

APPENDIX M: CLOSURE LIABILITY CALCULATION

CALCULATION OF THE CURRENT FINANCIAL CLOSURE LIABILITY ASSOCIATED WITH THE PROPOSED INFRASTRUCTURE CHANGES AT PILANESBERG PLATINUM MINE AS AT DECEMBER 2018

1.0 INTRODUCTION

This closure liability calculation has been prepared as an addendum to the latest current financial closure liability calculation (“*Pilanesberg Platinum Mines (NW/30/5/1/2/2/320 MR) DMR Financial Provision*”, dated 28 February 2018, compiled by Digby Wells and Associates), incorporating only the proposed infrastructure changes at Pilanesberg Platinum Mine (PPM).

The latest current financial closure liability for PPM (as at end December 2017) was calculated by Digby Wells and Associates to be R 284,565,367 (including VAT) as per the *Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine* as published by the DMR (previously known as the Department of Minerals and Energy (DME)), dated January 2005.

This addendum to the financial closure liability for the proposed infrastructure changes at PPM (as at December 2018) has also been calculated in accordance with the DMR Guideline Document.

2.0 INPUT TO THE FINANCIAL CLOSURE LIABILITY CALCULATION

The DMR procedure for calculating financial closure liability is summarised as follows:

- Step 1: Determine the primary mineral and saleable mineral by-products.
- Step 2: Determine the risk class of the mine.
- Step 3: Determine the area sensitivity in which the mine is located.
- Step 4.1: Determine the level of information available for calculating the financial liability.
- Step 4.2: Determine the closure components associated with the mine.
- Step 4.3: Determine the unit rates for the associated closure components.
- Step 4.4: Determine and apply various weighting factors (site specific).
- Step 4.5: Identify the areas of disturbance.
- Step 4.6: Identify any specialist studies required.
- Step 4.7: Calculate the closure liability using the DMR template provided.

The areas shaded in grey in the following sub-chapters are the values/information used in the calculation of the current financial liability associated with PPM.



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2.1 Step 1: Mine Type and Saleable Mineral By-Product

DMR require that the type of mineral mined or processed, and the saleable mineral by-products (not trace elements) be identified.

The primary minerals at PPM are platinum group elements. Saleable mineral by-products from the operations include nickel and copper.

Mine/Process type	Platinum Mine
Saleable mineral by-product	Refined PGE's, Ni and Cu

2.2 Step 2: Risk Ranking

According to the DMR guideline, PPM (due to its minerals mined (platinum), tonnages (greater than 10,000 tonnes per month), processing plant and plant waste/tailings) is classified as a Class B – Medium risk facility.

The risk ranking class is used later to determine the multiplication factors applied to the master rate (see Step 4.3).

Primary risk ranking	Class B – Medium risk (> 10,000 tonnes per month and processing plant) ¹
Revised risk ranking	N/A

2.3 Step 3: Environmental Sensitivity of the Mine Area

PPM is classified as having a Medium environmental sensitivity based on the classification criteria below.

- A medium biophysical sensitivity (based on the pre-mining environment of the project area).
- A medium social sensitivity (based on the proximity of the project area to local communities).
- A low economic sensitivity (based on the area's existing economic activity).

The environmental sensitivity ranking is used later to determine the multiplication factors applied to the master rate (see Step 4.3).

¹ Class B - Medium risk = Moderate probability of occurrence of an impact with a manageable consequence.

Sensitivity	Sensitivity Criteria		
	Biophysical	Social	Economic
Low	<ul style="list-style-type: none"> • Largely disturbed from natural state, • Limited natural fauna and flora remains, • Exotic plant species evident, • Unplanned development, • Water resources disturbed and impaired. 	<ul style="list-style-type: none"> • The local communities are not within sighting distance of the mining operation, • Lightly inhabited area (rural). 	<ul style="list-style-type: none"> • The area is insensitive to development, • The area is not a major source of income to the local communities.
Medium	<ul style="list-style-type: none"> • Mix of natural and exotic fauna and flora, • Development is a mix of disturbed and undisturbed areas, within an overall planned framework, • Water resources are well controlled. 	<ul style="list-style-type: none"> • The local communities are in proximity of the mining operation (within sighting distance), • Peri-urban area with density aligned with a development framework, • Area developed with an established infrastructure. 	<ul style="list-style-type: none"> • The area has a balanced economic development where a degree of income for the local communities is derived from the area, • The economic activity could be influenced by indiscriminate development.
High	<ul style="list-style-type: none"> • Largely in natural state, • Vibrant fauna and flora, with species diversity and abundance matching the nature of the area, • Well planned development, • Area forms part of an overall ecological regime of conservation value, • Water resources emulate their original state. 	<ul style="list-style-type: none"> • The local communities are in close proximity of the mining operation (on the boundary of the mine), • Densely inhabited area (urban/dense settlements), • Developed and well-established communities. 	<ul style="list-style-type: none"> • The local communities derive the bulk of their income directly from the area, • The area is sensitive to development that could compromise the existing economic activity.

