Mine Health and Safety Council

MHSC

Designing a feasible methodology for selecting permanent areal support for varying environments in underground mines

Research agency:	SRK Consulting (South Africa) (Pty) Ltd
Project number:	SIM 15-02-02 Designing a feasible methodology for selecting permanent areal support for varying environments in underground mines
Date:	November 2016

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1. ABBREVIATIONS AND NOMENCLATURE

Abbreviation	Description
A_c	Adhesion capacity
CoP	Code of Practice
D_{20}	Displacement at 20 % of design load
dbs	depth below surface
δ_d	Quasi-static displacement
D_d	Design load displacement
DMR	Department of Mineral Resources
D_o	Intersection of the line used to calculate the stiffness and the x-axis
FoS	Factor of Safety (Ratio of capacity vs demand)
FRS	Fibre-reinforced shotcrete
GSI	Geological Strength Index
K_s	Screen stiffness
kN	kiloNewton (SI unit)
L_{20}	20% of the design load
L_d	Design load
m_d	Moment (demand), $kNm.m^{-1}$
MHSC	Mine Health and Safety Council
σ_a	Adhesive strength (lab test results), MPa
σ_p	Shotcrete panel deflection
σ_{sa}	Shotcrete adhesive bond strength, MPa
σ_s	Shear strength
σ_t	Tensile strength (MPa)
s	Block width (m)
SIMRAC	Safety in Mines Research and Advisory Committee
RYHP	Rapid Yielding Hydraulic Props
T_c	Direct shear capacity (tau), MPa
T_d	Direct shear demand (tau), MPa
t	Thickness (mm)

Abbreviation	Description
TSL	Thin Sprayed Liner
vs	versus
W	Weight (kN)
w_b	Bond width (mm)
W_{pc}	Peak load capacity
za	Shotcrete adhesive bond length

Where not stipulated, units of measure are presented in S.I. (metric, System Internationale).

2. ACKNOWLEDGEMENTS

The research agency would like to thank the following institutions and persons for their valuable contributions during the research project:

- The Mine Health and Safety Council (MHSC) for sponsoring the research;
- The mines and rock engineering personnel that contributed their technical documents, data, knowledge, insights and availability during the site visits and interviews through the course of the project – namely:
    - Harmony Gold Mines (Bambanani)
    - Northam Platinum Mines (Booysendal)
    - Sibanye Gold Mines (Kloof 4 Shaft)
    - AngloGold Ashanti (Tau Tona)
    - ARM – Impala Platinum Mines (Two Rivers Platinum)
    - Anglo Platinum Mines (Tumela Mine and Dishaba Mine); and
    - Lonmin Platinum Mines (Karee 3 Shaft)
- The delegates of the various workshops for their time and inputs to the deliberations in refining the methodology and ranking tool.
- The academic personnel at the University of Pretoria for hosting the workshops for the research project, at their Virtual Reality (VR) Centre.
- Geobrugg Southern Africa (Pty) Ltd for facilitating site visits as well as providing technical product information.

3. EXECUTIVE SUMMARY

The project was initiated by the Mine Health and Safety Council (MHSC), to design a feasible methodology for selecting permanent areal support for varying environments in underground mines. Implementation of the outcomes of the study will improve understanding of permanent support installations and their performance in different mining environments. The transfer of this knowledge will enable mining operations to implement appropriate strategies for reducing rockfalls and associated fatalities in South African underground mines.

In order to meet the objectives, a number of mining operations were identified for the purpose of participation in the research project. Site visits were undertaken to the participating mines, discussions with key rock engineering personnel were engaged and information was documented from observations of underground operations. Further to this, documentation was collected for the purpose of identifying and collating support system components, design and selection methodology as well as quality assurance testing procedures.

A review of South African and international publications was undertaken to contrast and compare the pertinent elements of different support systems. Using the information collected during interviews and from mine-specific documents, as well as published literature, an assessment tool was developed to guide the selection of permeant areal support for varying environments.

Preliminary findings and rationale of the assessment tool were demonstrated at a workshop. While the workshop was poorly attended, comments received from the audience informed considerations in the assessment tool.
Many delegates at the workshops voiced their preference for temporary areal support, over a permanent installation. The methodology developed allows the principles to be extrapolated to temporary areal support.

