



DIGBY WELLS
ENVIRONMENTAL

Closure Cost Assessment Report

Closure Cost Report FS30/5/1/2/2/86MR

Project Number:

HAR5113

Prepared for:

Harmony Gold Mining Company Limited



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Name	Responsibility	Signature	Date
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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been requested by Harmony Gold Mining Company Limited (hereafter Harmony) to review the unscheduled closure cost at the St. Helena 10 Mining Operation (FS86MR). This document details the assessment of the relevant costs pertaining to St Helena Operation as required in the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as amended. Section 41 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2008) (MPRDA) has been repealed and Section 24P in the NEMA, as amended, provides that the holder of a mining right must make financial provision for rehabilitation of negative environmental impacts.

The report and its associated costing have been based on the Department of Mineral Resources' (DMR) guidelines set out by the DMR (2005) in the *"Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine"*.

The St. Helena Shafts were one of the first gold mining operations established on the outskirts of the town of Welkom in the Free State Province. Multiple shafts were sunk under the St. Helena mining right, including the St. Helena 10 Shaft located directly south of Welkom.

Harmony personnel undertook a site visit to the St. Helena 10 shaft during April 2018, which was followed by computing the closure cost calculations. Digby Wells' scope was to review the closure cost calculations by updating the rates used in the calculations and compile a closure cost assessment report. The rates were updated using quotations from demolition and civil contractors and professionals wherever possible.

This report contains the estimated closure costs as well as the methodology and assumptions made to arrive at the final closure estimate. The unscheduled closure cost for the operation was assessed as at March 2018.

All infrastructures have been demolished on site. The shafts are currently being filled to surface and will then be plugged based on the approved engineering design.

The total closure cost for 2018 according to Digby Wells is depicted in the table below. This table also compares the liability cost difference between the 2017 assessment and the 2018 assessment.

Table 1-1: Comparison of the 2017 and 2018 closure cost

Mining Right: FS30/5/1/2/2/86 MR	2017	2018	Cost Increase/Decrease 2017 vs. 2018	Cost (%) Increase/Decrease 2017 vs. 2018	Reasons
St. Helena 10 Shaft	R 6,617,507	R 6,369,194	R -248,313	-3.75%	Shafts currently being filled to surface

TABLE OF CONTENTS

1	Introduction	1
1.1	Site Location	1
1.2	Project Description	1
1.3	Scope of Work.....	2
2	Terms of Reference	2
3	Expertise of Specialist.....	3
4	Methodology.....	3
4.1	Site Visit	3
4.2	Infrastructure Measurement	3
4.3	Cost Calculation	3
4.3.1	<i>Rates</i>	3
4.3.2	<i>Model Compilation</i>	4
5	Rehabilitation and Closure Objectives	4
6	Assumptions.....	5
7	Rehabilitation Required.....	6
7.1	Sealing of Shafts Audits and Inclines.....	6
7.2	Other Components	7
7.2.1	<i>Overburden and Spoils</i>	7
7.3	General Rehabilitation	8
8	Post-Closure Management	8
9	Long Term Water Impacts.....	8
10	Summary of Liabilities	9
11	Recommendations	10
12	Conclusion	10
13	References.....	12

LIST OF FIGURES

Figure 7-1: St Helena 10 shaft	7
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LIST OF TABLES

Table 1-1: Comparison of the 2017 and 2018 closure cost	iii
Table 4-1: Weighting Factor – Proximity to Urban Areas (DMR, 2005).....	4
Table 10-1: Summary of Liabilities	9

LIST OF APPENDICES

Appendix A: Detailed Cost Breakdown	
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1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been requested by Harmony Gold Mining Company Limited (hereafter Harmony) to review the closure cost for the St. Helena 10 Shaft Mining Operation. This report contains the estimated closure costs as well as the methodology and assumptions made to arrive at the final closure estimate.