2.4 Step 4.1: Level of Information Available

The level of information available allows DMR to either accept (and/or independently review) the financial closure liability submitted, otherwise follow the 'rule-based' approach.

Extensive	<p>Information available must include the following:</p> <ul style="list-style-type: none"> • An Approved EMP, or in the process of being approved, • A detailed Closure Plan based on the EMP, • A detailed breakdown of costs envisaged for rehabilitation and closure.
Limited	Information available is less comprehensive than that given above

Since no detailed breakdown of costs envisaged for rehabilitation and closure has been prepared, the step-by-step 'rule-based' DMR approach for calculating closure liability has been followed (as per the latest current financial closure liability calculation compiled by Digby Wells and Associates ("*Pilanesburg Platinum Mines (NW/30/5/1/2/2/320 MR) DMR Financial Provision*", dated 28 February 2018).

2.5 Step 4.2: Closure Components to be Used

The closure components relevant to the proposed infrastructure changes at PPM have been selected from the list provided below. Further details of these closure components as provided by the DMR are summarised in Appendix C.

No.	Description of Closure Components	Valid
1	Dismantling of processing plant & related structures (incl. overland conveyors & power lines)	Yes
2 (A)	Demolition of steel buildings & structures	Yes
2 (B)	Demolition of reinforced concrete buildings & structures	Yes
3	Rehabilitation of access roads	No
4 (A)	Demolition & rehabilitation of electrified railway lines	No
4 (B)	Demolition & rehabilitation of non electrified railway lines	No
5	Demolition of housing &/or administration facilities	No
6	Opencast rehabilitation including final voids & ramps	No
7	Sealing of shafts, adits & inclines	No
8 (A)	Rehabilitation of overburden & spoils	No
8 (B)	Rehabilitation of processing waste deposits & evaporation ponds (basic, salt producing waste)	No
8 (C)	Rehabilitation of processing waste deposits & evaporation ponds (acidic, metal-rich waste)	No
9	Rehabilitation of subsided areas	No
10	General surface rehabilitation	No
11	River diversions	No
12	Fencing (i.e. high level security perimeter fencing)	Yes
13	Water management	No
14	2 to 3 years of maintenance & aftercare	No

2.6 Step 4.3: Unit Rates for Closure Components

The unit (Master) rates for each closure component is taken from the DMR guideline (and inflated by the Consumer Price Index (CPI) to account for escalation since January 2005) and a Multiplication Factor applied depending on the Risk Ranking and the Environmental Sensitivity.

The average annual percentage change in the CPI as provided by Statistics South Africa is:

January to December						
2005	2006	2007	2008	2009	2010	2011
3.4 %	4.6 %	7.2 %	11.5 %	7.1 %	4.3 %	5.0 %
2012	2013	2014	2015	2016	2017	2018
5.6 %	5.7 %	6.1 %	4.6 %	6.4 %	5.3 %	4.7 %

i.e. a total of 120.34 % since January 2005 (i.e. 1.034 x 1.046 x 1.072 ... etc.).

The escalated unit (Master) rates, as at December 2018, are provided in the table below.

No.	Description	Unit	Master Rate (at December 2018)	Multiplication Factor ²
1	Dismantling of process plant & related structures (incl. overland conveyors & power lines)	m ³	R 15.03	1.00
2 (A)	Demolition of steel buildings & structures	m ²	R 209.32	1.00
2 (B)	Demolition of reinforced concrete buildings & structures	m ²	R 308.47	1.00
3	Rehabilitation of access roads	m ²	R 37.46	1.00
4 (A)	Demolition & rehabilitation of electrified railway lines	m	R 363.56	1.00
4 (B)	Demolition & rehabilitation of non electrified railway lines	m	R 198.30	1.00
5	Demolition of housing &/or administration facilities	m ²	R 418.64	1.00
6	Opencast rehabilitation including final voids & ramps	Ha	R 213,065.97	0.52
7	Sealing of shafts, adits & inclines	Ha	R 112.37	1.00
8 (A)	Rehabilitation of overburden & spoils	Ha	R 146,303.83	1.00
8 (B)	Rehabilitation of processing waste deposits & evaporation ponds (basic, salt producing waste)	Ha	R 182,218.77	1.00
8 (C)	Rehabilitation of processing waste deposits & evaporation ponds (acidic, metal-rich waste)	Ha	R 529,249.69	0.76
9	Rehabilitation of subsided areas	Ha	R 122,507.42	1.00
10	General surface rehabilitation	Ha	R 115,897.31	1.00
11	River diversions	Ha	R 115,897.31	1.00
12	Fencing	m	R 132.20	1.00
13	Water management	Ha	R 44,067.42	0.60
14	2 to 3 years of maintenance & aftercare	Ha	R 15,423.60	1.00

2.7 Step 4.4: Weighting factors to be Used

Weighting Factors based on the specific mine/process location are selected from the tables below.