A final workshop was hosted to demonstrate the improved version of the assessment tool. The information was simultaneously described in an e-book, as a ‘Guide Booklet’.

4. PROJECT INTRODUCTION

The project entitled “Designing a feasible methodology for selecting permanent areal support for varying environments in underground mines” was initiated by the Mine Health and Safety Council (MHSC) and is referred by the project number , Safety in Mining (SIM) 15 02 02. The overall aim of the project was to develop a user-friendly tool which allowed for the selection of suitable, permanent areal support for varying environments in underground mines.

Implementation of the outcomes of the study will improve understanding of permanent support installations and performance thereof. Furthermore, the versatility of the tool facilitates use in a number of different mining environments. It is envisioned that the transfer of knowledge from the research outcomes to industry at large, will enable mining operations to implement appropriate strategies for reducing rockfalls and associated fatalities in South African underground mines.

The research project was scoped to be carried out over two years, where Year 1 required the completion of the research and site investigations to develop a methodology for the selection of areal support and Year 2 relied on the training of personnel and transfer of knowledge which had been gained in Year 1.

4.1. Project Aims

The aims of the project were to develop a feasible methodology to guide mining operations on their selection of permanent areal support.

4.2. Project Hypothesis

The project hypothesised that an effective methodology for selection of permanent areal support for varying environments is possible, based on a methodical approach and comparison of parameters associated for stereotypical mining environments.

4.3. Project Methodology

The methodology followed comprised the following activities:

a) Conducting a detailed literature study of available technologies used as permanent areal support (including a description of the areal coverage abilities and limitations for varying mining environments).
b) Conducting site investigations to view permanent areal support existing and trialled technologies (including observations of the performance of the different support types as well as reviewing documentation on successes and failures thereof) and consequently developing an assessment tool for ranking the effectiveness of the technologies.
c) Identifying any shortcomings of the permanent areal support systems and identifying ways to address the shortcomings.
d) Combining the lessons learned and interpretations to develop an effective methodology for selection of permanent areal support for varying environments

4.4. Project Milestones

The project has a whole, was divided into two major elements – namely, the work to be completed in Year 1 and the work to be completed in Year 2. This project report only addresses the project milestones for Year 1; the milestones are shown in Table 4-1.

Table 4-1: Project milestones for Year 1

Milestone number	Milestone description
1	Project initiation (start-up presentation and report)
2	Detailed underground assessments
3	Development of assessment tool
4	Development of methodology for permanent areal support
5	Year Closure

4.5. Champion Mines

The mines which participated in the research project, termed ‘champion mines’, are shown in Table 4-2.

Table 4-2: Champion mines for project SIM 15 02 02

Group	Operation
Harmony Gold	Bambanani
Harmony Gold	Bambanani
Northam Platinum	Booysendal
Northam Platinum	Booysendal
Sibanye Gold	Ikamva Shaft (Kloof 4 Shaft)
ARM-Impala	Two Rivers
Lonmin plc	Karee 4 Belt
AngloGold Ashanti	Tau Tona
AngloAm Platinum	Tumela
AngloAm Platinum	Dishaba

5. MILESTONE DELIVERABLES

The research project was composed of five distinct milestones, each with specific deliverables.

5.1 Milestone 1

Milestone 1 consisted of two aspects, namely a start-up workshop and a literature review. With regard to the start-up workshop, the purpose thereof was to obtain input and guidance on the topic as well for underground rock engineers to assist in selecting support types and locations for review. The workshop also facilitated detailed project planning.

The literature review sought to determine the current use of permanent areal support methods South African and international underground mines.

5.1.1 Results per Milestone 1

The start-up workshop was held on 19 August 2015; different support systems were identified for different locations, as shown in Table 5.1-1.

A preliminary literature review was carried out for permanent areal support methods currently in use in local and international underground mines. A template worksheet was prepared using the key findings from the start-up workshop and using the main findings of the literature review.

