, the location of the mine makes it easy for these employees to be absorbed by other mines around. Hence, the focus is also on how to make them more marketable to other mines given their experience in mining. NA will assist these miners in acquiring self-marketing skills through CV writing and interview skills, and also assist them to obtain employment in the surrounding mines.
- Sibanye-Stillwater K4 Shaft Mine will implement a sustainable community development initiative to ensure that Sibanye-Stillwater K4 Shaft Mine meet the requirements of participation in Local Economic Development (LED) programmes. These LED will be aligned with the initiatives of the Integrated Development Plans (IDP's) of Local Municipality (Rustenburg) and the District Municipality (Bojanala Platinum District Municipality).

7 Surrounding Mining Activities

The Rustenburg surrounding area is Chrome and Platinum rich as can be seen in **Figure 7-1.** The following are some of the mining companies ,but not limited to, located in the surrounding area:

- Impala Platinum (Implats)
- Anglo American Platinum (Amplats)
- Northam Platinum
- Eastern Platinum (Eastplats)
- Norilsk Nickel
- Sylvania Platinum
- African Thunder Platinum
- Aberdeen International Inc
- African Rainbow Minerals (ARM)
- Lonmin Plc
- Wesizwe Platinum
- Platinum Group Metals
- Nkwe Platinum
- Sedibelo Platinum Mines
- Sibanye Platinum
- Ivanhoe

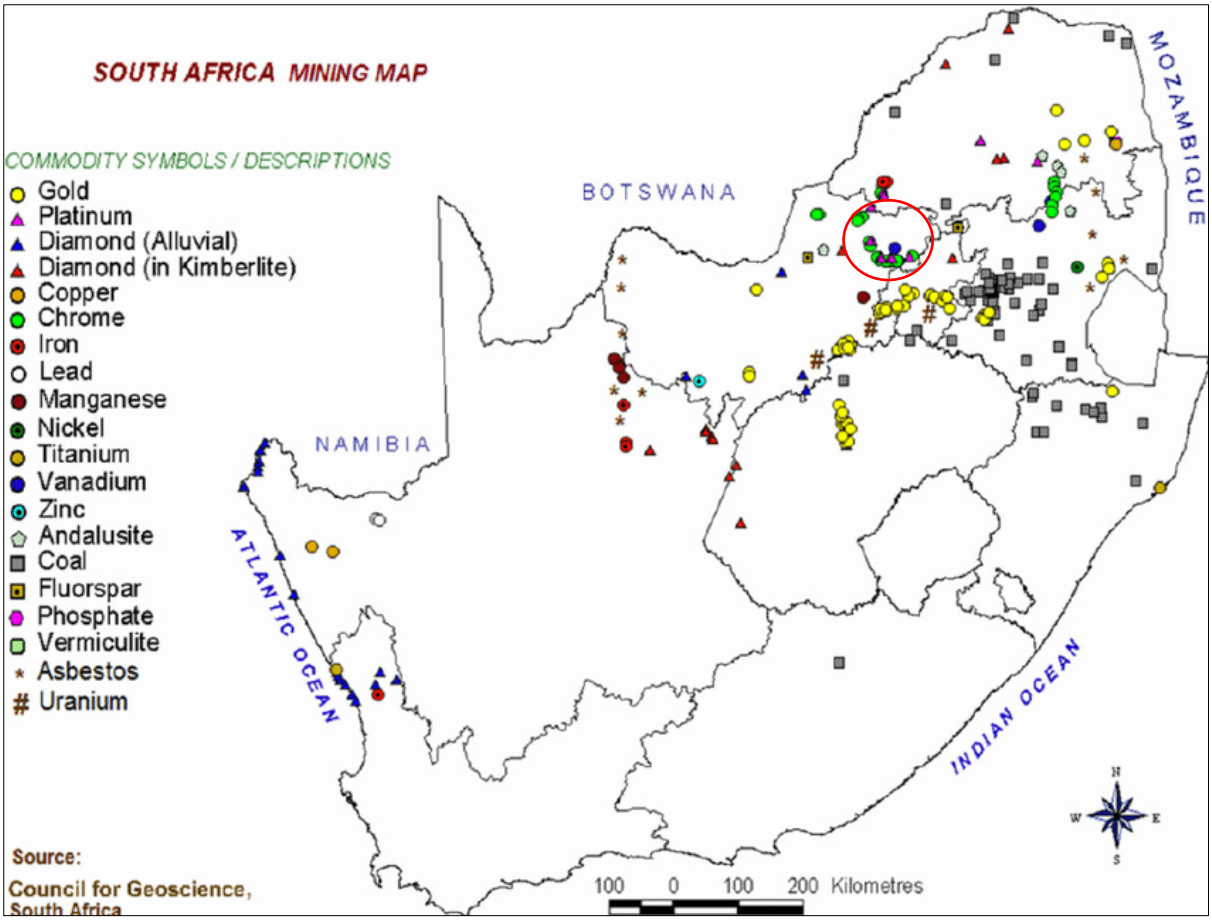

Figure 7-1: South Africa Mining Map

8 Stakeholder issues

Stakeholder issues are written in a logbook that will be kept at the mine office and the mine have a department to address and attend to relevant engagement and support.

9 Results of environmental risk assessment

The rehabilitation plan is based and addresses the findings of the Risk Assessment (RA) as compiled in this section.

9.1 Risk Assessment methodology

A risk assessment table was compiled in order to quantify the risks. The significance of the identified impacts will be determined using an accepted methodology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998. As with all impact methodologies, the impact is defined in a semi-quantitative way and will be assessed according to methodology prescribed in the following section.

The EIA methodology complies to Regulation 31(2)(l) of the National Environmental Management Act (Act 107 of 1998) (NEMA), and requires that each potential impact is assessed in terms of the following components:

Table 9-1: Scale utilised for the evaluation of the Environmental Risk Ratings

Evaluation Component	Rating	Scale	Description / criteria
MAGNITUDE of negative impact (at the indicated spatial scale)	10	Very high	Bio-physical and/or social functions and/or processes might be *severely* altered.
	8	High	Bio-physical and/or social functions and/or processes might be *considerably* altered.
	6	Medium	Bio-physical and/or social functions and/or processes might be *notably* altered.
	4	Low	Bio-physical and/or social functions and/or processes might be *slightly* altered.
	2	Very low	Bio-physical and/or social functions and/or processes might be *negligibly* altered.
	0	Zero	Bio-physical and/or social functions and/or processes will remain *unaltered*.
MAGNITUDE of POSITIVE IMPACT (at the indicated spatial scale)	10	Very high	Positive: Bio-physical and/or social functions and/or processes might be *substantially* enhanced.
	8	High	Positive: Bio-physical and/or social functions and/or processes might be *considerably* enhanced.
	6	Medium	Positive: Bio-physical and/or social functions and/or processes might be *notably* enhanced.
	4	Low	Positive: Bio-physical and/or social functions and/or processes might be *slightly* enhanced.
	2	Very low	Positive: Bio-physical and/or social functions and/or processes might be *negligibly* enhanced.
	0	Zero	Positive: Bio-physical and/or social functions and/or processes will remain *unaltered.*
DURATION	5	Permanent	Impact in perpetuity. –
	4	Long term	Impact ceases after operational phase/life of the activity

Evaluation Component	Rating	Scale	Description / criteria
	3	Medium term	Impact might occur during the operational phase/life of the activity
	2	Short term	Impact might occur during the construction phase
	1	Immediate	Instant impact.
EXTENT (or spatial scale/influence of impact)	5	International	Beyond the National boundaries.
	4	National	Beyond provincial boundaries, but within National boundaries.
	3	Regional	Beyond 5 km of the Mine and within the provincial boundaries.
	2	Local	Within a 5 km radius of the Mine.
	1	Site-specific	On site or within 100 meters of the site boundaries.
	0	None	Zero extent.
IRREPLACEABLE loss of resources	5	Definite	Definite loss of irreplaceable resources.
	4	High potential	High potential for loss of irreplaceable resources.
	3	Moderate potential	Moderate potential for loss of irreplaceable resources.
	2	Low potential	Low potential for loss of irreplaceable resources.
	1	Very low potential	Very low potential for loss of irreplaceable resources.
	0	None	Zero potential.
REVERSIBILITY of impact	5	Irreversible	Impact cannot be reversed.
	4	Low irreversibility	Low potential that impact might be reversed.
	3	Moderate reversibility	Moderate potential that impact might be reversed.
	2	High reversibility	High potential that impact might be reversed.
	1	Reversible	Impact will be reversible.
	0	No impact	No impact.
PROBABILITY (of occurrence)	5	Definite	>95% chance of the potential impact occurring.
	4	High probability	75% - 95% chance of the potential impact occurring.
	3	Medium probability	25% - 75% chance of the potential impact occurring
	2	Low probability	5% - 25% chance of the potential impact occurring.
	1	Improbable	<5% chance of the potential impact occurring.
	0	No probability	Zero probability.

Evaluation Component	Rating	Scale	Description / criteria
Evaluation Component	**Rating scale and description / criteria**		
CUMULATIVE impacts	High: The activity is one of several similar past, present or future activities in the same geographical area, and might contribute to a very significant combined impact on the natural, cultural, and/or socio-economic resources of local, regional or national concern. *Medium:* The activity is one of a few similar past, present or future activities in the same geographical area, and might have a combined impact of moderate significance on the natural, cultural, and/or socio-economic resources of local, regional or national concern. *Low:* The activity is localised and might have a negligible cumulative impact. *None:* No cumulative impact on the environment.		

Once the Environmental Risk Ratings have been evaluated for each potential environmental impact, the Significance Score of each potential environmental impact is calculated by using the following equation:

SS (Significance Score) = (magnitude + duration + extent + irreplaceable + reversibility) x probability.

The maximum Significance Score value is 150.

The Significance Score is then used to rate the Environmental Significance of each potential environmental impact as per **Table 9-2** below. The Environmental Significance rating process is completed for all identified potential environmental impacts both before and after implementation of the recommended mitigation measures.

Table 9-2: Scale used for the evaluation of the Environmental Significance Ratings

Significance Score	Environmental Significance	Description / criteria
125 – 150	Very high (VH)	An impact of very high significance will mean that the project cannot proceed, and that impacts are irreversible, regardless of available mitigation options.
100 – 124	High (H)	An impact of high significance which could influence a decision about whether or not to proceed with the proposed project, regardless of available mitigation options.
75 – 99	Medium-high (MH)	If left unmanaged, an impact of medium-high significance could influence a decision about whether or not to proceed with a proposed project. Mitigation options should be relooked at.
40 – 74	Medium (M)	If left unmanaged, an impact of moderate significance could influence a decision about whether or not to proceed with a proposed project.
<40	Low (L)	An impact of low is likely to contribute to positive decisions about whether or not to proceed with the project. It will have little real effect and is unlikely to have an influence on project design or alternative motivation.
+	Positive impact (+)	A positive impact is likely to result in a positive consequence/effect, and is likely to contribute to positive decisions about whether or not to proceed with the project.

9.2 Planned activities

The proposed development and its associated activities are all planned within the mining right area and confined to the Waste Rock Stockpile extension, Pollution Control Dam and related structures. The “spatial extent is regarded as “Site Specific”, with the exception of the effects from erosion (water and/or wind) which might impact the downslope/downwind environments. These impacts are considered to be of a “Localised” spatial effect.

The infrastructure considered as part of this investigation include:

- The stormwater control berms, trenches, from the Waste Rock Stockpile
- Pollution Control Dam and related infrastructure,
- Pipeline from Pollution Control Dam to the shaft.

These facilities and associated support activities will entail the removal of significant quantities of utilisable soil soft overburden and hard rock. This will include the design of engineered foundations for the associated stormwater control trenches, berms and PCD and the construction and implementation of support infrastructure and activities (piping).

All of these soils will be sterilised and lost from the system for the life of the operation.

A number of site-specific baseline (existing environment) conditions need mention here if the relative significance of the activities being planned are to be understood.

Of importance are:

- The soil structure and clay content are important when considering the effects of compaction and the potential impacts of storage of the soil structure and soil health.
- The occurrence/presence of soils with a shallow rooting depth (<400mm) that form restrictions and or inhibiting layers to soil water movement (hydro pedological conditions) down the profile. This will in almost all cases [deep foundations or facilities (dams etc.)] be destroyed and possibly removed from the system. Reinstatement of these layers is difficult, and the impacts will affect the end land use and overall ecological status at closure as a result.
- Removal of vegetation from any of the soils mapped will result in increased erosion to varying degrees and impacts on the receiving environment (streams, rivers and dams).

These conditions will have an influence on the overall impact significance rating as loss of these features will have a definite localised or site-specific negative impact on the ecological functionality of the area and will have a bearing on the management recommendations tabled.

9.3 Mitigation of risk by closure plan

The following matrix describe all identified risks, the mitigation thereof and the resultant risk quantification. It can be seen that the rehabilitation measures reduce the risks significantly.