Nature of the terrain/accessibility	Flat – Generally flat over the mine area	Undulating - A mix of sloped and undulating areas within the mine area	Rugged – Steep natural ground slopes (greater than 1:6) over the majority of the mine area
Weighting Factor 1	1.00	1.10	1.20

Proximity to urban area where goods and services are supplied	Urban – Within a developed urban area	Peri-urban – Less than 150 km from a developed urban area	Remote – Greater than 150 km from a developed urban area
Weighting Factor 2	1.00	1.05	1.10

² Multiplication factor based on Risk Ranking = Class B and Environmental Sensitivity = Medium.

2.8 Step 4.5: Areas of Disturbance

The proposed PPM infrastructure changes that have been incorporated into this liability calculation are:

- New waste facility and sorting area.
- New hydrometallurgical plant.
- Upgrade of existing sewage treatment plant.
- New milling and flotation section within process plant area.

All of these proposed infrastructure changes will be established on already disturbed areas (i.e. general surface rehabilitation of already disturbed areas that has been previously accounted for in the December 2017 financial closure liability calculation compiled by Digby Wells and Associates (“Pilanesburg Platinum Mines (NW/30/5/1/2/2/320 MR) DMR Financial Provision”, dated 28 February 2018).

Other already existing infrastructure changes that have not been included in this liability calculation (and that have already been included in the December 2017 financial closure liability calculation compiled by Digby Wells and Associates are:

- Existing aggregate crusher.
- Existing car wash bay.
- Existing brick yard.
- Existing composting site.
- Existing vegetable garden and nursery.

It is currently assumed that all PPM mine infrastructure will be demolished and no handover of any facilities (for post closure use) has been allowed for. Furthermore, the PPM mine infrastructure is assumed to have zero salvage value.

The proposed PPM infrastructure changes that have been incorporated into this liability calculation are shown in Appendix A.

2.9 Step 4.6: Identify Closure Costs from Specialist Studies

The risk ranking identifies what type of specialist studies should be carried out to ensure successful closure of the mine and/or process operation.

Risk Ranking	Specialist Studies
Class A (High risk)	<ul style="list-style-type: none"> • Water pollution potential studies • Overall quantified risk assessment
Class B (Medium risk)	<ul style="list-style-type: none"> • Screening level risk assessment
Class C (Low risk)	

Note: A screening level risk assessment has already previously been undertaken by PPM and this item has therefore been zero rated in the calculation.

3.0 STEP 4.7: CALCULATE THE CLOSURE LIABILITY

The current financial closure liability associated with the proposed infrastructure changes at PPM (as at December 2018) is R 11,859,378 including VAT. This amount has been calculated at Current Value (CV) as at December 2018. The liability calculation is provided in Appendix B.

The calculated financial liability is considered to be Class 1 estimate (with an accuracy between +25% and -15%) based on the overall generic approach as stipulated by the DMR Guideline Document.

4.0 ASSUMPTIONS AND EXCLUSIONS

The DMR Guideline Document is a “high-level” closure liability estimate that does not necessarily address all the mine related closure issues (hence the replacement of the DMR Guideline as at 19 February 2020, and the implementation of the Financial Provisioning Regulations – with specific guidance and instruction when developing closure plans).

The calculated financial closure liability only considers the routine costs associated with decommissioning of plant and infrastructure, the restoration of any environmental damage caused predominantly at the pre-production stage, and the maintenance and aftercare of the rehabilitated sites.

This closure liability calculation currently assumes that all infrastructure will be demolished, and that the mine infrastructure has zero salvage value. Further work to identify exactly what infrastructure may remain post closure to support the proposed community water supply scheme for livestock, irrigation or human consumption still needs to be undertaken (“Pilanesberg Platinum Mine Rehabilitation Plan Report”, GCS, Project Number: 15-0276, 03 May 2016).

Site specific aspects such as surface and groundwater remediation have not been costed at this stage – the likelihood of such remediation will be identified through ongoing surface and groundwater monitoring and/or by carrying out risk assessment and water pollution potential studies/investigations during mine operations. This issue will be dealt with as part of detailed closure planning as per the Financial Provisioning Regulations (GNR 1147).

Revegetation trials (and hence the sustainability of any rehabilitation works) is currently ongoing and will be addressed as part of operations, as well as, the requirements of a detailed closure plan (as per GNR 1147).

Lastly, the current financial closure liability does not make allowance for the development of a detailed closure plan, final groundwater modelling, drafting of engineering drawings and specifications, procurement of specialist work, and any administration and site supervision costs. These expenses should therefore be accounted for by PPM in the operations expenditure of the mine.

5.0 CONCLUSION

The current financial closure liability associated with the proposed infrastructure changes at PPM (as at December 2018) is R 11,859,378 (CV including VAT) as per the *Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine* as published by the Department of Mineral Resources (DMR).