The focus of this project was on the calculation of the closure costs including the demolition and management of the physical infrastructure as well as the rehabilitation of these affected areas. The approach followed for the calculation of the closure costs was to reflect the “snapshot-in-time” principle as at March 2018. Costs have been calculated assuming that the mine would have to close immediately and would have to rehabilitate or remediate the impacts without delay.

There are numerous benefits of appropriate closure management including:

- Minimised residual environmental impacts upon closure;
- Advanced financial planning for environmental rehabilitation costs; and
- Reduced cost of financial provision through proactive completion of rehabilitation.

The Digby Wells method is based on the Department of Mineral Resources’ (DMR) mine closure principles, but is refined for the mine/operation and its specific considerations. The Digby Wells calculation allows for more accurate closure cost determination through itemisation, the use of current contractor rates and considers the unique nature of the operation.

Harmony personnel undertook site visits to all the shafts during April 2018, which was followed by computing the closure cost calculations. Digby Wells’ scope was to review the closure cost calculations by updating the rates used in the calculations and compile a closure cost assessment report. The rates were updated using quotations from demolition and civil contractors and professionals wherever possible.

Digby Wells assume that the survey data provided by Harmony is correct. This project did not involve a legal due diligence process.

1.1 Site Location

1.2 Project Description

The St. Helena Shafts were one of the first gold mining operations established on the outskirts of the town of Welkom in the Free State Province. Multiple shafts were sunk under the St. Helena mining right, including the St. Helena 10 Shaft located directly south of Welkom.

Below is a list of current infrastructure which was considered for the closure cost estimate for the Operation:

- Waste rock dump (WRD);
- Shaft; and
- Road.

1.3 Scope of Work

Digby Wells was responsible for the following:

- Calculating market-related rates for demolition and rehabilitation to be used in the closure cost assessment;
- Volume and area calculations of WRDs and tailings storage facilities (TSFs);
- Update of associated plans with reference points linked to the closure cost spreadsheet;
- Review of cost estimates for each Mining Right;
- Compilation of closure cost reports for each Mining Right based on the reviewed and finalised cost estimates;
- Compilation of an independent consolidated report which should include the following:
 - Description of the methodology;
 - Legislative requirements;
 - Review of the status of the financial liability provision; and
 - Identification of potential material issues affecting the provisioning.

Verification of the current situation on the sites and the update of the closure cost assessments were done internally by Harmony personnel.

2 Terms of Reference

The closure cost assessment is done in accordance with the requirements of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), as amended. Section 41 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2008) (MPRDA) has been repealed and in terms of Section 24P in the NEMA, as amended, which provides that the holder of a mining right must make full financial provision for rehabilitation of negative environmental impacts.

The regulations for the determination of financial provision for mine rehabilitation and closure were promulgated on 20 November 2015 (GN R1147 in GG 39425 of 20 November 2015) under the NEMA, as amended. This report and associated review of the financial provision did not, however, address any of the requirements of these regulations.

3 Expertise of Specialist

The specialist involved in reviewing the closure cost for St. Helena 10 Operation was Leon Ellis. His curricula vita is available on request.

4 Methodology

The methodology applied was as follows:

- Digby Wells updated the rates used in the cost calculation;
- Harmony personnel verified the current status of infrastructure and mining activities at all the Operations;
- Using ArcGIS, Digby Wells calculated the volumes and areas of WRDs and TSFs using survey data supplied by the Harmony survey team;
- Where required, maps were updated by Digby Wells;
- The detailed closure cost assessment conducted by Harmony personnel in 2018 was reviewed independently by Digby Wells; and
- The goals to be achieved for the various items requiring rehabilitation were taken from the DMR Guideline.

4.1 Site Visit

Harmony personnel undertook a site visit to all of the operations to identify and verify new or demolished, rehabilitated and/or reclaimed sites. Specific attention was given to those sites where changes occurred between February 2017 and March 2018.

All infrastructures have been demolished on site. The shafts are currently being filled to surface and will then be plugged based on the approved engineering design.