Table 5.1-1: Support systems evaluated at participating mines

Group	Operation	Support system	Mining method	Mining environment
Harmony Gold	Bambanani	Steel rope mesh (netting) with tendons - high stope width	Conventional	Deep mining, intermediate to high s/w
Harmony Gold	Bambanani	Steel rope mesh (netting) - low stope width	Conventional	Deep mining, intermediate to low s/w
Northam Platinum	Booysendal	Shotcrete – on-reef development (MR)	Bord and pillar	Shallow, very high s/w
Northam Platinum	Booysendal	Shotcrete (UG2)	Bord and pillar	Shallow, high s/w
Sibanye Gold	Ikamva Shaft (Kloof 4 Shaft)	Mesh (weld mesh) in gullies.	Conventional	Deep mining, soft h/w
ARM-Impala	Two Rivers	Thin spray-on liner (TSL)	Bord and pillar	Shallow to intermediate mining, high s/w
Lonmin plc	Karee 4 Belt	Mesh (Geobrugg) – high-tensile chainlink (completed study)	Conventional	Shallow to intermediate mining, intermediate s/w
AngloGold Ashanti	Tau Tona	Weld mesh (gullies only)	Conventional	Deep mining, intermediate to high s/w
AngloAm Platinum	Tumela	Thin spray-on liner (TSL)	Conventional	Deep mining, intermediate s/w
AngloAm Platinum	Dishaba	Weld mesh (gullies only)	Conventional	Shallow to intermediate mining, intermediate s/w

5.1.2 Conclusions from Milestone 1

Ten sites were selected for site investigations in order to make underground observations of their respective areal support methods.

The literature review provided insight that no existing methodology exists for the selection of permanent areal support in underground mines.

5.2 Milestone 2

Milestone 2 was undertaken systematically, with two sites visited for each support type. For each operation, an assessment of the support performance and suitability to the local environment was carried out based on visual observations (underground) and a review of available data, including, but not limited to:

- Support standards
- Code of Practice to combat rockfall and rockburst accidents in tabular metaliferous mines
- Fall of ground records
- On-mine design and selection criteria
- Support specifications
- Support costs
- Blast design
- Seismic history

5.2.1 Results per Milestone 2

Site inspections were carried out as described in Table 5.2-1.

Table 5.2-1: Support systems evaluated at participating mines and date of evaluation

	Group	Operation	Support system	Mining method	Mining environment	Period
2a-1	Harmony Gold	Bambanani	Steel rope mesh (netting) with tendons - high stope width	Conventional	Deep mining, intermediate to high s/w	27 August 2015 to 3 September 2015
2a-2	Harmony Gold	Bambanani	Steel rope mesh (netting) - low stope width	Conventional	Deep mining, intermediate to low s/w	27 August 2015 to 3 September 2015
2b-1	Northam Platinum	Booysendal	Shotcrete – on-reef development (MR)	Bord and pillar	Shallow, very high s/w	28 September 2015 to 10 October 2015
2b-2	Northam Platinum	Booysendal	Shotcrete (UG2)	Bord and pillar	Shallow, high s/w	28 September 2015 to 10 October 2015
2c-1	Sibanye Gold	Ikamva Shaft (Kloof 4 Shaft)	Mesh (weld mesh) in gullies.	Conventional	Deep mining, soft h/w	3 November 2015 to 6 November 2015
2c-2	ARM-Impala	Two Rivers	Thin spray-on liner (TSL)	Bord and pillar	Shallow to intermediate mining, high s/w	January 2016
2d-1	Lonmin plc	Karee 4 Belt	Mesh (Geobrugg) – high-tensile chainlink (completed study)	Conventional	Shallow to intermediate mining, intermediate s/w	January 2016
2d-2	AngloGold Ashanti	Tau Tona	Weld mesh (gullies only)	Conventional	Deep mining, intermediate to high s/w	10 November 2015 to 13 November 2015
2e-1	AngloAm Platinum	Tumela	Thin spray-on liner (TSL)	Conventional	Deep mining, intermediate s/w	January 2016
2e-2	AngloAm Platinum	Dishaba	Weld mesh (gullies only)	Conventional	Shallow to intermediate mining, intermediate s/w	January 2016

5.2.2 *Conclusions from Milestone 2*

Detailed observations of ten permanent areal support systems in different mining environments carried out in Milestone 2 revealed the following findings:

- In conventional mines, the transport and installation of permanent areal support is often a challenge. In these mining environments, temporary nets may provide a more appropriate solution.
- In the ten permanent areal support systems evaluated, only two are installed routinely at the stope face, one was installed routinely in stope gullies and the remainder are ad hoc installations. This represents current practice.