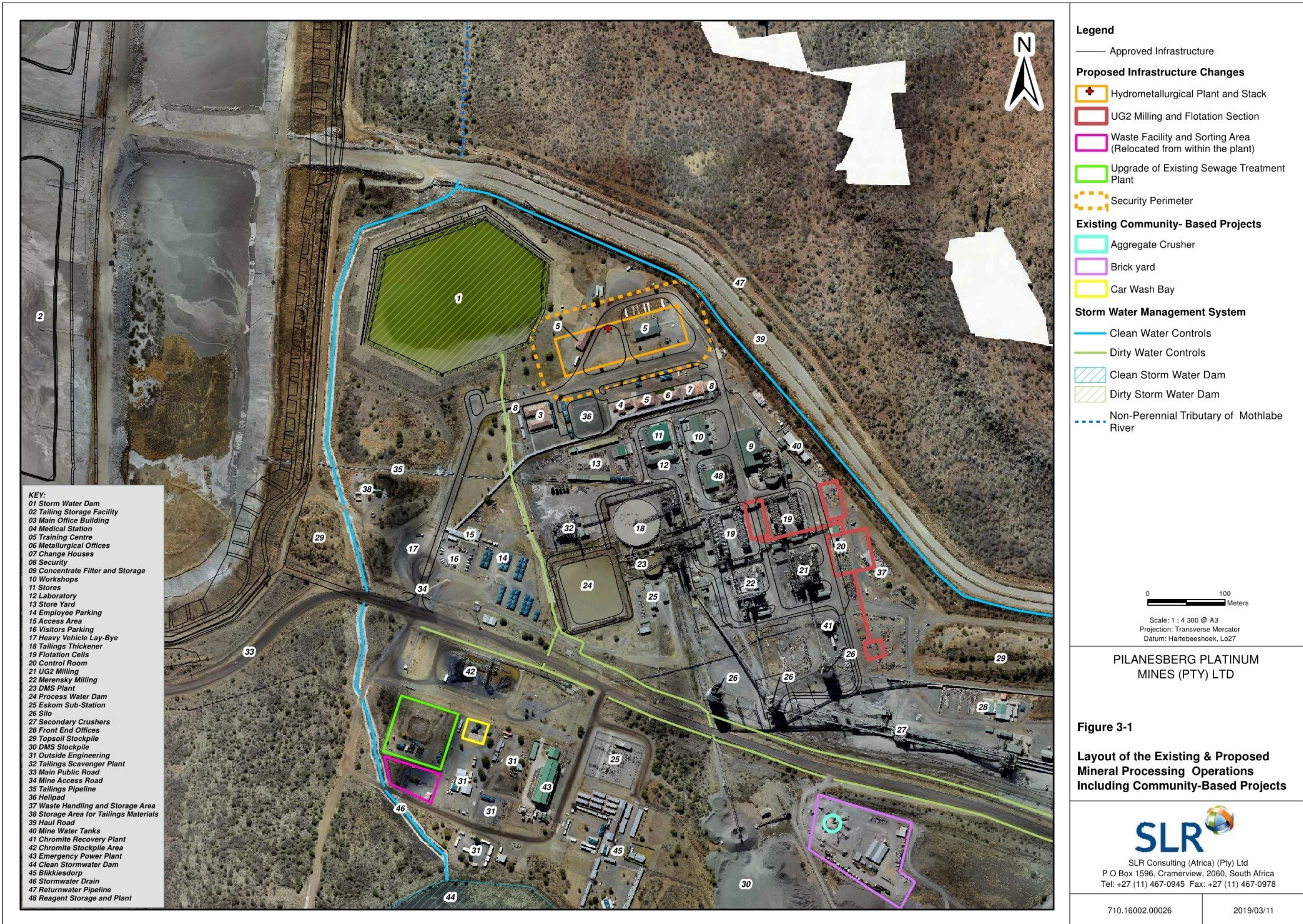
The calculated financial liability is considered to be Class 1 estimate (with an accuracy between +25% and -15%) based on the overall generic approach as stipulated by the DMR Guideline Document.



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APPENDIX A: Proposed Infrastructure Changes at PPM considered in the Financial Closure Liability Calculation



- KEY:**
- 01 Storm Water Dam
 - 02 Tailing Storage Facility
 - 03 Main Office Building
 - 04 Medical Station
 - 05 Training Centre
 - 06 Metallurgical Offices
 - 07 Change Houses
 - 08 Security
 - 09 Concentrate Filter and Storage
 - 10 Workshops
 - 11 Stores
 - 12 Laboratory
 - 13 Store Yard
 - 14 Employee Parking
 - 15 Access Area
 - 16 Visitors Parking
 - 17 Heavy Vehicle Lay-By
 - 18 Tailings Thickener
 - 19 Flotation Cells
 - 20 Control Room
 - 21 UG2 Milling
 - 22 Merensky Milling
 - 23 DMS Plant
 - 24 Process Water Dam
 - 25 Eskom Sub-Station
 - 26 Silo
 - 27 Secondary Crushers
 - 28 Front End Offices
 - 29 Topsoil Stockpile
 - 30 DMS Stockpile
 - 31 Outside Engineering
 - 32 Tailings Scavenger Plant
 - 33 Main Public Road
 - 34 Mine Access Road
 - 35 Tailings Pipeline
 - 36 Helipad
 - 37 Waste Handling and Storage Area
 - 38 Storage Area for Tailings Materials
 - 39 Haul Road
 - 40 Mine Water Tanks
 - 41 Chromite Recovery Plant
 - 42 Chromite Stockpile Area
 - 43 Emergency Power Plant
 - 44 Clean Stormwater Dam
 - 45 Blikkiesdorp
 - 46 Stormwater Drain
 - 47 Returnwater Pipeline
 - 48 Reagent Storage and Plant