Table 9-3: Identified risk, mitigation measures and mitigated quantified risks

RISK BEFORE AND AFTER REHABILITATION PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								Cumulative	Status	RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	E	I	R	Tot	Prob	SS				M	D	E	I	R	Tot	Prob	SS
SOILS, LAND USE AND LAND CAPABILITY (REMOVED WRD BERMS, POLLUTION CONTROL DAM AND PIPELINE)																					
Decommissioning and Closure Phase	Soil erosion	Management of surface water run-off and erosion through gully formation	8	3	3	3	2	19	4	76	Medium High	Negative	Management of Soil Erosion	4	1	1	2	2	10	4	40
			Mitigating measures: • Topsoil and contour/bench rehabilitated areas as to prevent wind and water erosion. • Monitor the impact from erosion after a severe rainfall event and implement repairs immediately. Where appropriate, allow for energy dissipation structures or sedimentation traps to be constructed. • Stabilise all open slopes immediately to prevent erosion and gully formation. Ensure that gradients of the slopes are planned in such a way so that the run-off water will not cause wash ways. • Allow for the natural succession of indigenous species. Should it seem that indigenous species battle to colonise the areas, consideration should be given to the establishment of vegetation by means of a seed mix.																			
	Soil compaction	Mechanical foundation compaction from increased vehicular movement.	4	2	2	2	2	12	4	48	Medium	Negative	Management of Soil Compaction	1	5	1	1	1	9	4	36
			Mitigating measures: • Minimise catchment hardening as far as possible, and design and implement a rigorous storm water management system for the development area. • Restrict vehicular movement to the demarcated areas as to allow for rehabilitation to occur successfully. • For rehabilitation purposes, rip the soils to at least 25cm to allow for seed germination and natural plant succession.																		
	Soil contamination	Spills/leaks of minerals and improper waste handling, storage, and disposal.	2	3	1	1	1	8	4	32	Low	Negative	General – All areas	0	0	0	1	1	2	1	2
			Mitigating measures: • Provide spill containment kits across the operation in suitable locations and train staff how to use these. • Maintain and implement an Incident Management and Emergency Procedure/s. • Maintain the vehicle and equipment maintenance plan. Vehicles and machinery must be regularly serviced and operated according to manufacturer's specifications. When an emergency breakdown occurs, adequate drip plates shall be used to prevent oils / lubricants / fuels from spilling onto exposed soils. • Vehicles only to be services at dedicated areas located outside of the development area. No servicing or repairs to take place on bare soil. • Burying of waste to be strictly prohibited. • Any general waste that cannot be recycled must be disposed of at an approved landfill site as general waste. Make use of a licensed/permitted waste contractor. • Hazardous waste should be placed into hazardous waste skips and should then be removed together with other hazardous waste by a licensed/permitted waste management contractor and disposal of at a licensed hazardous landfill site. • Ensure that dirty areas are contained, and oil separators are incorporated as relevant. • Development of updated closure plans based on the outcome of the soil and aquifer characterisation studies.																			
SURFACE WATER																					
Decommissioning and Closure Phases	Water Quality	Siltation of surface water resource - transportation of disturbed soils.	2	4	1	3	1	11	5	55	Medium	Negative	Storm Water Management	1	4	1	2	1	9	3	27
			Mitigating measures: • Maintain an appropriate stormwater management system throughout the decommissioning and closure phase. • Implement rehabilitation and monitor the adequacy of vegetation cover of disturbed areas. • Confine any unpolluted water to a clean water system, away from any dirty area. • Implement a suitable water monitoring programme as per the requirements of the Water Use Licence. • Inspect diversion trenches and berms after a heavy storm event as to ensure the integrity and stability and to address erosion problems immediately. • Implementation of energy dissipaters at the appropriate places as to reduce the velocity and speed of surface water run-off and the risk of erosion and sedimentation.																			
			3	4	1	1	1	10	4	40	Medium	Negative	Hydrocarbon Management	0	0	0	1	1	2	1	2

RISK BEFORE AND AFTER REHABILITATION PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								Cumulative	Status	RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	E	I	R	Tot	Prob	SS				M	D	E	I	R	Tot	Prob	SS
		Hydrocarbon Contamination - Spillages / leaks of oil, grease, diesels etc	Mitigating measures: • Repairs must take place in designated areas where there are adequate facilities to contain spills and leaks of the hydrocarbon products. • Drip trays must be used where spills/leaks are likely to occur. • Drip trays must be placed under vehicles/machinery. • If spills or leaks do occur, they must be cleaned up immediately. Drainage Systems, Sumps and Separators: • No dirty or contaminated water must be discharged into the surrounding environment. • All channels and drains should be shaped to smooth slopes and integrated into natural drainage patterns. Disposal: • No oil is to be disposed of in the veld or down any drains. • A reputable hazardous waste removal company must collect waste oil for recovery. • Hazardous waste contaminated with oil must be correctly disposed of. Spills and leaks • All commitments as provided for under “spills and leaks”.																			
		Surface water contamination by solids and mineral solids	2	3	1	1	1	8	4	32	Low	Negative	Management of Leaks and Spills	2	1	1	1	1	6	3	18
			Mitigating measures: • All spills and leaks of chemical and petrochemical products must be reported as per the Incident and Emergency Response Procedure/s. • Allow for drip trays to contain possible spillages/leakages from equipment. • The spill must be assessed and addressed in accordance with EMS Procedures. • All commitments as provided for under the “Hydrocarbon Management” section.																		
		Poor general and hazardous waste management practices.	5	4	1	1	1	10	4	40	Medium	Negative	General and Hazardous Waste Management	0	1	1	1	1	4	2	8
			Ensure compliance with applicable legislation. • National Environmental Management Waste Act 59 of 2008 (NEMWA) and all the relevant regulations and Norms and Standards. • Respective Municipal by-laws. No person may: • Dispose of waste, or knowingly or negligently cause or permit waste to be disposed of, in or on any land, water body or at any facility unless the disposal of that waste is authorised by law. • Dispose of waste in a manner that is likely to cause pollution of the environment or harm to health and well-being. • Dumping or impounding of rubble, litter, garbage, rubbish or discards of any description, whether solid or liquid, must take place only at the site or sites demarcated for such purpose in accordance with the measures stipulated in this document. • Where possible and in terms of safety and security, waste receptacles should be provided so at to prevent littering and dumping on site. Illegal disposal, dumping and littering is illegal. • All hazardous wastes (non-recyclable) are to be transported directly off site to hazardous waste disposal facilities by Hazardous waste contractor. • Implement a suitable water monitoring programme as per the requirements of the Water Use Licence. • Spill kits must be available at all areas where hazardous waste is being handled; if spills occur they must be cleaned up immediately by following the Spill Procedure. • Waste may not be burnt.																			
		Reduced catchment yield - containment of water on site.	2	5	1	1	5	14	5	70	Medium	Negative	Catchment Yield and Water Demand	2	5	1	1	5	14	5	70
			• Implement effective clean and dirty water separation systems as part of the storm water management plan - Ensure through effective implementation that clean water is allowed to leave the site clean and that clean water is not allowed to spill into the dirty water system and vice versa. • Confine any unpolluted water to a clean water system, away from any dirty areas.																		
BIODIVERSITY – FAUNA, FLORA AND WETLAND AREAS																					
Decommissioning and Closure Phases	Alien and Invasive Plant Colonisation		4	5	1	1	1	12	5	60	Medium	Negative	Alien and Invasive Plant Management	2	1	1	1	1	6	2	12
			Mitigating measures: • Recurring invasive species must be controlled and removed (Category 1a and 1b (NEM:BA) and Category 1 and 2 (CARA)).																		

RISK BEFORE AND AFTER REHABILITATION PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								Cumulative	Status	RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	E	I	R	Tot	Prob	SS				M	D	E	I	R	Tot	Prob	SS
			• Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment. • The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing off-spring, forming seed, regenerating or re-establishing itself in any manner. • A programme should be implemented to identify, manage and eradicate alien and invasive species. • The use of herbicides and pesticides must be limited as far as possible. • Herbicides should only be applied in the concentrations prescribed by the product labels and the safety instructions on the product labels should be followed at all times. • Only contractors with a valid pest control operator (PCO) certificate (certified by the Department of Agriculture, for a specific field of pest control) will be permitted to oversee the application of chemicals for the eradication of alien vegetation. Copies of these valid certificates must be kept																			
	Destruction / alteration of protected species and their habitat	Wetland degradation due to sedimentation and water quality and quantity impacts	6	4	1	3	3	17	5	85	Medium High	Negative	Protection of Sensitive Landscapes	2	1	1	3	3	10	3	30
			Mitigating measures: • Ensure an effective clean and dirty water separation systems as part of the storm water management plan - Ensure through effective implementation that clean water is allowed to leave the site clean and that clean water is not allowed to spill into the dirty water system and vice versa. • Implement an effective monitoring programme as per the approved Water Use Licence. • Ensure stabilisation of slopes to reduce erosion into the wetlands																			
		Uncontrolled veld fires	2	2	1	1	1	7	3	21	low	Negative	Management of veldt fires	2	2	1	1	1	7	3	21
			Mitigating measures: • No informal fires are allowed within the area as to prevent veld fires. • Adequate firefighting equipment should be provided on-site. • Correct PPE should be used.																			
		Poaching	3	5	1	3	1	13	2	26	Low	Negative	Poaching	3	5	1	3	1	13	2	26
			Mitigating measures: • Implement an Anti-Poaching Procedure. • No trapping or hunting of any faunal species is to take place within the mining area and should any faunal species be encountered that may need relocation, these species will be relocated to a suitable habitat. • Implement access control to site as to manage the movement of construction workers on and off site.																			
GROUNDWATER																					
Decommissioning and Closure Phases	Groundwater Pollution / Hydrocarbon Pollution	Contamination of groundwater due to waste management, sewage management and chemical spills onto the soils.	4	3	1	3	1	4	4	60	Medium	Negative	Management of Groundwater Contamination	4	3	2	2	2	3	3	39
			Mitigating measures: • All management / mitigation measures outlined in the surface water section above must be fully implemented. • To prevent groundwater pollution, it is critically important that all spills are collected and treated immediately after the incident occurs, to prevent leaching of contaminants into the groundwater resources. • Leaks must be repaired immediately to stop leaching into soils and subsequently into the groundwater resource. • Implement suitable barrier (liner) and leachate detection systems where required. • A suitable monitoring program is to be implemented as per the approved Water Use Licence. • Routine checks should be done on all mechanical instruments for problems such as leaks.																			
NOISE																					
Decommissioning and Closure Phases	Elevated noise levels causing disturbance	Noise caused by the construction activities, site clearance activities, stripping and stockpiling, civil works and	4	3	2	3	3	15	3	45	Medium	Negative	Management of elevated noise levels	3	3	2	3	3	14	2	28
			Mitigating measures: • Implement regular engineering maintenance schedules for construction equipment. • Implement a vehicle and equipment maintenance plan. • Implement a noise monitoring program. • Implement appropriate Personal Protective Equipment in working areas with elevated noise levels. • Implement noise grievance procedure. • Vehicular speeds should be restricted as to limit noise levels.																			

RISK BEFORE AND AFTER REHABILITATION PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								Cumulative	Status	RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	E	I	R	Tot	Prob	SS				M	D	E	I	R	Tot	Prob	SS
		haulage of building materials, operational activities and decommissionin g and closure activities	• Regular maintenance schedules, especially for diesel-powered equipment, must include the checking of the functional state of all intake and exhaust noise attenuators, the effectiveness of enclosures or any other noise control measures. • Decommissioning and closure phase activities to be undertaken during the day-time. • Mobile equipment noise: • Use designated routes. • Fit efficient silencers and enclose engine compartments. • Damp mechanical vibrations where practicable. • Ensure that all machinery and vehicles are well maintained.																			
VISUAL																					
Decommissioning and Closure Phases	Generation of dust leading to visual intrusion and impacts on the overall landscape character.	Generation of dust during construction, operation and closure activities.	2	2	1	1	1	7	2	14	Low	Negative	Fugitive Dust	2	2	1	1	1	7	2	14
			Mitigating measures: • Implement all measures as per the Air Quality Section. • Implement dust suppression on all dirt roads. • Implement speed limits and traffic calming measures where appropriate. • Implement dust suppression on overburden stockpiles																		
AIR QUALITY																					
Decommissioning and Closure Phases	Increased fugitive dust.	Vehicular movement.	2	2	1	1	1	7	2	14	Low	Negative	Fugitive Dust	2	2	1	1	1	7	2	14
			Mitigating measures: • Keep footprint as small as possible. • Enforce speed limits on site. • Implement a dust monitoring network. • Implement dust suppression measures. • Dust fallout from unpaved roads is to be mitigated.																		
	Increased emissions.	Generation of greenhouse gasses caused by construction machinery and vehicles.	2	2	1	1	1	7	2	14	Low	Negative	Emissions, Gaseous and Particulate matter	2	2	1	1	1	7	2	14
			Mitigating measures: • Implement a vehicle and equipment maintenance plan. • Any vehicles (Construction vehicles, fleet vehicles, Ore Transport vehicles, Private vehicles) continuously emitting black smoke must undergo the necessary repairs. • Pesticides and Herbicides • Spraying of pesticides and herbicides must take place by a registered Pest Control Officer (PCO), certified to apply pesticides and/or herbicides.																		
ARCHAEOLOGICAL (Heritage/Cultural)																					
Decommissioning and Closure Phases	Graves and archaeological structures	Loss and demolishment of structures	4	5	1	5	5	20	2	40	Medium	Negative	Heritage and Archaeological Aspects	2	1	1	1	1	6	2	12
			Mitigating measures: • Ensure all aspects of archaeological recommendations are adhered to																		
TRAFFIC																					
Decommissioning and Closure Phases	Increased traffic volumes and increased road safety risks	Impact on existing traffic	4	3	1	1	1	10	5	50	Medium	Negative	Road Safety	4	3	1	1	1	10	2	20
			Mitigating measures: • All employees, contractors and transporters should be made aware on the safe use of the roads, including adhering to the speed limit and emergency preparedness measures. • Implement traffic calming measures, where required. • Implement a Traffic Management Plan in areas where it may be required to manage vehicle flow. • Conduct alcohol breathalyser testing on all drivers entering and leaving the operation, and where necessary, take relevant action (to be defined in the operation's Fitness for Work procedure). • Ensure that roads are maintained at all times to an acceptable standard. • Ensure that all vehicles are road worthy.																		