4.2 Infrastructure Measurement

The previous measurements for each mining area, which has not changed from the assessment conducted in March 2017, were assumed to be correct.

Where it was required, Digby Wells measured new infrastructure identified on site using plans provided by the client's survey team. Further to this, Digby Wells calculated the volumes and areas of the WRDs and TSFs and provided this to Harmony for inclusion into the closure cost assessment.

4.3 Cost Calculation

4.3.1 Rates

Digby Wells updated their internal rates database to reflect current market related rates. The rates were updated by quotes from demolition and civil contractors and professionals

wherever possible. Rate formulation takes into consideration the total labour costs, plant costs, fuel costs and construction costs, thus providing a more accurate, defensible rate.

It must be accepted that actual unit rates at various facilities may differ depending on their geographical location or contractor availability for demolition projects at the time they are conducted. Please note that the contractors were not prepared to account, in their rates, for the geographical location of each mine, thus the DMR's guideline on proximity to urban areas was applied (Table 4-1).

Table 4-1: Weighting Factor – Proximity to Urban Areas (DMR, 2005)

	Urban ¹	Peri-urban ²	Remote ³
Proximity to urban area weighting factor	1.00	1.05	1.10

The St Helena Operation and associated infrastructure areas have been defined as urban, thus the total has been multiplied by 1.

4.3.2 Model Compilation

The closure cost model was developed by Digby Wells and compiled in Microsoft Excel for each area of Harmony's operations. The model consists of an input sheet, containing all measurements of each area of the mine, a standard rate sheet and a summary sheet, which summarises the costs for closure. Each sheet is linked to the rate sheet, thereby, allowing the costs calculations to be updated easily from year to year.

5 Rehabilitation and Closure Objectives

The specific objectives that Harmony will adopt for rehabilitation and closure are to:

- Protect the environment and public health and safety by using safe and responsible closure practices;
- Minimize potential environmental effects, such as surface or ground water impacts;
- Rehabilitate or remove any waste or potentially hazardous substances from site;
- Develop landforms that, within reasonable and practical limitations, are stable and blend with the surrounding terrain;
- Improve water quality consistent with the water quality standards within Harmony's area of responsibility;
- Development of end land use that takes into account the beneficial uses of the site and surrounding areas;

¹ Within a developed urban area

² Less than 150 km from a developed urban area

³ Greater than 150 km from a developed urban area

- Leave a closed mine that does not represent a risk to the health and safety of the community;
- Reduce the requirement for long-term monitoring and maintenance by establishing stable landforms;
- Comply with national regulatory requirements;
- Address relevant stakeholder expectations, concerns and issues by forming participative communication channels;
- To enhance a positive socio-economic impact by achieving a sustainable land-use condition or alternatively as agreed upon with the applicable government regulator and affected communities;
- Avoid or minimise costs and long-term liabilities to the company and to the government and public; and
- Exonerate the company and its directors of further responsibility and accountability post end of life.

In addition to these objectives Harmony has considered relevant pieces of legislation, own environmental policies and commitments on mine rehabilitation and closure.

The benefits arising from the rehabilitation are:

- Harmony's legal obligation of mine rehabilitation and closure is met;
- Restoration of the environment;
- The site is made safe;
- Address long-term fauna, flora and aesthetic impacts;
- Address long-term water impacts;
- The visual impact of the mine will be reduced;
- Some areas could be used for future alternate uses; and
- Able to leave a positive legacy for future generations.