- Legend**
- Approved Infrastructure
 - Proposed Infrastructure Changes**
 - + Hydrometallurgical Plant and Stack
 - UG2 Milling and Flotation Section
 - Waste Facility and Sorting Area (Relocated from within the plant)
 - Upgrade of Existing Sewage Treatment Plant
 - Security Perimeter
 - Existing Community- Based Projects**
 - Aggregate Crusher
 - Brick yard
 - Car Wash Bay
 - Storm Water Management System**
 - Clean Water Controls
 - Dirty Water Controls
 - Clean Storm Water Dam
 - Dirty Storm Water Dam
 - Non-Perennial Tributary of Motlabe River

0 100 Meters
 Scale: 1 : 4 300 @ A3
 Projection: Transverse Mercator
 Datum: Hartebeeshoek, Lo27

PILANESBERG PLATINUM MINES (PTY) LTD

Figure 3-1
 Layout of the Existing & Proposed Mineral Processing Operations Including Community-Based Projects

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APPENDIX B: Closure Liability Calculation

CALCULATION OF THE QUANTUM								
Area	Pilanesburg Platinum Mine - Plant Expansion Infrastructure (CV as at December 2018)							
No.	Description:	Unit:	Operational Area	A Quantity	B Master rate	C Multiplication factor	D Weighting factor 1	E=A*B*C*D Amount (Rands)
				Step 4.5	Step 4.3	Step 4.3	Step 4.4	
1	Dismantling of processing plant & related structures (incl. overland conveyors & structures)	m ³	Hydrometallurgical Plant	247500	R 15.03	1	1.1	R 4 091 097.90
		m ³	Milling and Flotation Section	93890	R 15.03	1	1.1	R 1 551 972.45
2 (A)	Demolition of steel buildings & structures	m ²	Hydrometallurgical Plant	8250	R 209.32	1	1.1	R 1 899 581.14
		m ²	New Milling and Flotation Section	3005	R 209.32	1	1.1	R 691 908.04
2 (B)	Demolition of reinforced concrete buildings & structures	m ²	Upgraded Sewage Treatment Plant	100	R 308.47	1	1.1	R 33 931.91
		m ²	New Milling and Flotation Section	250	R 308.47	1	1.1	R 84 829.78
3	Rehabilitation of access roads	m ²	n/a	0	R 37.46	1	1.1	R 0.00
4 (A)	Demolition & rehabilitation of electrified railway lines	m	n/a	0	R 363.56	1	1.1	R 0.00
4 (B)	Demolition & rehabilitation of non electrified railway lines	m	n/a	0	R 198.30	1	1.1	R 0.00
5	Demolition of housing &/or administration facilities	m ²	n/a	0	R 418.64	1	1.1	R 0.00
6	Opencast rehabilitation including final voids & ramps	ha	n/a	0	R 213 065.97	0.52	1.1	R 0.00
7	Sealing of shafts, adits & inclines	m ³	n/a	0	R 112.37	1	1.1	R 0.00
8 (A)	Rehabilitation of overburden & spoils	ha	n/a	0	R 146 303.83	1	1.1	R 0.00
8 (B)	Rehabilitation of processing waste deposits & evaporation ponds (basic, salt producing waste)	ha	n/a	0	R 182 218.77	1	1.1	R 0.00
8 (C)	Rehabilitation of processing waste deposits & evaporation ponds (acidic, metal-rich waste)	ha	n/a	0	R 529 249.69	0.76	1.1	R 0.00
9	Rehabilitation of subsided areas	ha	n/a	0	R 122 507.42	1	1.1	R 0.00
10	General surface rehabilitation - of newly disturbed areas only	ha	Waste Facility and Sorting Area	n/a	R 115 897.31	1	1.1	R 0.00
		ha	Hydrometallurgical Plant	n/a	R 115 897.31	1	1.1	R 0.00
		ha	Upgraded Sewage Treatment Plant	n/a	R 115 897.31	1	1.1	R 0.00
		ha	New Milling and Flotation Section	n/a	R 115 897.31	1	1.1	R 0.00
11	River diversions (to be decommissioned)	ha	n/a	0	R 115 897.31	1	1.1	R 0.00
12	Fencing	m	Waste Facility and Sorting Area	110	R 132.20	1	1.1	R 15 996.47
		m	Hydrometallurgical Plant	670	R 132.20	1	1.1	R 97 433.06
		m	Upgraded Sewage Treatment Plant	n/a	R 132.20	1	1.1	R 0.00
		m	New Milling and Flotation Section	n/a	R 132.20	1	1.1	R 0.00
13	Water management	ha	n/a	0	R 44 067.42	0.60	1.1	R 0.00
14	2 to 3 years of maintenance & aftercare	ha	n/a - no newly disturbed areas	0	R 15 423.60	1	1.1	R 0.00
15 (A)	Specialist study (Screening level risk assessment)	SUM	n/a	0	R 0.00	1	1.1	R 0.00
Sub Total 1 (Sum of items 1 to 15 Above)								R 8 466 750.75
17	Multiply Subtotal 1 by Weighting Factor 2 (step 4.4)					5.0% of Subtotal 1		R 423 337.54
Subtotal 2 (Subtotal 1 plus Weighting Factor 2 value)								R 8 890 088.29
18	Preliminary and General (P&G's)					6.0% of Subtotal 2		R 533 405.30
Subtotal 3 (Subtotal 2 plus P&G's value)								R 9 423 493.58
19	Contingency					10.0% of Subtotal 2		R 889 008.83
Subtotal 4 (Subtotal 3 plus Contingency value)								R 10 312 502.41
20	VAT					15.0% of Subtotal 3		R 1 546 875.36
GRAND TOTAL (Subtotal 4 plus VAT)								R 11 859 377.78