RISK BEFORE AND AFTER REHABILITATION PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								Cumulative	Status	RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	E	I	R	Tot	Prob	SS				M	D	E	I	R	Tot	Prob	SS
SOCIO-ECONOMIC																					
Decommissioning and Closure Phase	Job losses	Rehabilitation and closure at the end of operation may result in job losses	4	5	1	1	1	12	5	60	Medium	Negative	Retrenchments	4	1	1	1	1	8	5	32
			Mitigating measures: • Consideration must be given to measures that will reduce retrenched employees' difficulties in finding work elsewhere and consequent unemployment for long periods. • Ensure that skills transfer programmes are successful. • Ensure that the closure objectives are incorporated into the Closure Plan.																		
Decommissioning and Closure Phases	Community health and safety.	Anti-social behaviour.	4	3	1	1	1	10	4	40	Medium	Negative	Anti-Social Behaviour	4	3	1	1	1	10	2	20
			Mitigating measures: • Implement strict access control to the site. • Develop a training and awareness programme addressing the spread and control of communicable diseases and anti-social behaviour. • Ensure safe transportation is available to and from the site. • Undertake alcohol and drug testing if and when required. • Implement a suitable disciplinary procedure.																		

10 Design principles

The relevant design principles are:

- Contour spacing: The basis of this is the USLE (La grange matthee, Van Staden, & Smithers, 1979) equation.
- All areas should be safeguarded as far as practically possible.
- Velocities allowable over soil range between 0.6m/s on sand to 2.5m/s on Kikuyu grass (Kruger, Van Vuuren, Van Dijk, & Gomes, 2013).

Mean annual rainfall (mm)	< 600			600 – 700			> 700		
Type of grass	% Clay content in the soil								
	> 15	6 - 15	< 6	> 15	6 - 15	< 6	> 15	6 - 15	< 6
Kikuyu	No data			1,8	1,5	0,8	2,5	2,0	1,2
NK 37				2,0	1,5	0,8	2,0	1,5	1,0
K11				1,5	0,8	0,6	2,0	1,5	1,0
Rhodes				1,2	0,8	0,6	1,5	1,0	0,8
*E Curvula	1,0	0,8	0,8	1,2	0,8	0,6	1,5	1,0	0,8
Blue Buffalo	1,0	0,8	0,8	1,2	0,8	0,6	No data		
Paspalum didatum	No data			1,2	0,8	0,6	2,0	1,5	1,0

- Rational method alternative 3 for any peak run-off calculations (Kruger, Van Vuuren, Van Dijk, & Gomes, 2013).
- Mix of local grass species for vegetation of areas.
- Ameliorants can consist of organic material.

10.1 Legal framework

The following Acts have relevance to the rehabilitation and closure action by a mine:

10.1.1 Minerals and petroleum resources development (MPRDA) Act, Act 28 of 2002

The following extracts relate to the closure of a mine and for any right issued under the MPRDA:

- *Section 43(1): The holder of a prospecting right, mining right, retention permit, mining permit, or previous holder of an old order right or previous owner of works that has ceased to exist, remains responsible for any environmental liability, pollution, ecological degradation, the pumping and treatment of extraneous water, compliance to the conditions of the environmental authorisation and the management and*

sustainable closure thereof, until the Minister has issued a closure certificate in terms of this Act to the holder or owner concerned.

- *Section 43(4): An application for a closure certificate must be made to the Regional Manager in whose region the land in question is situated within 180 days of the occurrence of the lapsing, abandonment, cancellation, cessation, relinquishment or completion contemplated in subsection (3) and must be accompanied by the required information, programmes, plans and reports prescribed in terms of this Act and the National Environmental Management Act, 1998.*
- *Section 43 (5): No closure certificate may be issued unless the Chief Inspector and each government department charged with the administration of any law which relates to any matter affecting the environment have confirmed in writing that the provisions pertaining to health and safety and management pollution to water resources, the pumping and treatment of extraneous water and compliance to the conditions of the environmental authorisation have been addressed.*
- *Section 43 (7): The holder of a prospecting right, mining right, retention permit, mining permit, or previous holder of an old order right or previous owner of works that has ceased to exist, or the person contemplated in subsection (2), as the case may be, must plan for, manage and implement such procedures and such requirements on mine closure as may be prescribed.*
- *Section 43 (8): Procedures and requirements on mine closure as it relates to the compliance of the conditions of an environmental authorisation, are prescribed in terms of the National Environmental Management Act, 1998.*

10.1.2 Mineral and petroleum resources development regulations

The following extracts from the MPRDA Regulations are specifically applicable to the preparation of this Financial Provisioning and Closure of a mine:

- *Regulation 51 (a)(i): An environmental management programme contemplated in section 39(1) of the Act must include the following: A description of the environmental objectives and specific goals for mine closure;*
- *Regulation 54: Quantum of financial provision:*

  (1) The quantum of the financial provision as determined in a guideline document published by the Department from time to time, include a detailed itemization of all actual costs required for-

  a. premature closure regarding- (i) the rehabilitation of the surface of the area; (ii) the prevention and management of pollution of the atmosphere; and (iii) the

prevention and management of pollution of water and the soil; and (iv) the prevention of leakage of water and minerals between subsurface formations and the surface.

b. decommissioning and final closure of the operation; and

c. post closure management of residual and latent environmental impacts.

(2) The holder of a prospecting right, mining right or mining permit must annually update and review the quantum of the financial provision –

a. in consultation with a competent person;

b. as required in terms of the approved environmental management programme or environmental management plan; or

c. as requested by the Minister.

- *Regulation 56: Principles for mine closure: In accordance with applicable legislative requirements for mine closure, the holder of a prospecting right, mining right, retention permit or mining permit must ensure that -*

(a) the closure of a prospecting or mining operation incorporates a process which must start at the commencement of the operation and continue throughout the life of the operation;

(b) risks pertaining to environmental impacts must be quantified and managed pro-actively, which includes the gathering of relevant information throughout the life of a prospecting or mining operation;

(c) the safety and health requirements in terms of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) are complied with;

(d) residual and possible latent environmental impacts are identified and quantified;

(e) the land is rehabilitated, as far as is practicable, to its natural state, or to a predetermined and agreed standard or land use which conforms with the concept of sustainable development; and

(f) prospecting or mining operations are closed efficiently and cost effectively.

- *Regulation 61: Closure objectives- Closure objectives form part of the draft environmental management programme or environmental management plan, as the case may be, and must –*

(a) identify the key objectives for mine closure to guide the project design, development and management of environmental impacts;

(b) provide broad future land use objective(s) for the site; and

(c) provide proposed closure costs.

- *Regulation 62: Contents of closure plan: A closure plan contemplated in section 43(3)(d) of the Act, forms part of the environmental management programme or environmental management plan, as the case may be, and must include -*
  - *(a) a description of the closure objectives and how these relate to the prospecting or mine operation and its environmental and social setting:*
  - *(b) a plan contemplated in regulation 2(2), showing the land or area under closure;*
  - *(c) a summary of the regulatory requirements and conditions for closure negotiated and documented in the environmental management programme or environmental management plan, as the case may be;*
  - *(d) a summary of the results of the environmental risk report and details of identified residual and latent impacts;*
  - *(e) a summary of the results of progressive rehabilitation undertaken;*
  - *(f) a description of the methods to decommission each prospecting or mining component and the mitigation or management strategy proposed to avoid, minimize and manage residual or latent impacts;*
  - *(g) details of any long-term management and maintenance expected;*
  - *(h) details of a proposed closure cost and financial provision for monitoring, maintenance and post closure management;*
  - *(i) a sketch plan drawn on an appropriate scale describing the final and future land use proposal and arrangements for the site;*
  - *(j) a record of interested and affected persons consulted; and*
  - *(k) technical appendices, if any.*

10.1.3 National environmental management Act (Act 107 of 1998)

The requirement for rehabilitation, decommissioning and closure planning and associated financial provisions are incorporated into the NEMA. Specific sections of the act are extracted below:

- *Section 24P: Financial provision for remediation of environmental damage:*
  - *(1) An applicant for an environmental authorisation relating to prospecting, exploration, mining or production must, before the Minister responsible for mineral resources issues the environmental authorisation, comply with the prescribed financial provision for the rehabilitation, closure and ongoing post decommissioning management of negative environmental impacts.*
  - *(2) If any holder or any holder of an old order right fails to rehabilitate or to manage any impact on the environment, or is unable to undertake such rehabilitation or to*

manage such impact, the Minister responsible for mineral resources may, upon written notice to such holder, use all or part of the financial provision contemplated in subsection (1) to rehabilitate or manage the environmental impact in question.

(3) Every holder must annually-

a. assess his or her environmental liability in a prescribed manner and must increase his or her financial provision to the satisfaction of the Minister responsible for mineral resources; and submit an audit report to the Minister responsible for mineral resources on the adequacy of the financial provision from an independent auditor.

(4) (a) If the Minister responsible for mineral resources is not satisfied with the assessment and financial provision contemplated in this section, the Minister responsible for mineral resources may appoint an independent assessor to conduct the assessment and determine the financial provision. (b) Any cost in respect of such assessment must be borne by the holder in question.

(5) The requirement to maintain and retain the financial provision contemplated in this section remains in force notwithstanding the issuing of a closure certificate by the Minister responsible for mineral resources in terms of the Mineral and Petroleum Resources Development Act, 2002 to the holder or owner concerned and the Minister responsible for mineral resources may retain such portion of the financial provision as may be required to rehabilitate the closed mining or prospecting operation in respect of latent, residual or any other environmental impacts, including the pumping of polluted or extraneous water, for a prescribed period.

(6) The Insolvency Act, 1936 (Act No. 24 of 1936), does not apply to any form of financial provision contemplated in subsection (1) and all amounts arising from that provision.

(7) The Minister, or an MEC in concurrence with the Minister, may in writing make subsections (1) to (6) with the changes required by the context applicable to any other application in terms of this Act.

- *Section 24R: Mine closure on environmental authorisation:*

(1) Every holder, holder of an old order right and owner of works remain responsible for any environmental liability, pollution or ecological degradation, the pumping and treatment of polluted or extraneous water, the management and sustainable closure thereof notwithstanding the issuing of a closure certificate by the Minister responsible for mineral resources in terms of the Mineral and Petroleum Resources Development Act, 2002, to the holder or owner concerned.

(2) When the Minister responsible for mineral resources issues a closure certificate, he or she must return such portion of the financial provision contemplated in section 24P as the Minister may deem appropriate to the holder concerned, but may retain a portion of such financial provision referred to in subsection (1) for any latent, residual or any other environmental impact, including the pumping of polluted or extraneous water, for a prescribed period after issuing a closure certificate.

(3) Every holder, holder of an old order right or owner of works must plan, manage and implement such procedures and requirements in respect of the closure of a mine as may be prescribed.

(4) The Minister may, in consultation with the Minister responsible for mineral resources and by notice in the Gazette, identify areas where mines are interconnected or their impacts are integrated to such an extent that the interconnection results in a cumulative impact.

(5) The Minister may, by notice in the Gazette, publish strategies in order to facilitate mine closure where mines are interconnected, have an integrated impact or pose a cumulative impact.