6 Assumptions

The following assumptions have been developed based upon the information provided and obtained from the site visit:

- The calculations do not account for any value recovered from the sale of plant, steel or other material;
- All roads within the mining area are the responsibility of the mine, except where they are proclaimed national or provincial roads;
- Survey data (footprints, volumes, etc.) provided by the mine's surveyor is correct;

- A contingency of 10% has been included to allow for areas which may have been undervalued or which have been overlooked;
- This study did not include a detailed assessment of issues concerning shallow or deep aquifer groundwater pollution and long-term decant from workings;
- Digby Wells measured the volumes and areas of the WRD using survey data provided by Harmony;
- The closure cost estimate does not include VAT;
- For post-closure vegetation monitoring and maintenance, costs for monitoring and maintenance the success of vegetation growth at rehabilitated sites has been assumed to take place for a period of three years with assessments taking place on an annual basis. A 75% vegetation success rate has been assumed on rehabilitated areas, hence vegetation maintenance only accounted for 25% of the rehabilitated areas for vegetation maintenance; and
- For post-closure monitoring, sampling of groundwater and surface water has been assumed to take place for a period of 10 years with sampling taking place twice a year.

7 Rehabilitation Required

The report and its associated costing have been based upon DMR guidelines set out by the DMR (2005) in the “Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine”. The guidelines outline the methods for infrastructure removal and rehabilitation required for closure, and the actions which are described below follow these guidelines.

7.1 Sealing of Shafts Audits and Inclines

Sealing of vertical and incline shafts is set to minimise risks associated with these shafts. The shaft must first be filled with building rubble of demolished infrastructure nearby. This is followed by a mass concrete cap (1 000 mm thick) built on top to seal the shaft (DME, 2005).



Figure 7-1: St Helena 10 shaft

7.2 Other Components

7.2.1 Overburden and Spoils

It is envisaged that the rock dumps will be reclaimed by Harmony in future, however, for the purposes of this assessment, cost were calculated for the shaping of the rock dumps to establish a safe slope.

Based on the Code of Practise (COP) for the operation and rehabilitation of waste rock dumps, only those slopes steeper than 30° need to be shaped. The COP ensures that slopes are left in a stable state and suggest that this is achieved at the angle of repose, which is between 37° and 45°. A slope angle of 30° is deemed to be safe for closure.

Alternatives as opposed to shaping the sides of the WRDs may be considered. These are as follows:

- Ore bearing material identified in waste rock can be processed through gold plants. As a result the waste rock dump can be removed and the processed material deposited on an active tailings facility;
- Inert waste rock material can be deposited down a shaft (provided it meets the necessary radiation standards);
- Inert waste rock material can also and is being used as backfill material for demolished and rehabilitated sites (provided it meets the necessary radiation standards); and
- Inert waste rock material can be crushed and used for aggregate material, bearing in mind that the radioactivity levels of crushed waste rock cannot exceed 0.5 Bq/g.

The above-mentioned alternatives need to consider the following aspects:

- All ore bearing material needs to be identified in waste rock dump facilities;
- All inert waste rock material needs to be identified; and
- Radioactive hotspots within the waste rock needs to be identified.

7.3 General Rehabilitation

General surface rehabilitation must involve the shaping of the surface topography to minimise ponding as well as erosion and to match the surrounding landscape as far possible.

It is recommended that the subsoil be ripped, fertilised and vegetated. This process may need to be repeated until acceptable vegetation growth is established over a three year period.

8 Post-Closure Management

Each mine site requires management, maintenance and monitoring after the operation has ceased and its facilities have been demolished and rehabilitated. This will be undertaken according to the existing EMPs, which were compiled jointly with the regulatory authorities and Interested and Affected Parties (I&APs).

Maintenance and aftercare must be planned for 3 years after rehabilitation is concluded. Maintenance will specifically focus on vegetation of rehabilitated areas and on tailings dams and any alien vegetation which will need to be controlled. Furthermore monitoring will have to take place for both surface and groundwater.

The cost associated with post-closure management has been calculated and rates for vegetation maintenance have been used. The post-closure vegetation monitoring should take place for 3 years or until a long-term acceptable trend can be determined and groundwater monitoring for a period of 10 years after closure. These costs have been included in the total for closure liability.

A contingency of 10% on all infrastructure costs has been allowed for. A 12% allowance has been made for project management fees as the costs are below R100, 000, 000. The latter two figures have been applied to capital expenditure only.