APPENDIX C: Details of DMR Closure Components

1.0 INTRODUCTION

Generally accepted closure methods, based on experience in the field, have been used as the basis for determining the Master rates for the various closure components in the DMR “rules-based” approach.

The details enclosed in the approved EMP will however take precedence over these generally accepted closure methods.

2.0 GENERALLY ACCEPTED CLOSURE METHODS USED TO DETERMINE THE DMR MASTER RATE

2.1 Component 1: Processing Plant

The common method of valuation to determine the Master rate for processing plants is that:

- All infrastructure and concrete buildings should be broken down to natural ground and buried adjacent to the plant site,
- Foundations, structures and conveyors should be broken down to natural ground level,
- The areas are to be covered with 1,0m subsoil, top soiled with 300mm of topsoil and vegetation established, or as noted in the relevant EMP,
- The monitoring and maintenance of these areas has been costed under the appropriate areas,
- Top soiling and vegetation for the areas are included under general surface rehabilitation,
- No credits are allowed for scrap steel and equipment that can be re-used or sold.

2.2 Components 2(A) and 2 (B): Steel and Reinforced Concrete Buildings and Structures

The common method of valuation to determine the Master rate for steel and reinforced concrete buildings and structures is that:

- All structures should be demolished to 1m below ground level,
- The rubble is to be buried adjacent to the sites, provided this adheres to the National Waste Management Strategy,
- Silos should be imploded and buried,
- The areas should be shaped, top soiled with 300mm of topsoil and vegetated or as stated in the relevant EMP document,
- Monitoring and maintenance is costed in the relevant areas,

2.3 Component 3: Access Roads

(No details provided in DMR guideline)

2.4 Component 4 (A) and 4 (B): Railways

The valuation of the removal of railway lines is based on:-

- The removal of the ballast, sleepers and rail,
- All culverts, bridges and structures are to remain,
- No rehabilitation to the general earthworks, neither cut nor fill,
- Removal of the electrification of the railway lines, including sub-stations and signalling,
- General clean up and making certain of adequate drainage,
- No credit is allowed for second-hand rail and ballast.

2.5 Component 5: Housing and Administration Facilities

Same as for Component 2(A) and 2(B): Steel and Reinforced Concrete Buildings and Structures

2.6 Component 6: Opencast Rehabilitation

Some form of beneficial land use is desirable after mining. Hence, in-filling of opencast pits is advocated in order to facilitate post-mining beneficial land use. In-filling normally constitutes the following modes of action:

- Concurrent in-filling and subsequent spoils rehabilitation as routinely conducted for opencast pits on collieries.
- In-filling by obtaining material from adjacent opencast pits and/or other parts of the same opencast pit as routinely conducted on iron ore mines.

Difficulties could be experienced with concurrent infilling in those cases where the ore body is limited to a single opencast pit and various grades of ore need to be sourced from the pit. This requires access to the full pit and in-filling could sterilise ore reserves. In these cases rehabilitation should be facilitated as follows:

- Excess material from the opencast pit is deposited in close proximity to the pit for in-filling of the opencast pit once the ore body has been removed.
- Excess material is deposited in such a manner in relation to the opencast pit that mine residue deposit rehabilitation can be conducted with respect to this material. In this case the opencast pit perimeter walls must still be rendered safe for humans and domestic animals. This is normally achieved by means of the following:
 - Sloping the perimeter walls of the opencast pit at 1:3 (18°) to the pit floor or to the stable groundwater level that could establish within a reasonable period within the opencast pit.
 - Providing enviro berms along the opencast pit perimeter when perimeter wall flattening is not feasible as in those cases where opencast mining has been conducted on steep mountain sides.