10.1.4 Financial provisioning regulations

On the 11th of November 2015, the Minister promulgated the Financial Provisioning Regulations under the NEMA. The regulations aim to regulate the determine and making of financial provision as contemplated in the NEMA for the costs associated with the undertaking of management, rehabilitation and remediation of environmental impacts from prospecting, exploration, mining or production operations through the lifespan of such operations and latent or residual environmental impacts that may become known in the future. These regulations provide for, *inter alia*:

- *Determination of financial provision: An applicant or holder of a right or permit must determine and make financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of prospecting, exploration, mining or production operations, as contemplated in the Act and to the satisfaction of the Minister responsible for mineral resources.*
- *Scope of the financial provision: Rehabilitation and remediation; decommissioning and closure activities at the end of operations; and remediation and management of latent or residual impacts.*

- *Regulation 8: Method for determining financial provision – An applicant must determine the financial provision through a detailed itemisation of all activities and costs, calculated based on the actual costs of implementation of the measures required for:*
    - *progressive rehabilitation, determined in an annual rehabilitation plan, conforming to the requirements of Appendix 1 to these Regulations*
    - *final rehabilitation, decommission and mine closure, determined in the final rehabilitation, decommissioning and mine closure plan, conforming to the content requirement of Appendix 2 to these Regulations; and*
    - *rehabilitation and management of latent environmental impacts, including the ongoing pumping and treatment of polluted or extraneous water, where relevant, determined in an environmental risk assessment report, conforming to the content requirements of Appendix 3 to these Regulations; and*
    - *calculating the financial provision using the methodology conforming to the requirements identified in Appendix 4 to these Regulations. This cost include the cost associated with the rehabilitation and management of impacts from:*
        - *the current disturbed area;*
        - *the anticipated disturbance of the next year of mining operations; and*
        - *the latent impacts associated with the current disturbed area, the anticipated disturbance of the next year of mining operations.*
- *Regulation 9 (1): A holder must provide funds for the cost required to implement the activities for annual rehabilitation through the operational budget of the holder.*
- *Regulation 9 (2): "An applicant contemplated in regulation 7 (1) and 8(1) must provide proof of the arrangements made to secure financial provision prior to…."*
- *Regulation 11: Requires annual review, assessment and adjustment of the financial provision. The review of the adequacy of the financial provision including the proof of payment must be independently audited (annually) and included in the audit of the EMPR as required by the EIA regulations.*

10.1.5 Other guidelines

The following additional guidelines which relate to financial provisioning and closure have been published in the South African context:

- Best Practice Guideline G5: Water Management Aspects for Mine Closure: This guideline was prepared by the then Department of Water and Sanitation (DWS) and aims to provide a logical and clear process that can be applied by mines and the competent authorities to enable proper mine closure planning that meets the

requirements of the relevant authorities. This guideline is aimed primarily at larger scale mines and does not specifically address closure issues related to closure of prospecting activities, however certain principles related to closure and water management are relevant. The following technical factors which should be considered during closure, and which are likely to relate to prospecting activities, have been considered:

- Land use plan: directly interlinked with water management issues in so far as water is required to support the intended land use- in this regard the surrounding communities and the land uses implemented rely on available ground and surface water to be sustained. Management of water quality and quantity has been identified as an aspect to be covered.
- Public participation and consultation: consultation is fundamental to closure and there is a need for full involvement of stakeholders in the development of the final closure plans, and in the agreement of closure objectives- in this regard this document must be made available through the Basic Assessment public participation process for comment by relevant stakeholders.

- Guideline for the Evaluation of the Quantum of Closure Related Financial Provision Provided by a Mine (2005):
  The objectives of the guideline include the need to improve the understanding of the financial and legal aspects pertaining to the costing of remediation measures as a result of mining activities. Whilst this guideline predates the recent NEMA Financial Provisioning Regulations, it does contain certain principles and concepts that remain valid and have been considered.

10.2 Closure objective

The vision and closure objectives aim to reflect the local environmental and socio-economic context of the project and to represent both the requirements and expectations of the stakeholders. The determination of a realistic post-closure vision for the mining site is based on a good understanding of the ecological, physical, socio-economic and operational characteristics of the area within which the mine is located. Site specific closure objectives are then developed taking into consideration these characteristics inclusive of legal compliance, financial and end-land use goals. Each of these closure objectives as set forth are defined and discussed in further detail below.

10.2.1 Safety

To ensure physical safety of the closed mining site over time, any void or pit left after mining activities have ceased will be filled accordingly or fenced as to ensure the safety of human and/or animal and prevent falls from height.

For this part of the project the berms, Pollution Control Dam and pipelines will be removed and therefore it should pose no safety risk at closure.

10.2.2 Physical and Ecological stability

To ensure the physical stability, and therefore the physical sustainability of the closed mining site over time, physically stable landscapes that are compatible with the intended post-mining land use will be worked towards. This will limit the latent occurrence of environmental degradation by limiting water and wind erosion.

A physically stable and sustainable landscape post-mining can be achieved by implementing the following measures:

- Maintain and restore biodiversity levels as to provide appropriate habitats.
- Shape all channels, drains and dams to smooth slopes and integrate into natural drainage patterns or to original topographical levels.
- Remove alien and/or invasive vegetation.

10.2.3 Chemical Stability

To ensure the prevention of negative effects on the local and adjacent environment quality by chemical contamination arising from mining and mining related activities by ensuring the prevention of soil, surface and groundwater contamination by managing water on the site.

10.2.4 Socio-economic transition

To ensure as far as practically possible a smooth transition in the socio-economic conditions that exist pre-mine closure to that will exist post-mine closure. The socio-economic transition will comprise of a net beneficial socio-economic impact to the affected communities in the region.

10.2.5 Risk Limitation

To ensure a restraint in the number and acceptable level of numerous risks such as safety, environmental, financial, legal and social aspects as to safeguard the execution of closure activities in such a way that it is the most cost-effective and efficient approach for the mine.

10.2.6 Long-Term Care

To ensure the design and implementation of a closure plan that will guarantee the minimization or elimination of the need for long-term post-closure care and maintenance. This is achievable by ensuring physical, ecological, chemical and socio-economic stability that will allow for the relinquishment of the closed site to the appropriate third parties.

10.3 Alternative closure options

The major infrastructure for this project is the Pollution Control Dam and canals/berms diverting water from the Waste Rock Dump to the PCD as well as a pipeline to the Plant area.

The Pollution Control Dam can only be removed once the Waste Rock Facility (Dump) is fully rehabilitated.

An alternative is to allow or maintain the Pollution Control Dam in order to provide a stock watering source to the community.

The following alternatives have been investigated for the LoM closure:

- **Option 1 – Total removal of the Pollution Control Dam**
  - The area will be reinstated to pre-mine environment.
  - A free draining surface will be formed as close as possible to pre-mining area.
  - Minimal monitoring will be required.

- **Option 2 – Maintenance of the Pollution Control Dam**
  - The dam will be fenced off by a security fence and donated for use by the community.

10.4 Preferred closure action

The advantages and disadvantages of each option to support this option is depicted in **Table 10-1,** with Option 1 being the proposed method.

Table 10-1: Motivation for preferred option

Option	Advantage	Disadvantage
1	• Little visual impact and close to original land state. However, altered topography but with soil erosion reduction.	• Higher closure cost

Option	Advantage	Disadvantage
2	• Pollution Control Dam will fill with water and community could have access to stock watering (Social impact). • Lower closure cost	• Safety risk to people and animals • Minimal catchment area with possible redundant and dry reservoir

10.5 Post closure period

The closure period can be defined as the period when mining operations has ceased and all rehabilitation in terms of the final rehabilitation plan is completed. The post closure monitoring will then commence. This period must be evaluated after 5 years of the last rehabilitation and the mine is only in the monitoring phase.

The following infrastructure and items post closure will need to be monitored:

- Alien vegetation to be eradicated,
- Ensure local vegetation has established,
- Monitor erosion and contour berms where constructed.

10.6 Assumptions

The following assumptions were made in relation to the rehabilitation for final closure:

- The Waste Rock Dump will be fully rehabilitated when the Pollution Control Dam and berms will be rehabilitated.

11 Post mining land use

11.1 Description of land use

Post closure land use is normally determined in consultation with the stakeholders (inclusive of the tribal authorities who hold the surface rights) as to allow for the disturbed areas to be restored to pre-mining conditions which is inclusive of grazing land as to meet the requirements of the stakeholders, within the context of the closure plan. The post closure land use for Option 1 and Option 2 are discussed in **Table 11-1.**

Table 11-1: Post Mining Land Use

Post Closure Rehabilitation	Option 1	Option 2
Backfilling of benches with overburden material will take place as the mining benches are advanced. Each bench will be fully rehabilitated and covered with topsoil as backfilled.	√	√
All infrastructure (pipelines) not issued to the community will be demolished and the area rehabilitated by ripping and revegetating to be able to deliver an area as close as possible to the natural state.	√	√
The PCD will be decommissioned and backfilled.	√	

The rehabilitation of the project will aim to ensure the re-establishment of specific disturbed areas for grazing purposes as well as ensure landforms that has the capability to sustain indigenous vegetation as to limit water and wind erosion and provide sustainable grazing whilst enabling the gradual reestablishment of indigenous vegetation for a more diverse natural species composition.

The closure objective is that the land use, after mining, should be the same as before mining occurred.

11.2 A map of post closure land use

The area available for land use after mining is the same as before mining and is shown in **Figure 11-1.** The affected area is ± 6.5 ha.

Figure 11-1: Total Area of land use after closure

11.3 Post Closure Period

The closure period can be defined as the period when mining operations has ceased and all rehabilitation in terms of the final rehabilitation plan is completed. The post closure monitoring will then commence. This period must be evaluated after 5 years of the last rehabilitation and the mine is only in the monitoring phase.

The following infrastructure and items post closure will need to be monitored:

- Contours to ensure no breaching or erosion and repair thereof. This should be monitored yearly to determine the ongoing sedimentation and requirement for desilting of the flow areas.
- Alien vegetation to be eradicated,
- Ensure local vegetation has established.

12 Annual rehabilitation actions

This section describes the annual rehabilitation measures to be implemented over the LoM. Annexure 1 in the NEMA, 1998 (Act 107 of 1998), Government Notice Regulation 1147 dated 20 November 2015, states that the annual rehabilitation plan is allowed to form a chapter in the final rehabilitation and closure plan report due to the simplicity of the required annual rehabilitation.

12.1 Technical solutions

No progressive or continuous rehabilitation can be implemented for the diversion berms/canals, Pollution Control Dam and pipeline to the Plant while operating. No annual rehabilitation plan is therefore practical for the Pipeline, Pollution Control Dam or the diversion berms/canals.

13 Final rehabilitation and closure actions

The technical solutions in this section are described for closure at any time and for the next 12 months.

13.1 General technical solutions

The general rehabilitation plan for the area (**Figure 13-1**):

- All areas should be safeguarded as far as practically possible,
- The Waste Rock Stockpile (WRS) side slopes will be vegetated as per the approved EMPR. It is accepted that minimal erosion will be from the WRS after rehabilitation and vegetation.

13.2 Pollution Control Dam technical solution

- The Pollution Control Dam (**Figure 13-2**, **Figure 13-3**) will be decommissioned:
    - The security fence around the Dam will be removed and hauled to the local scrap metal dealer.
    - All water will be used to final plant process.
    - The barrier system, from the top of the embankment to 1m below the embankment, will be removed and hauled to an approved landfill site,
    - The concrete/brick Pollution Control Dam infrastructure will be demolished and used in backfill of the Pollution Control Reservoir.
    - The gabion spillway will be demolished and the wire netting removed to a scrap facility. The rock will be used for backfill of the reservoir.
    - The embankment will be the source of material to fill the reservoir. Additional waste rock or inert material will be required to over fill the reservoir area in order to allow for settlement and shaping of the area to be free draining.
    - The access to the penstock will be demolished and hauled to a scrap metal yard.
    - The pumps and mechanical equipment will be hauled to a local scrap metal dealer.
    - The area will be shaped to be free draining and covered with imported 200mm topsoil and vegetated with local grass species. Soil ameliorants will be added if required.
    - Contouring of the area will ensure the minimal erosion of the area.

13.3 Diversion canals and berms

- The canals with concrete pitched lining will be demolished and the material used in the backfill of the Pollution Control Dam.
- The diversion berms will be used to shape the affected area to the original topographical area shape. These berms would have an active seed bed and will vegetate on its own.

13.4 Pipeline

The pipeline will be;

- Dismantled and hauled to a scrap metal yard or approved landfill site depending on the type of pipeline material.
- The pedestals will be demolished and used as backfill or as inert material.

13.5 Culvert

The culvert will be demolished and the 1050 ND pipes donated to the community. The concrete will be used as backfill in the reservoir basin.