9 Long Term Water Impacts

Mining operations have long since established their undeniable impacts on both surface and groundwater quantity and quality. These impacts vary according to the type of mining operation and the geological characteristics of the operational settings. This assessment did not attempt to quantify the groundwater impacts or the implications for any required remediation. The report only discusses the potential implications for financial purposes.

Generally the cost of mitigating the discharges expected from the remediation of near surface aquifers has not been studied in sufficient detail to make an accurate assessment of the remediation costs. No figure can be given with any level of confidence unless a number of detailed studies are conducted and an agreed strategy for dealing with this issue has been adopted.

It is recommended that Harmony address potential long-term water issues by establishing a plan to deal with any decant of contaminated groundwater. This may involve investigation into regional mine water treatment options, systems, designs and costs for the greater Welkom and Virginia areas. Where information is not available it is suggested that specialist studies be conducted to determine whether groundwater impacts due to mining exist.

10 Summary of Liabilities

Closure costs were calculated by means of the Digby Wells method of calculation. A summary of the calculated closure costs is presented in Table 10-1. A copy of the detailed spreadsheets can be found in Appendix A.

Table 10-1: Summary of Liabilities

Summary - St. Helena #10		
Shafts	Total	
Shaft 10	R	1,088,421
	R	1,088,421
Waste Rock Dump	Total	
WRD #10	R	3,686,011
TOTAL (excludes rehabilitation)	R	4,774,431
TOTAL (includes rehabilitation)	R	4,937,298
Monitoring Costs (Groundwater)	R	279,100
Monitoring Costs (Vegetation)	R	34,623
Maintenance Costs (Vegetation)	R	31,967

Summary - St. Helena #10		
Shafts	Total	
Project Management (12%)	R	592,476
Contingency (10%)	R	493,730
GRAND TOTAL	R	6,369,194

Note: No allowance has been made for Value Added Tax (VAT) in the above Digby Wells figures. This issue should be noted where appropriate and for the purposes of which the financial figures are used. The DMR has in the past insisted on its inclusion for the purposes of assessing liabilities but have met with almost uniform resistance by the industry.

11 Recommendations

The recommendations are as follows:

- The figures should be updated as rehabilitation progresses at the mine and as actual costs become clear. This will enable more accurate cost calculations over time and will reflect current market conditions;
- This report should be updated annually to reflect more recent knowledge of events, issues and prices;
- It is recommended that approval from the South African National Heritage Resources Agency be obtained for all buildings to be demolished which are older than 60 years; and
- A long term water management and treatment plan should be compiled where applicable.

The reflected costs provide a good indication of the costs for unscheduled situations as at March 2018, providing a sound basis for making the required financial provision.

12 Conclusion

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this

concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation.

The closure cost assessment is done in accordance with the requirements of the NEMA, as amended. Section 41 of the MPRDA has been repealed and in terms of Section 24P in the NEMA, as amended, which provides that the holder of a mining right must make full financial provision for rehabilitation of negative environmental impacts. In terms of the Financial Provisioning Regulations (GN R1147), a holder will have until February 2019 to assess, review and adjust the sum of the financial provision in accordance with Regulation 9.

It is strongly recommended that Harmony begin assessing the additional requirements associated with the regulations and put in place an appropriate action plan to ensure compliance to the legislative requirements can be maintained. If convicted of an offence in terms of the Regulations, a holder will be liable to a fine not exceeding R10 million or to imprisonment for a period not exceeding ten years, or to both such fine or such imprisonment.

13 References

- DME, 2005: Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine, Department of Minerals and Energy, Pretoria.
- Digby Wells, 2017: Closure cost assessment for Harmony Gold Mining Company 2017.