Notwithstanding the above, owing to removal of the mined product off-site, notably less material remains on site for pit in-filling than was originally removed from the opencast pit. This could be despite bulking of the removed material. Hence final voids with respect to most opencast pits would be unavoidable. These voids should be addressed in the same manner as making the opencast pit safe as described above.

2.7 Component 7: Sealing of Shafts, Adits and Inclines

The sealing of vertical and incline shafts are primarily a safety consideration and this should be conducted in such a manner that potential safety risks are largely obviated.

Normally, inert building rubble arising from the demolition of surface infrastructure should be deposited into the shafts. A mass concrete cap of 1 000 mm thickness is placed onto the building rubble deposited into the shaft. It should be noted that, in specific circumstances, dedicated engineering design and specification of these caps could be required.

Allowance should also be made for methane venting of the underground mine workings with a methane formation potential by means of strategically placed venting boreholes.

2.8 Components 8 (A), 8 (B) and 8 (C): Overburden and spoils, Process plant waste: basic, salt-producing and Process plant waste: acidic, metal-rich.

2.8.1 Component 8A: Overburden and spoils

Overburden and spoils normally have a low pollution potential and hence only need to be shaped to create a stable landform. The Master rate thus includes shaping and grassing/vegetation of the overburden and spoils.

2.8.2 Component 8B: Process plant waste: basic, salt-producing

The Master rate for basic, salt-producing process plant waste includes shaping and grassing/vegetation of the dumps as well as establishing an armoured cover on the reshaped surface of the dump.

2.8.3 Component 8C: Process plant waste: acidic, metal-rich

The Generally accepted closure methods for acidic, metal-rich plant waste are primarily aimed at the following:

- Limiting seepage of contaminants from the processing waste deposit
- Prevention of contaminated seepage entering local surface and groundwater sources.

The Master rate includes allowances for slope modification, armouring and evaporative covers, lined pollution control dams and lined cut-off trenches.

2.8.4 Closure elements specific to 8 (A), 8 (B) or 8 (C)

Generally, average modified outer slopes of 1:3 (18°) are required. Although not specifically stated, benches at regular intervals are also required. This should ensure that the modified outer slopes between benches do not exceed 35 to 40 m in order to curb stormwater flow velocities on the outer slopes. Benches should be at least 5 m wide, sloping inwards at a slope of about 1:10.

Current generally accepted closure methods allows for a dedicated cover to be provided on the modified outer slopes of the residue deposit. The cover has to fulfil the following primary functions:

- Protection of the integrity/stability of the modified outer slope.
- Limiting the ingress of air and water into residue material that has the potential to contaminate local groundwater by means of contaminated seepage arising from the footprint area of the deposit.
- Separation of the deposited residue from uncontaminated surface runoff arising from the outer slopes of the residue deposit.
- Contribution to the aesthetic appeal of the rehabilitated residue deposit.

Covers fulfilling the above functions could be of varying nature, comprising of natural and/or synthetic material. If natural materials are to be used, current practice allows for an evaporative cover, varying in thickness between 750 and 1 000 mm, with an outer cover layer of 300 mm thickness of armouring or topsoil with vegetation. The armouring also requires vegetation, but this is not essential for the long-term integrity of the outer cover layer. Depending on the nature of the deposited material covered, capillary breaker layers between the evaporative cover and the deposited material could also be required.

Current generally accepted closure methods indicates that operational pollution control dams are properly lined to prevent the migration of the contaminated water impounded in the dam to the shallow groundwater or the nearby receiving surface water environment. Mostly, synthetic (HDPE) liners are provided for this purpose. However, these liners have a finite life and eventual failure of these liners would result in the salts and other contaminants that accumulated in the pollution control dam(s) over the years to be dissipated into the receiving water environment. Hence, from a holistic view the provision of a pollution control dam served a limited function, only postponing the release of contaminants into the receiving water environment. However, contaminant release has been spread-out over a period of about 50 years, starting from mine residue deposit rehabilitation to final disintegration of the liner in the pollution control dam(s). This situation would most likely allow for an acceptable residual impact, with salt/contaminant release into the receiving water environment at a rate that does not exceed the “natural” assimilative capacity of the receiving water resource. The only exception could be extremely sensitive water resources.

Stormwater runoff arising from the upper and outer slopes of the rehabilitated residue deposit should be managed for the following primary reasons:

- Prevention of uncontrolled runoff from the residue deposit, thereby creating surface erosion and resultant damage to the cover and under extreme cases exposing the deposited material.
- Routing of the runoff arising from the rehabilitated residue deposit into the surrounding surface water drainage regime in a manner that would limit the creation of secondary erosion in the receiving surface water environment and/or possible damage to downstream surface infrastructure.

- Allowing for the control routing of the runoff collected on the rehabilitated residue deposit across cut-off, seepage or solution trenches provided to handle excess contaminated seepage from the residue deposit.