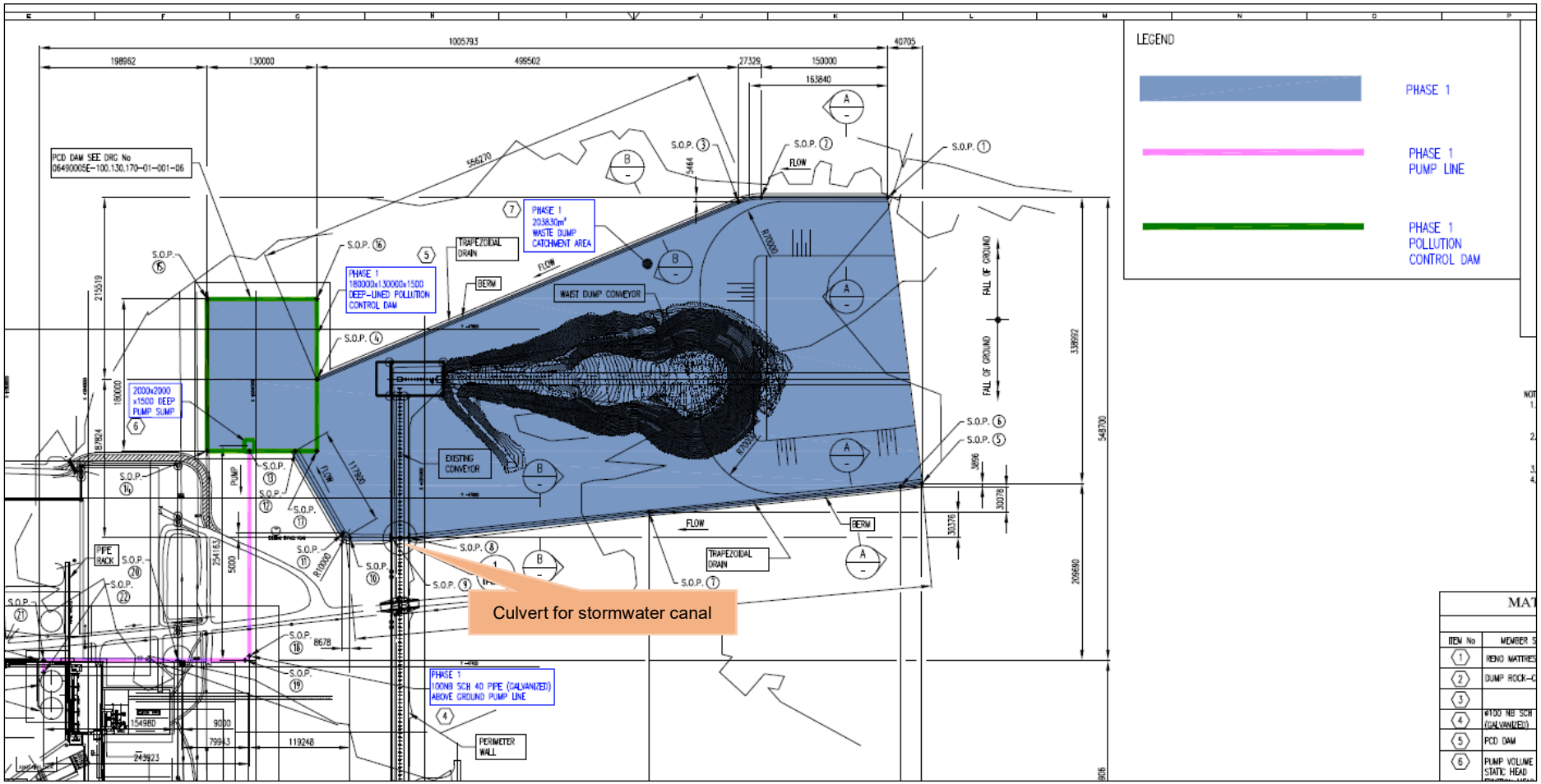

Figure 13-1; General layout of project (RSV Minerals, drawing number 500032877)

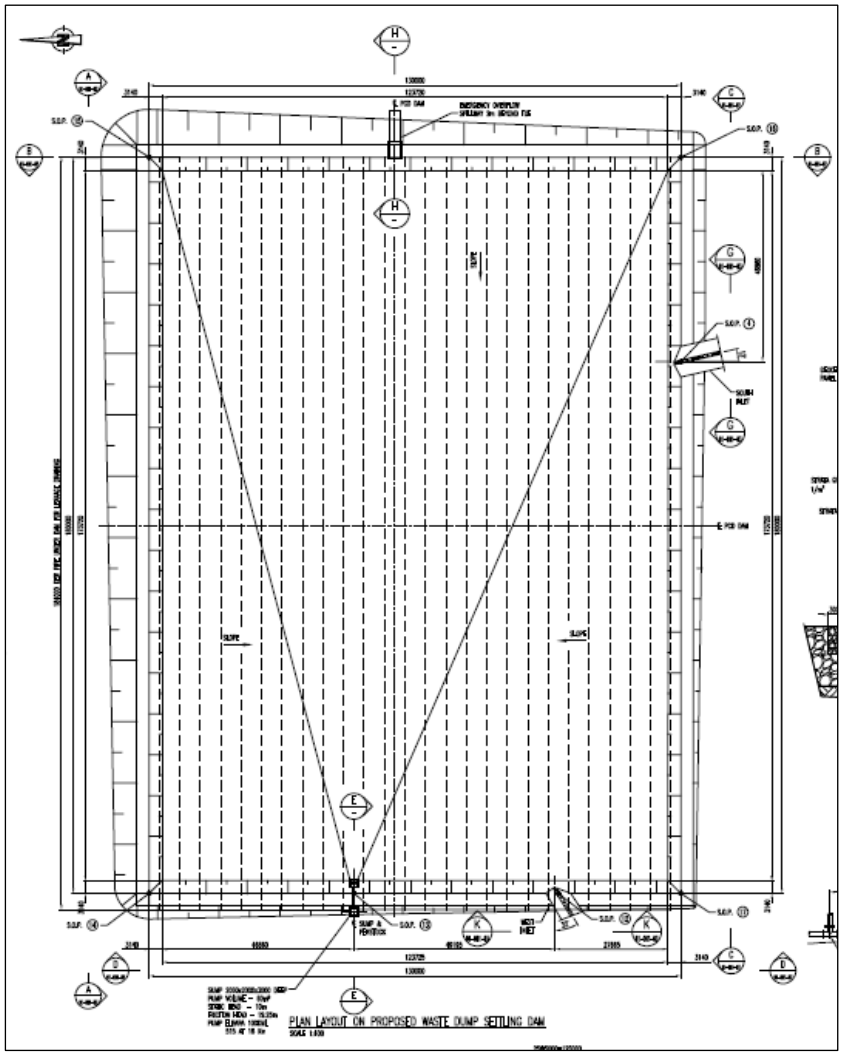

Figure 13-2: Pollution Control Dam Layout (RSV minerals, Drawing no. 064900SE-100.130.170-01-001-06)

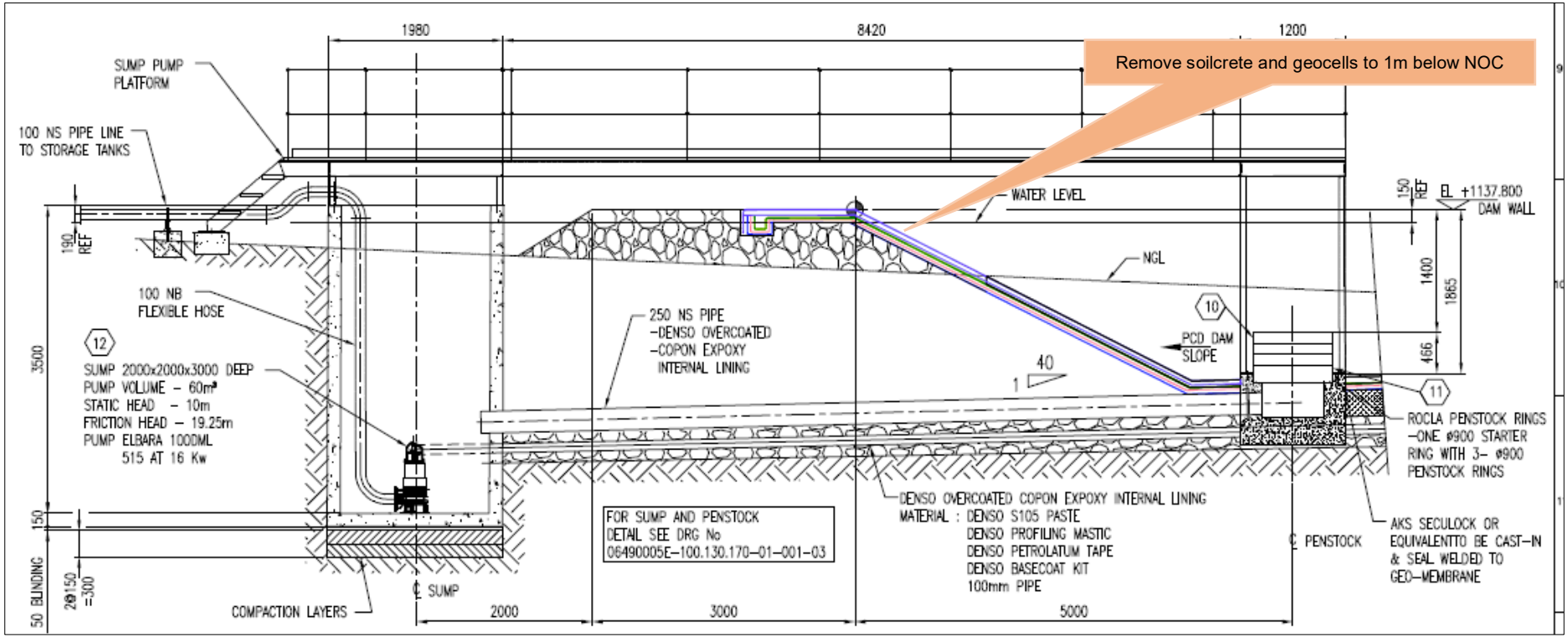

Figure 13-3: Pollution Control Dam extraction layout (RSV minerals, Drawing no. 064900SE-100.130.170-01-001-06)

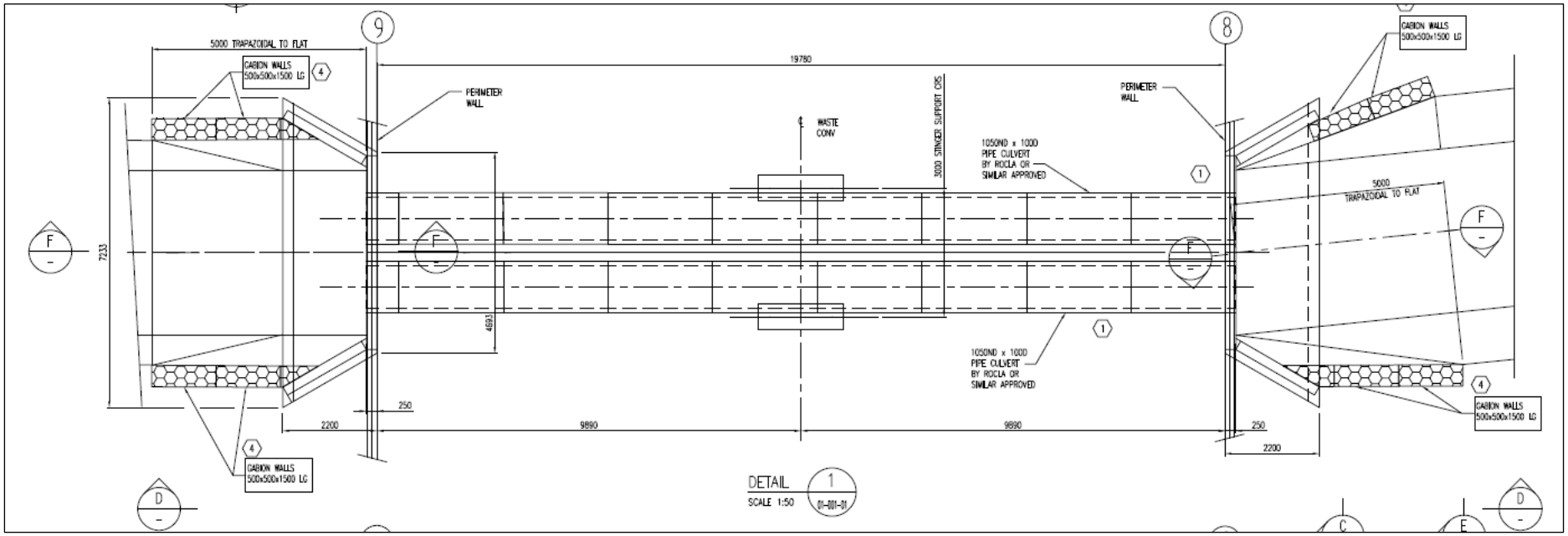

Figure 13-4: Culvert for diversion canals

13.6 Threats and opportunities

A list of threats and opportunities as well as uncertainties for rehabilitation are relevant issues that must be updated yearly, or as new issues are identified. Current identified threats, opportunities and uncertainties for post mining are described in **Table 13-1**.

Table 13-1: Threats, Opportunities and Uncertainties (Post Mining)

Item	Threat	Opportunity	Uncertainties
Surface area	Erosion	Grazable area	Final slope of rehabilitated area
Surface area	Invader species	High quality veld	Rainfall and overgrazing

14 Schedule of actions

A schedule of actions is proposed in this section. These actions are scheduled as below.

The high level of actions proposed are shown in **Table 14-1**. These actions must be scheduled in detail as to incorporate the mine equipment, capacity and scheduling.

The assumptions of this schedule are that the available equipment can be utilised in the rehabilitation measures at closure.

Table 14-1: Rehabilitation planning

		Activity				
		Decommissioning and rehabilitation of PCD	Rehabilitation of berms/canals and area	decommissioning of pipeline and removal	Vegetation	Monitoring
Year	2025					
	2026					
	2027					
	2028					
	2029					
	2030					

15 Organisational capacity

The current Mine Overseer Production is Dawie Marx while the Environmental Superintendent is Yolandé Janse van Rensburg.