Appendix A: Detailed Cost Breakdown

	Company:	Harmony Gold Mining Company Limited				Date:	27/06/2018
	Mining Right:	FS86MR				Assignment:	Closure Cost Assessment
							Detailed Breakdown
	Mine:	St Helena #10					
Ref.	Description	Class	Unit	Quantity	Rate	Amount	Comments
Area 1	10 Shaft - Shaft Area						
	Demolish Infrastructure						
562	Winder House	110	m³		R 1,105.15		Concrete base removed, updated in 2017
563	Lamp House	107	m³		R 413.23		
564	SSB Building	107	m³		R 413.23		
565	Offices	107	m³		R 413.23		
566	Warehouse	107	m³		R 413.23		
567	Toilets	107	m³		R 413.23		
568	Loco Repair Shop + Stores	107	m³		R 413.23		
569	SSB Building	107	m³		R 413.23		
570	Explosives Delivery Bay	107	m³		R 413.23		
	Fence	153	m		R 8.87		
571	Demolished Carport	107	m³		R 413.23		
572	Demolished Area - Rubble	128	m³		R 12.52		
573	Compressor House	110	m³		R 1,105.15		
574	SSB - Behind Compressor	107	m³		R 413.23		
575	Substation	142	m²		R 434.63		
576	Transformer Bay Area	107	m³		R 413.23		
577	Substation	142	m²		R 434.63		
578	Pre Cooling Tank Steel	140	t		R 2,318.04		
	Concrete Base	107	m³		R 413.23		
	Concrete Slab Underneath	108	m³		R 440.57		
579	SSB Building	107	m³		R 413.23		
580	Cooling Tower	108	m³		R 440.57		
581	Dams (2 exist)	113	m²		R 4.96		
	Flatten Walls	115	m³		R 16.75		
	Vent Shaft Long Drift	120	Sum		R 226,002.77		
	Transporting of Slime	128	m³		R 12.52		
582	Plug	150	Sum	1	R 544,210.33	R 544,210.33	
583	Head Gear	135	t		R 1,738.53		
	Transporting of Slime	128	m³		R 12.52		shaft currently being filled, updated in 2018
	Plug Shaft	150	Sum	1	R 544,210.33	R 544,210.33	
584	Substation To Vent Shafts	142	m²		R 434.63		Concrete base removed, updated in 2017
585	Steel Silos	143	m³		R 81.13		
586	Banksman Cabin (SSB)	107	m³		R 413.23		
587	DST (Store)	107	m³		R 413.23		
	Rehabilitation						

	Pick up spilled slime	125	m³		R	122.50		
	Grade an area	126	ha		R	1,964.98		
	General clean up	127	m²	1400	R	10.87	R	15,212.15
	Rubble	128	m³		R	12.52		verified in 2013
	Replace soil and spread	129	m²		R	11.55		Load and Cart away - 2km
	Replace soil and spread	130	m²		R	18.51		150mm thick
	Revegetate areas	131	Ha	1.331673	R	32,006.61	R	300 mm thick, updated in 2013
	Bulldoze material	132	m³		R	16.25		Where Structures Have Been Removed
	Rip Area	134	m²	13316.73	R	7.89	R	50m
								Cart Away - 2km
					Demolition Total	R	1,088,420.66	
					Rehabilitation Total	R	162,867.15	
					Block Total	R	1,251,287.81	
Area 2	Waste Rock Dump							
	Demolish Infrastructure							
	Waste rock dump (#10)							
	Shape	132	m³	226792.16	R	16.25	R	3,686,010.55
	Rehabilitation							
	Pick up spilled slime	125	m³		R	122.50		
	Grade an area	126	ha		R	1,964.98		
	General clean up	127	m²		R	10.87		
	Rubble	128	m³		R	12.52		Load and Cart away - 2km
	Replace soil and spread	129	m²		R	11.55		150mm thick
	Replace soil and spread	130	m²		R	18.51		300 mm thick
	Revegetate areas	131	Ha		R	32,006.61		Where Structures Have Been Removed
	Bulldoze material	132	m³		R	16.25		50m
	Rip Area	134	m²		R	7.89		Cart Away - 2km
					Demolition Total	R	3,686,010.55	
					Rehabilitation Total	R	-	
					Block Total	R	3,686,010.55	