In addition to the above, upslope stormwater diversion measures could also be required to route upslope runoff past the residue deposit to prevent possible cover damage and other specific local drainage requirements. Toe paddocks could also be required along the outer perimeter toe of the rehabilitated residue deposit to capture sediment arising from the cover material whilst vegetation on the cover is still in the process of establishment.

Current practice allows for two broad approaches to handle runoff arising from the rehabilitated residue deposit. These are as follows:

- Collection of the runoff arising from the benches in chutes to route this water to the toe of the residue deposit. Chutes must be constructed from concrete or other suitable material to cater for the high flow velocities that could be encountered.
- Collection of runoff arising from the modified outer slopes on the benches itself and allowing this water to evaporate on the benches. Under these circumstances bench width could be wider than the normal 5 m width, with parapet walls provided on the outer edges of the benches. These walls must be designed for at least the 1:200 year rainfall events. The residue deposit material must also be suitable for this type of stormwater contaminant and must not be susceptible to slumping under saturated conditions.

In very sensitive environmental situations and/or where the seepage from the residue deposit could be highly contaminated, a cut-off drain around the perimeter of the residue deposit may be required. Abstraction of the seepage collected in the cut-of drain by means of pumps at predetermined spacing would be required. The collected seepage has to be routed to a pollution control dam for disposal.

2.9 Component 9: Subsided Areas

(No details provided in DMR guideline, but presumed to be similar to Component 10: General Surface Rehabilitation)

2.10 Component 10: General surface rehabilitation

Final surface rehabilitation of areas disturbed by mining and related activities should be aligned to the selected final land use.

Irrespective of the final land use, general surface rehabilitation normally should ensure the following:

- Surface topography that emulates the surrounding areas and aligned to the general landscape character. Steep slopes in excess of 6 percent should also be avoided if possible.
- An area without unnecessary remnants of structures and surface infrastructure to give the rehabilitated area a “neat” appearance. Special attention must be given to shape and/or removal of heaps of excess material being the legacy of prolonged mining and related activity.

- Landscaping that would facilitate surface runoff and result in free draining areas. If possible, the drainage lines should be reinstated.
- An area suitable for revegetation.

The unit cost for general rehabilitation allows for shaping and landscaping of disturbed areas. The Master rate allows for the shaping of material to a depth/thickness of about 500 mm. An extra over allowance in the unit cost of 50 percent has been made to cover the removal and/or destruction of surface infrastructure remnants and/or other undesirable objects such as trees, foundations, concrete slabs, etc.

2.11 Component 11: River diversions

Although not desirable, river diversions are unavoidable in some cases to allow mining, especially opencast mining, to proceed.

Wetland areas are normally associated with river diversions and during the operational period some form of riparian habitat could most likely have established within the stream diversion area. Hence considerations should be given whether a stream diversion should be changed at mine closure. This could require dedicated assessments to guide decision-making in this regard. Moreover, removal of stream diversions could result in stream flow over mined areas that could result in undesirable water quality effects.

In the event that river diversions should be removed at closure, the Master rate is the same as for general surface rehabilitation.

2.12 Component 12: Fencing

(No details provided in DMR guideline)

2.13 Component 13: Water management

Current practice is to provide in-pit evaporation dams for opencast pits. Ideally these dams should coincide with pit final voids. The dams should be sized that groundwater inflow into the pit plus rehabilitated spoils recharge can be evaporated from the dam. The dam perimeter as in the case of opencast pits must be shaped to render it safe. The same approach as for opencast pits is generally followed.

Underground mine workings has the potential to eventually fill up with water and decant. Depending on the decant mode and the type of product mined, this water could be of a poor quality. Hence provision should be made to collect and handle this water to limit degradation of water resources in the vicinity of potential decant. Collection and neutralisation (with associated metal removal) is an established management practice to deal with this water. However, the elevated salt content normally associated with this water is still a matter of concern. Hence, advanced treatment such as desalination of this water is currently considered and in some cases pilot plants have been established to assess feasibility. Treatment technologies not producing brine are currently favoured. However, this is not possible with all types of excess mine water.

It should be noted that the filling of a mine could involve a notable period of time and the required treatment capacity to handle the excess mine water could only be required decades after mine closure. Hence the future implementation of these plants most likely by third parties should also receive consideration.

Note: Costs associated with brine producing treatment technologies were also assessed. Although the capital costs associated with these technologies could be lower than for non-brine producing technologies, the operating and maintenance costs are notably higher. Hence the overall costs for water management and treatment in the guideline document are not notably different, based on the water treatment method, to warrant distinction.

2.14 Component 14: Maintenance and aftercare

Maintenance and aftercare is planned for 2 to 3 years after mine production ceases, and covers:

- Annually fertilising of rehabilitated areas,
- Monitoring of surface and subsurface water quality surface,
- Control of wattle and all other alien plants,
- General maintenance, including rehabilitation of cracks and subsidence.