Table 15-1: Organisational Capacity

Person	Responsibility	Contact details
Dawie Marx	Mine Overseer Production	dawie.marx@sibanyestillwater.com
Yolandé Janse van Rensburg	Environmental Superintendent	Yolande.JansevanRensburg@sibanyestillwater.com

16 Relinquishment criteria

Relinquishment can be defined as the approval by the regulator indicating that the rehabilitation and closure criteria for the mining activity have been met to the satisfaction of the Regulatory. Therefore, the relinquishment criteria are driven by the objectives of the rehabilitation and closure plan and consequently the indicators applicable to each impact associated with the rehabilitation, closure and decommissioning of the mining. In this regard reference is made to **Table 9-3** which presents each identified environmental impact, the associated indicators and proposed closure targets. In summary, the proposed relinquishment criteria include:

- Biodiversity and soils: The vegetation cover of the rehabilitated areas must be consistent with the surrounding vegetative cover. There must be ecosystem functionality which is consistent with the surroundings.
- Social: There must be no unattended complaints. Where possible written confirmation from the affected landowner must be solicited confirming that outstanding issues have been addressed and closed out.
- Waste: There must be no waste materials remaining on site after rehabilitation.

17 Monitoring

A monitoring plan will be developed to include monitoring that will be undertaken prior to decommissioning and rehabilitation activities as well as after mine closure (inclusive of already in-place monitoring networks) as to evaluate the effectiveness of closure activities in meeting agreed closure objectives. Monitoring of the mine site will then be compared against success criteria that may lead to the identification of maintenance needs.

Post-closure monitoring will include:

- The confirmation that any and all waste, wastewater and pollutants generated as a result of decommissioning is properly managed;
- The confirmation that all disturbed and previously rehabilitated areas are free of residual pollution after decommissioning;
- The confirmation that the re-establishment of indigenous vegetation is encouraged within the disturbed areas and that these areas have a density similar to the surrounding environment, is non-eroding and free of alien and invasive species.

17.1 Schedule

17.1.1 Water quality

Monitoring of surface and groundwater occurs on a monthly basis by an external services provider at the current mining operations.

- Currently the external services provider is Aquatico Laboratories (Pty) Ltd which provides a surface water report on a monthly basis to Sibanye-Stillwater K4 Shaft Mine for record keeping purposes.
- Monitoring of groundwater occurs on a quarterly basis of which Aquatico Laboratories (Pty) Ltd send on a quarterly basis to Sibanye-Stillwater K4 Shaft Mine for record keeping purposes.

17.1.2 Physical properties

The erosion, siltation and vegetative investigations must be surveyed on a yearly basis for a period of 5 years post closure. If the erosion is minimal a decision can, then be taken for further monitoring and survey requirements.

17.2 Responsible persons

The CEO remains responsible for the implementation of the Rehabilitation and Closure Plan and is supported by the Mine Manager.

17.2.1 Water quality

Surface and Groundwater monitoring is conducted by Aquatico Laboratories (Pty) Ltd as external services providers.

Aquatico Laboratories (Pty) Ltd.
89 Regency Drive
R21 Corporate Park
Centurion
South Africa
Tel:+27 (0) 12 450 3800
Fax:+27 (0) 12 450 3851

17.2.2 Physical properties

Erosion and siltation monitoring are conducted by HEES (Pty) Ltd as External Services Provider:
16 Lemonwood street,
Centurion, 0181, SOUTH AFRICA
T: +27(0) 82 895 1538
Email: ees@lantic.net

17.3 Schedule of reporting

17.3.1 Water quality

Monitoring of surface water occurs on a monthly basis of which a report from Aquatico Laboratories (Pty) Ltd is sent on a monthly basis to Sibanye-Stillwater K4 Shaft Mine for record keeping purposes.

Monitoring of ground-water occurs on a quarterly basis of which a report from Aquatico Laboratories (Pty) Ltd is sent on a quarterly basis to Sibanye-Stillwater K4 Shaft Mine for record keeping purposes.

17.3.2 Physical properties

A yearly report must be provided to Sibanye-Stillwater K4 Shaft Mine for decision and record keeping purposes and implementation of maintenance recommendations.

17.4 Monitoring plan

17.4.1 Monitoring parameters for water quality

The following chemical parameters are analysed for, as stipulated in the Water Use Licence, for both the surface and groundwater aspects:

Table 17-1: Water Quality Parameters for Surface and Groundwater Monitoring

Chemical Parameters	Unit
pH	pH unit
Electrical Conductivity (EC)	mS/m
Nitrates (NO3)	mg/l
Chloride (Cl)	mg/l
Fluoride (F)	mg/l
Iron (Fe)	mg/l
Zinc (Zn)	mg/l
Manganese (Mn)	mg/l
Aluminium (Al)	mg/l
Sodium (Na)	mg/l
Magnesium (Mg)	mg/l
Calcium (Ca)	mg/l
Potassium (K)	mg/l
Sulphate (SO4)	mg/l
Faecal Coliforms	Counts / 100ml
Cd	mg/l
Cr	mg/l
Cu	mg/l
Hg	mg/l
Ni	mg/l
Pb	mg/l
Se	mg/l
Zn	mg/l

17.4.2 Monitoring parameters for physical rehabilitation structures

The following must be investigated, and maintenance recommended:

- Erosion in the storm water trenches (van der Merwe, 2022);
- Siltation in benches;
- Erosion of side slopes of stockpiles;
- Density of vegetation;

- Stability of safety berm;
- Adequacy of security fence;
- Erosion into and at the Open Pit sides;
- Stability of Open Pit; and
- Stability of stockpiles.

17.4.3 Surface Water monitoring positions

Surface Water quality monitoring is conducted on a monthly basis at various locations. There are two receiving environment monitoring localities. These monitoring localities are noted in **Table 17-2.** and depicted in Figure 17-1.

Table 17-2: Surface Water Quality Monitoring Points

Site No.	Description	Coordinates	
		X	Y
Karee Mine			
KM S 06	Upstream of Sterkstroom before Lonmin influence	S25°43'11.99"	E27°29'4.92"
KM S 32	Downstream Point Sterkstroom and Brakspruit with Lonmin Influence	S25°38'56.40"	E27°29'2.50"

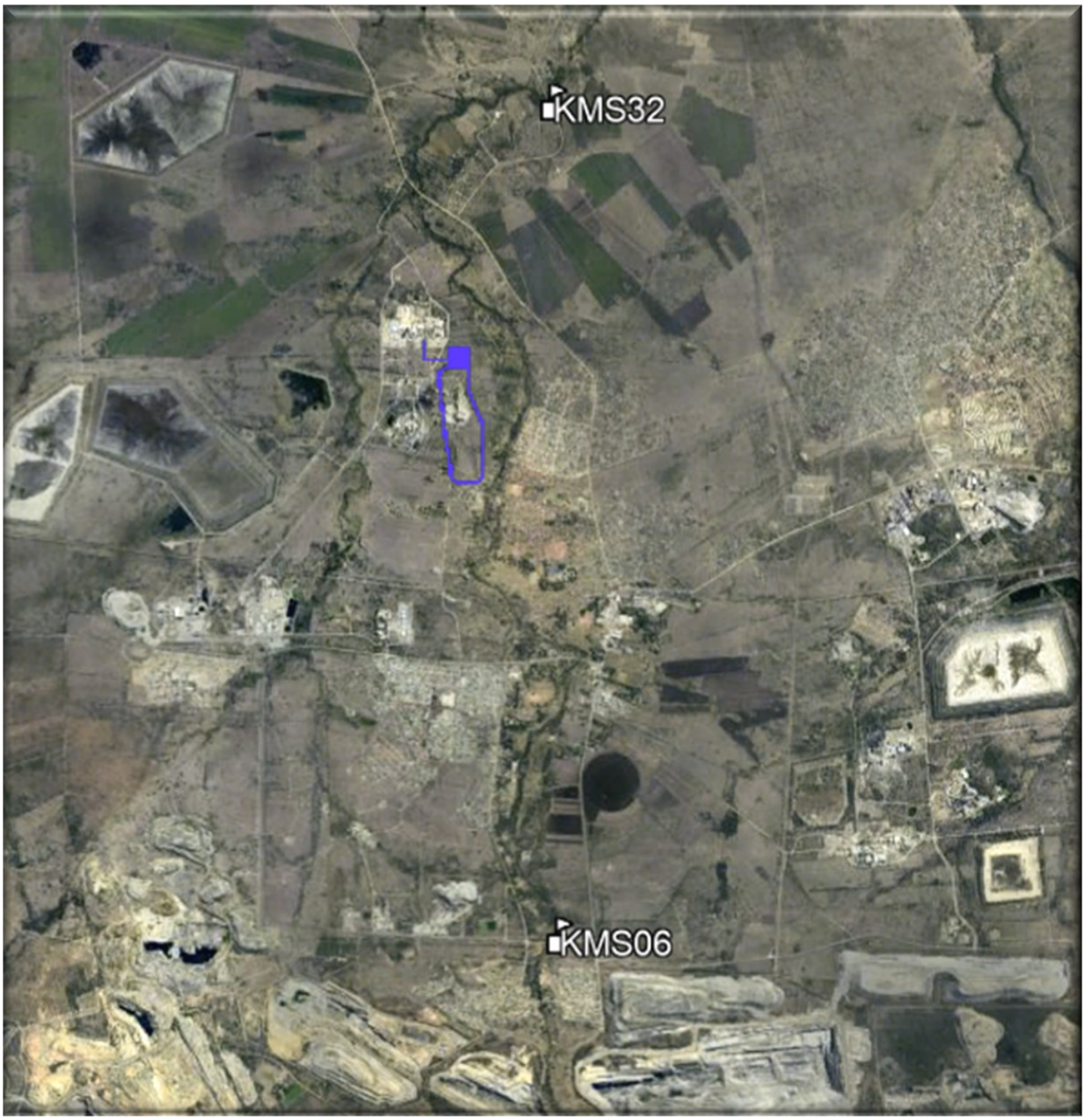

Figure 17-1: Surface monitoring positions

17.4.3.1 Groundwater Monitoring Positions

Groundwater quality monitoring is conducted on a monthly basis at various locations. There are 10 groundwater monitoring localities. These monitoring localities are listed in **Table 17-3** and illustrated in **Figure 17-2** and **Figure 17-3.**

Table 17-3: Groundwater Quality Monitoring Positions

Site No.	Description	Coordinate

		X	Y
Karee Mine			
KM BH 17	K3 Shaft	S25°41'41.47"	E27°27'36.08"
KM BH 29	K4 Shaft	S25°39'59.35"	E27°28'5.11"
KM BH 01	Tailings Dam 1, 2, 3 Upstream	S25°41'13.67"	E27°26'35.94"
KM BH 27	K3 Waste Rock Dump & Concentrator	S25°41'42.71"	E27°26'44.17"
KM BH 33	K4 Concentrator	S25°40'36.02"	E27°28'3.97"

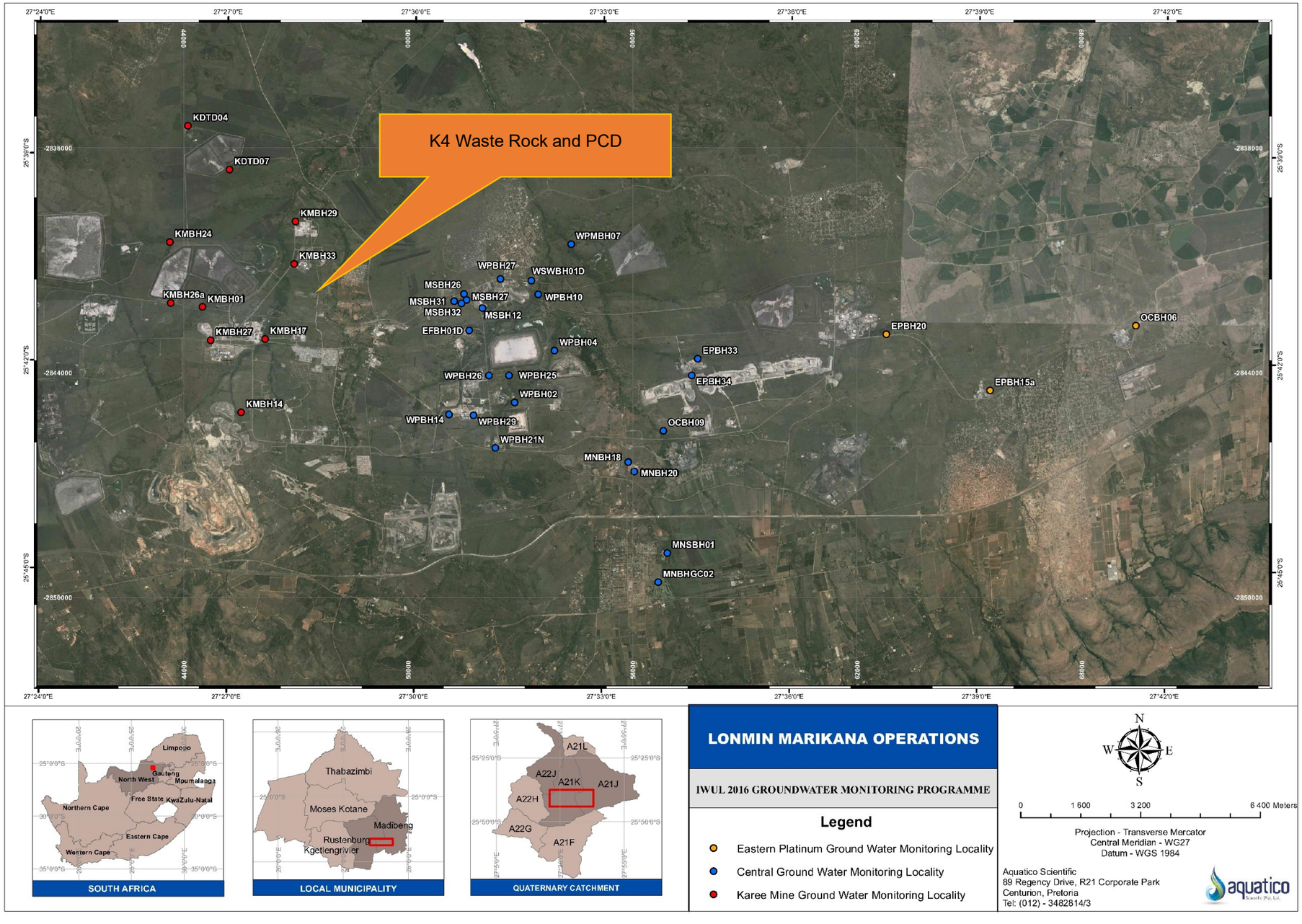

Figure 17-2:Surface water localities monitored around the WRD and PCD

Figure 17-3: Groundwater Localities monitored

18 Final and Annual rehabilitation cost

18.1 Calculations & Assumptions

The scope of the project made it possible for the quantities to be determined through the design layout of the Pollution Control Dam and the length of the pipeline and berms/canals.

The rates are obtained from previous similar projects and are subject to review as it was not tendered for in this specific project. The following assumptions are made:

- A contingency of 20% is allowed,
- Preliminary and General cost of 20% is allowed; and
- VAT of 15% is excluded in the summary cost.

The principles as described in this report were used to determine the final quantities. As these are new items, the quantities were determined as if the mine would close at the end of 2024, and it is assumed that construction of the PCD, berms/canals and pipelines were completed as in the design drawings.

18.2 Methodology and Costing

The methodology for costing is based on the rehabilitation plan:

A description of all actions, rates and results for **final rehabilitation** are shown below in **Table** 18-1**.**

Table 18-1: Financial provisioning – Final rehabilitation cost for 2023 to 2025

Closure Component	Area	Description as from DMR guideline (2005)	Reference	Notes	2025						
					Unit	Distance	Weight	Area	Volume	Rate m²/m³/unit	Cost
					#	m	kg	m²	m³	R	R
		Dismantling of processing plant and related structures (including overland conveyors and power lines),									**685 867**
	Pipeline	**Pump line to Plant**	**Sec 13.4**								0
		Demolish pipelines and allow for 493m of pipes less than 500mm diameter with 6m plinth spacing and disposes as waste at approved site				493				48.86	24 088
1A	**PCD**	**Walkway (Light plant structure)**	**Sec 13.2**								
		Steel structures light						17		1 295.81	22 029
		Pumps									
		Remove motor and pumps					200			4.58	916
		Demolish cabling				493				1 295.81	638 834
2A		**Demolition of steel buildings and structures**									
		Demolition of reinforced concrete buildings and structures									**31 218**
2B	**PCD**	**Penstock and Sump**	**Sec 13.2**								
		Light concrete structure							9.61	614.00	5 898
	Culvert	at Conveyor	**Sec 13.5**								
		Remove medium concrete (Wingwalls)							23.00	967.35	22 249
		Remove slabs/base, reinforced							**2.00**	338.57	677
		Remove 1050 ND concrete pipes (Load and haul)			18				46.12	51.90	2 393
3A		**Rehabilitation of access roads**									
4A		**Demolition and rehabilitation of electrified and non-electrified railway lines**									
5A		**Demolition of housing and facilities**									
6A		**Opencast rehabilitation including final voids and ramps**									
7A		**Sealing of shafts, adits and inclines,**									

Closure Component	Area	Description as from DMR guideline (2005)	Reference	Notes	2025						
					Unit	Distance	Weight	Area	Volume	Rate m²/m³/unit	Cost
					#	m	kg	m²	m³	R	R
8A		**Rehabilitation of overburden and spoils and processing plant waste: basic, salt-producing,**									
9A	**Subsided areas**	**Rehabilitation of subsided areas,**									
10A	**Surface**	**General surface rehabilitation,**									**10 697 704**
	PCD	**Pollution Control Dam**	**Sec 13.2**								
		Remove, HDPE liners to 1m below NOC						2 657		6.00	15 942
		Remove, GCL liner to 1m below NOC						2 657		6.00	15 942
		Remove tendon liner to 1m below NOC						2 657		6.00	15 942
		Remove and haul concrete liner of 150 mm to 1m below NOC						2 657		92.11	244 736
		Backfill with inert material (Load and haul)							33 631.20	51.90	1 745 459
		Shape and make free draining (general disturbed areas)						23 400		12.19	285 246
		Topsoil layer of 100mm						23 400		17.17	401 778
		Ameliorate and vegetate						23 400		6.70	156 780
	Canals	**Demolish concrete floors, bases and foundations**	**Sec 13.3**								
		Remove concrete pitching (concrete slabs)						42 599		153.51	6 539 316
		Rip to 500mm						42 599		0.64	27 263
		Shaping /levelling of berm						51 026		12.19	622 012
		Ameliorate and vegetate						93 625		6.70	627 288
11A	**River diversions**	**Rehabilitation of river diversions**									
14A	**Maintenance**	**Maintenance and after care**								**Rate for one year**	**376 622**
	Physical Monitoring										
		Specialist execute a site visit once a year to verify vegetative growth and erosion status and report on required actions to be taken		Total area for 5 years/yr				117 025		0.29	33 937
	Maintain vegetation	**Maintain vegetation**									
		Care and maintenance		Total area for 5 years/yr				117 025		2.93	342 684

Closure Component	Area	Description as from DMR guideline (2005)	Reference	Notes	2025						
					Unit	Distance	Weight	Area	Volume	Rate m²/m³/unit	Cost
					#	m	kg	m²	m³	R	R
										Sub Total	**11 791 411**
										P&G s 0.20	3 537 423
										Contingencies 0.20	2 358 282
										Total excluding VAT	17 687 117
										VAT 15%	2 653 068
										Total	**20 340 184**

18.3 Period of determination

Appendix 4[2] of the regulations provide that the cost for closure after the first 12months of operations plus the latent cost must be determined.

18.4 Results

Table 18-2 provide a summary of the required Financial Provisioning and Closure Cost for the PCD, Pipeline, Culvert and canals at Karee K4 shaft.

Table 18-2 : Summary of Financial Provisioning cost

Section	Final (R) 2025
Plant	685 867
Steel buildings	
Concrete buildings	31 218
Roads	
Railways	
Housing	
Opencast	
Sealing of shafts, adits and inclines,	
Rehabilitation of overburden and spoils and processing plant waste: basic, salt-producing,	
Subsided areas	
Surface	10 697 704
River diversions	
After care	376 622
Sub Total	11 791 411
P&Gs	3 537 423
Contingencies	2 358 282
Sub Total	17 687 117
VAT	2 653 068
Total	**20 340 184**

[2] national Environmental Management Act, Act 107 of 1998; Regulation No 2272 notice of proposed regulations

19 Assumptions, limitations and knowledge gaps

19.1 Assumptions

A limited number of assumptions were required with the following:

- Minimal bulking factor was assumed for the backfill of the Pollution Control Dam basin.

19.2 Limitation

Some limitations to this rehabilitation plan and costing are:

- The real cost of haulage depend on the contractor or if executed by the mine itself it could be less expensive.
- The real cost for vegetation and topsoil depend on the availability of material.

19.3 Information gaps

The information collected with this EIA study is comprehensive.

20 Bibliography

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Davis, S. (2023). *Wetland delineation and assessment, Sibanye-Stillwater.* Pretoria: WCS Scientific (Pty) Ltd.

de Beer, A. (2022). *Sibanye-Stillwater K4 shaft - Vegetation assessment.* Pretoria: Agrinco.

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Greecy, B. (2022). *Proposed regulations pertaining to financial provisioning for the mitigation and rehabilitation of environmental damage caused by reconnaisance, prospecting, explolration, mining or production opertions.* Pretoria: Government of SA.

Kruger, E., Van Vuuren, F., Van Dijk, M., & Gomes, N. (2013). *Drainage Manual.* Pretoria: South African Road Agency.

La grange matthee, J., Van Staden, H., & Smithers, A. (1979). *Beskerming van bewerkte landerye.* Pretoria: Directorate: Agricultural Engineering and Water Supply.

Lourens, S. (2019). *Sibanye Stillwater K4 Shafts GN704 Storm Water Assessment.* Rustenburg: Storm water Solutions (Pty) Ltd.

Mamera, M. (2023). *Soil compliancve statement for the proposed K$ Pollution Control Dam.* The Biodiversity Company.

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Minister of Water Affairs. (2012, February 24). Regulation. *Regulation 139 of the National Water Act, Act 36 of 1998*. Pretoria, Gauteng, South Africa: Water Affairs.

Smithers, J., & Schulze, R. (2002). *Rainfall Statistics for Design Flood Estimation.* Pretoria: Water Research Commission.

The Biodiversity Company. (2022). *Proposed Opencast Mining Development, Rustenburg - Vegetation Compliance Statement.* Rustenburg, North-West.

van der Merwe, H. (2022). *Waterval UG1 Stormwater Management Plant.* Pretoria: HEES (Pty) Ltd.

van der Walt, J. (2023). *Heritage Impact Assessment for the proposed K4 waste rock dump an pollution control am at the Marikana operations near Marikana.* Modimole: Beyond Heritage.

ANNEXURE A: CV OF DEON VAN DER MERWE

Hermanus Gideon van der Merwe (Deon)
Professional Engineer

Key skills
Dam design, Dam safety, Rehabilitation plans, Fin provisioning

Years of experience
27

Years owner of HEES (Pty) Ltd
2

Education
B.Eng(Agric), University of Pretoria, 1992
MBL, University of South Africa

Registrations/Certifications
PrEng, ECSA, 960070

Professional affiliations
SAIAI, 1992; SANCOLD, 2009

Training
Civil Designer, HEC RAS, Geoslope, Geotech

Language skills
English and Afrikaans

Date of birth
9 July 1968

Nationality
South African

Deon is a qualified professional engineer with more than 27 years' experience.

Deon specialises in the design and project management of projects comprising dams, SWMP, rehabilitation plans, canals, gabion structures and concrete structures. He also has experience in the management and maintenance of pump schemes and general management. He has successfully completed many water-related projects for the mining sector but has undertaken work for an array of other clients in other sectors.

Deon served as the area manager/deputy regional director of the Tugela-Vaal Government Water Scheme on behalf of the Department of Water Affairs (DWA), he was the deputy chief engineer for open channel systems and manager of the hydraulic laboratory at the DWA. He is thus aware of the challenges South Africa faces in terms of water resources. He started his career at the Department of Agriculture and at exiting was the Principal Engineer – Soil Conservation for the North West Province.

His most recent project experience includes the cost closure methods and rehabilitation plans for, Jwaneng mine and Mogalakwena mine, Approved Professional Person for the DSE of the 12 m high concrete gravity Wilgeriver Dam, Detail design of a Parshall flume and oil separator.

Other large projects include the civil design of the 55 m high ACR Itare Dam components, the EPC tender design of the ± 90 m high Arror ECRD, 3 130 m³/s diversion tunnels, dam intake structure and cofferdams for the 1000 MW Hydroelectric Power Sounda Gorge Project, serving as the Civil Design Engineer for a 40 m high Concrete Gravity Dam and Powerhouse on the Orange River in South Africa for a installed capacity of 22 MW, Assistant Civil Design Engineer for the water infrastructure tender design of the 40 MW Kabompo Gorge Hydroelectric scheme in Zambia, the Assistant Design Engineer for the feasibility investigations and option analysis for the uMkhomazi transfer scheme, Design Engineer on the river diversion tender design for Neckartal Dam, Design Engineer for the review on the river diversion of the Mphanda Nkuwa Hydroelectric Project, Member of the project team for the Safety Evaluation of the Category III Bivane (Paris) Dam, Locumue (Mozambique) Dams, the Category II

Doornpoort, Wilge River, 3rd Recovery, the Approved Professional Person for the Category II Raw Water Reservoirs at Lethabo Power Station and Imvutshane Dam and detail design and draughting of a 4 km concrete-lined canal for AngloGold Ashanti's West Complex (R6 million).

Activities Performed and work history

FROM 2018 to date

(Director: HEES (Pty) Ltd)

- Design Engineer for the construction of the 55m high Itare ACRDam, Kenya, for AECOM SA,
- Approved Professional Person for the Dam Safety Inspection of the 8.5 m high earth embankment Rustfontein Dam,
- Design Engineer for the SWMP for the WUL and EIA applications of the Mooifontein Cemetery,
- Design Engineer for the detail design of the sedimentation trap at Thorncliffe Mine, Steelpoort,
- Design Engineer for the detail design of the Oil Separator system at Thorncliffe Mine, Steelpoort.
- Rehabilitation costing review of the Jwaneng mine, Botswana,
- Rehabilitation design and costing of Mogalakwena mine TSF,
- Stormwater review for the Itare WtW,
- Approved Professional EWngineer for the Wilgeriver Dam. Safety Inspection,
- Design Engineer for the Dam Break analysis for 55m high dam in Kenya (Non Disclosure still valid)
- Tender Design Engineer for the Stability Analysis, River diversion, Floodlines and reservoir influence for Kinguele Aval Concrete gravity dam, Gabon, with Piano Key weir.
- Design Engineer for the Detail design installation for Parshall Flume at Mogalakwena mine (24" and 36")
- Design Engineer for the review of Manganang gauging weir in Swaziland and the design of rehabilitation of this weir.
- Approved Professional Person for the Dam safety Evaluation of the 8.5 m high Earth Rustfontein Dam.
- Design Engineer for the toe drain design of the Rustfontein Dam.
- Design Engineer for the design tender assistance on the 55m high earth Embankment (Dam break analysis, O&M, EPP) – Kenya (Non-disclosure still valid)

From 2011 to 2018 BKS / AECOM SA

(Executive: Dams and Hydropower)

- Approved Professional Person for the Safety Evaluation of the 29m high Imvutshane earth fill dam in Kwa-Zulu Natal (Supervisor and reviewer – Danie Badenhorst Pr Eng) (2018).

- Design Engineer for the detail design of components of the 55 m high Itare Dam an ACRD in Kenya. The components include, Embankment (plinth, core and shells), monitoring, spillway, river diversion conduit and grouting (±R1 billion construction value (2016 to -).
- Design Engineer for the tender submission design of the 90 m high ECRD Arror Dam in Kenya (2017).
- Sounda Gorge Hydropower Project, Congo. River diversion optimization of 3 310 m³/s (Design Engineer).
- Itare Dam, 55 m high ACRD, Kenya. Dam optimisation tender study. Peak flood determination, embankment stability design (± R800 mill construction value).
- Vioolsdrift/Noordoewer Dam on the Orange River. Peak flood determination for design purposes with a RMF of ± 32 589 m³/s and ± 884 206 km² catchment. (APP, supervisor - Danie Badenhorst).
- Mothusi Dam, Lesotho. Detail design and assistance to the construction of the rehabilitation of the dam to the value of R34 million. (Supervisor and APP role - Danie Badenhorst).
- Mohale Dam: Assistant Design Engineer on the rehabilitation of the crack on the concrete face. (APP role and supervisor, Danie Badenhorst)
- Nyamba B Hydropower Project, Uganda. Civil Design Engineer for the feasibility design of the 3.6 MW, R450 million, run-off river project (comprising of a 10 m concrete gravity weir, 3.1 km, 5.5 m³/s headrace canal, penstock and power house) (APP role and supervisor – Danie Badenhorst).
- Rooikat Hydropower Project, Orange River, South Africa. Design Engineer for the design, for tender, of the 40 m high concrete gravity dam and power house with installed capacity of 22 MW (2014) (> R400 million) (APP – Danie Badenhorst)
- uMkhomazi transfer scheme (Project value ± R16 Billion) (APP role – Danie Badenhorst).
    - Project manager for the Geotechnical investigations of the transfer scheme to the value of ±R 6 million (2013),
    - Assistant Design Engineer for the hydraulic design of the tunnel, connecting pipe, Intake works and project layout (2014),
    - Cost estimator.
- Approved Professional Person for the Dam Safety Inspection for the Category II Lethabo Power Station Raw Water Reservoir (2014).
- Design Engineer for the spillway on the Fairbreeze Pollution Control Dam (2014) (R 500 000),
- Design Engineer for the rehabilitation of the Category I, Lethabo Main Storm Water Dam (2013 - 2014, R 4 million)
- Dam Safety Inspections on the Lethabo Station Dams and Ash Water Storm Water Dams (2013).
- Pretoria Country Club. Dam Engineer responsible for the embankment stability evaluation with professional fees to the value of R 40 000 (2013-15).

- Mphanda Nkhuwa hydroelectric project. Assistant Design Engineer for the review of the diversion works of the project (2013) with estimated value of R 5 million.
- Prefeasibility studies for three Hydroelectric sites on the Orange River (2012 -). Civil Design Engineer for hydraulic, hydrology, financial and structural design with a project value of a possible R20 million.
- 3rd Overflow Dam Komati Power Station (2012). Dam Engineer on the Dam Safety Evaluation of the dam. Professional fees ± R100 000.
- uMkhomazi transfer scheme (2012) – Assistant Civil Design Engineer on the preliminary calculation on the hydropower potential for the transfer scheme with a project value of R 200 million (Technical supervisor – Willem van Wyk & Danie Badenhorst)
- uMkhomazi transfer scheme (2013) – Assistant Civil design Engineer on the hydraulic optimization of the transfer of water from the uMkhomazi River to the Mgeni system with an estimated project value of R10 billion. (Technical supervisor – Willem van Wyk & Danie Badenhorst)
- Neckertal Dam (2013) – Dam Engineer on the hydraulic calculation, program and design of the diversion works valued at approximately R 2 million (Supervisor – Danie Badenhorst).
- Lethabo Raw Water Reservoir – Dam Safety Inspection. APP for the evaluation of the safety of this Category II dam (R100 000 professional fees)(2013).
- Assistant Civil Design Engineer, water infrastructure, on the tender design of the 40 MW Kabompo Gorge Hydroelectric Scheme in Zambia to the value of R 800 million (2011) (Technical supervisor – Willem van Wyk & Danie Badenhorst).
- Assistant Civil Design Engineer for the feasibility design and option analysis on the eMkhomazi transfer scheme. Feasibility design of the ± 62 m high Smithfield Dam (R 1 100 million) and 44 m high Baynesfield Dam (R 800 million) (Technical supervisor – Danie Badenhorst)(2012).
- Design Engineer for the 7 m high Fairbreeze pollution control dam (R1 million)(2012).
- Team member for the Safety Evaluation of the 69 m double curvature concrete arch Category III Bivane Dam near Vryheid (Professional fees – R 180 000) (APP – Danie Badenhorst)(2011).
- Team member for the Safety Evaluation of the 12 m high concrete gravity Category II Doornpoort Dam, near Middleburg, Gauteng (Professional fees – R 120 000) (APP – Danie Badenhorst)(2012).
- Team member for the Safety Evaluation of the 14.5 m high earth embankment Locume Dam in Mozambique (Project value of R 4 million) (APP role – Danie Badenhorst) (2012).
- Civil Design engineer for the Preliminary design of the ± 10 m high earth Embankment, Hanna Lodge near Orighstad (R 2 million).

2010 to 2011 – Environmental Engineering Solution

(Owner)

- Civil Design Engineer and draught person of 5 m high earth fill embankment of Wonderstone Dam with a project value of R1.3 million (2011) (Supervisor – Helmuth Keller).
- Engineer responsible for hydrological investigations - Dam break analysis, flood line determination and dam safety investigation (not classified) for Wonderstone mine (2011).
- Design engineer for sub- surface drainage investigation for West Complex tailings facility with estimated project cost of R3.5 million (2011).
- Design Engineer and draughts person for an 800 m long storm water diversion berm with a project value of R400,000 (2011).
- Design Engineer and draught person of 4 km concrete lined trench for West Complex, AngloGold Ashanti with a project value of R6 million (2010).
- Design engineer and draught person of 1.5 km rectangular concrete lined trench, Mponeng Mine, AngloGold Ashanti with a project value of R7.5 million (2010).
- Supervisory Engineer and draught person of 1.5 km concrete lined trench at EGAF facility, AngloGold Ashanti to the value of R1 million (2010).
- Specialist modeler for airspace modelling of Waste Rock Dump for Modikwa Platinum (2010).
- Engineer responsible for the clean and dirty water separation investigations and recommendations for TauTona (R6 million), Great Noligwa (R40 million), Kopanang (R15 million), Moab Khotsong (R4 million) Mines and Rand Carbide (R35 million) (2010-2011).
- Engineer responsible for the storm water management plans for Van Ouds and Baken mines (2010).

2008 to 2010 - Tugela Vaal Water Transfer Scheme

(Deputy Regional Manager)

- Project Manager for all mechanical, electrical and civil maintenance on scheme (Sterkfontein, Woodstock, Killburn Dams, Driel barrage, TUVA and subsidiary canals, Driel and Jagersrust Pump stations) (2008-2010).
- Manager responsible for all expenditure on scheme: Operational budget R 60 million per year (2008-2010).
- Manager responsible for all operations on scheme (2008-2010).
- Manager responsible for all dam safety aspects (Sterkfontein, Woodstock, Killburn Dams and Driel barrage) (2008-2010).
- Manager responsible for a staff compliment of 170 employees (2008-2010).

2006 to 2008 – Department of Water Affairs

(Deputy Chief Engineer – Open canal systems)

- Project manager for the Department on the:

- Increase of Rietfontein weir to the value of R1.5 million (2007) (Supervisor - Kobus van Deventer, Client Danie Badenhorst).
- Feasibility study of the rehabilitation of Vlakfontein canal to the project value of R700 million (2007-2008).
- Oranje-Riet balancing Dam to the project value of R20 million (2008) (Supervisor – Kobus van Deventer Pr Eng, Client Danie Badenhorst).

- Manager with the responsibility of the construction and design of hydraulic models at Pretoria west to the value of R1.5 million per year (2006-2008).
- Assistant Civil Design Engineer on Banhoek intake weir with a project value of R20 million (2006-2008) (Supervisor – Kobus van Deventer Pr Eng).
- Construction supervision on rehabilitation of Tugela – Vaal Canal to the value of R4 million (2007).

2003 to 2006 – Administrator and Engineering consultant
(Owner)

- Rehabilitation of mines. Undertook the modelling of rehabilitation for:
- Eerstelingfontein (2005).
- Lovedale Quarry (2005).
- Corheim Asbestos mine (2006).
- AngloGold Ashanti – Bird Dam project (2006) – Dam safety evaluation of Category I dam.
- Administrator of estates under Section 74 of the Magistrates Court Act with branches in:
    - Ermelo and Standerton

1999 to 2003 – Administrator
(Manager – Hannatjie van der Merwe Administrators)

- Administrator of estates under Section 74 of the Magistrates Court Act
    - Manager for Hannatjie van der Merwe Attorneys
    - Branches in Potchefstroom, Klerksdorp, Wolmaranstad, Witbank, Thabazimbi, Northam.

1992 to 1999 – Department of Agriculture
(Candidate to Principal Engineer – Soil Conservation)

- Project manager, Design Engineer, Contracts administrator and Site Engineer of 4m high Magogong gabion erosion structure to a project value of R400,000 (1999) (Supervisor – W Viljoen Pr Eng).
- Engineer responsible for the design, contract administration and construction supervision of 32 km² Heuningsvlei water reticulation scheme with a project value of R3 million (1998).

- Design Engineer and construction supervision of 25 m high steel lighting for Agricultural Sport fields with a project value of R100 000 (1998).
- Design Engineer, Contracts Engineer and Site Engineer of ± 400 ha sub–surface drainage at Taung irrigation scheme to a project value of R500,000 (1997-1999).
- Design and Site Engineer of 2 ha sub-surface drainage at Bultfontein to the project value of R30,000 (1998).
- Engineering team member for the evaluation of centre pivot system at Taung irrigation scheme (1996).
- Design Engineer of 0.5 ha tunnel micro-sprinkle irrigation at Potchefstroom to a project value of (R25 000) (1995).
- Design Engineer of 30 ha micro-sprinkle irrigation at Reitz to a project value of R300,000 (1994).
- Soil Conservation Engineer responsible for the technical standards under the R4 million per year Soil Conservation scheme. Eastern Free State and North West Province (1992-1996).
- Project Engineer on the Grootlaagte soil conservation diversion structures (1996-1998).
- Specialist Engineer on Soil Conservation for Soil conservation enforcement (1996-1999).

Continuous professional development

#	Description	Entity	Validation number (ECSA)	Year	Days
Course attended					
1	Dam design course	US		2007	2
2	Drainage manual	SAICE		2007	2
3	Applied Geomechanics	US		2008	2
4	Pipeline design course	Sinotech		2008	2
5	Level 1 – First Aid	SA Red Cross		2009	1
6	Hazard identification and risk assessment	NOSA		2009	2
7	SHE Management tools	NOSA		2009	2
8	Sustainable rural livelihoods	ARC, Ag Engineering	AGEng006	2011	3
9	Management and design of Dams in Africa	University of Stellenbosch	3250	2011	4
10	Dam Engineering short course and symposium	University of Stellenbosch	K2922	2012	5
11	5th Annual Hydropower Africa	Spintelligent	UP2012-43	2012	4
12	Flood hydrology	UP		2014	
13	Pipeline design, Operation and Maintenance course	Sinotech	SAICEwat13/01343/16	2014	2
14	Modelling of free surface flow and dam break analysis	Sinotech	CESA-328-01/2016	2016	3

Conferences attended

SANCOLD, 2014 to 2018
SAIAE, 1992 to 2018

Publications

I. Curry, HG. Van der Merwe, R. Van Wyk, G. Benade, SANCOLD 2014, Feed Design for EPC contract of the Rooikat Hydropower project on the Orange River