5.3 Milestone 3

Milestone 3 consisted of two aspects, namely the development of an assessment tool and, subsequently, a workshop to showcase the assessment tool.

The assessment tool was developed based on the findings of the literature review and underground observations. The support systems were then ranked within the assessment tool to better describe their application to different mining environments.

The workshop was held to discuss the limitations of the assessment tools and to identify possible solutions, with the view of updating (tailoring) the ranking system.

5.3.1 Results per Milestone 3

The ranking tool was developed with the main themes of *Mining Environments, Performance characteristics, Resilience, Practicality and Costs* in mind. The initial ranking tool is shown in Table 5.3-2 (it is to be noted that this version was refined and improved during later milestones in the project).

The workshop was held during August 2016; a summary of attendance is shown in Table 5.3-1. Representatives from the Chamber of Mines (CoM), union representatives (labour) and the Department of Minerals and Resources (DMR) were unable to attend. The date for the workshop had been set and postponed several times until a core team of representatives were able to attend. It was felt incumbent on the project manager at the time to settle on the most available team in order to conclude the workshop. The core team, in spite of being limited in its representative capacity, was deemed to be more than fit to engage in essential discussions and provide sufficiently valuable input into guiding the construction of the final support assessment tool.

Table 5.3-1: Delegate attendance for Milestone 3b workshop

Surname	First name	Company
Carstens	Riaan	Anglo American Platinum
Gumbie	Alec	Mine Health and Safety Council
Joughin	William	SRK Consulting (South Africa) (Pty) Ltd
Maritz	Jannie	University of Pretoria
Miovski	Petr	Impala Platinum Mines
Mulenga	Prince	SRK Consulting (South Africa) (Pty) Ltd
Walls	Jeanne	SRK Consulting (South Africa) (Pty) Ltd

Table 5.3-2: Support assessment tool (ranking) as at 30 June 2016

SIM150202 - Milestone 3a: SUPPORT ASSESSMENT TOOL

Analysis element			Mining Environment	High stress (dynamic) environment						Low stress and jointed (static) environment			
Analysis element			Case Study	Case Study 1 Bambanani Gold Mine	Case Study 2 Bambanani Gold Mine	Case study 5 Kloof 4 Shaft	Case study 6 Tau Tona	Case Study 10 Dishaba	Case Study 8 Karee 4 Belt	Case Study 3 Booysendal Platinum - normal	Case Study 4 Booysendal Platinum - high	Case Study 7 Two Rivers	Case Study 9 Tumela
Analysis element			Support system	steel rope netting and hydrabolts	steel rope netting	weld mesh and hydrabolts	weld mesh and split - sets	weld mesh and cable anchors	high tensile steel chain link mesh and mechanical end anchors	shotcrete and resin rebars	shotcrete and resin rebars	TSL and resin rebars	TSL and mechanical end anchors
Load-bearing capacity (performance) characteristics	Mesh / Steel net		Visual Effectiveness	8	8	5	6	3	7	8	9	9	8
		Manufacturer's Specifications	Strand tensile steel strength (MPa)	900	900	400 - 600	400 - 600	400 - 600	1 770				
			Strand thickness (mm)	5.0	5.0	4.0	5.6	4.0	3.0				
			Stand strength (kN)	17.7	17.7	5.0 - 7.5	9.9 - 14.8	5.0 - 7.5	12.5				
			Apperture size (mm)	150 × 150	150 × 150	100 × 100	100 × 100	100 × 100	80.0				
		Potvin corrections after (Ortlepp and Stacey, 1997)	Deformation (mm)			99 - 141	145 - 207	99 - 141	> 270	2 - 38	2 - 38		
			Total energy (kJ)			3.5 - 4.5	10.0 - 13.0	3.5 - 4.5	15 - 26	0.8 - 1.3	0.8 - 1.3		
		CHR	Peak load (kN)			12 -18	34 - 42	12 -18	64 - 76				
			Peak deformation (mm)			100 -150	150 - 200	100 -150	> 400 - 450				
			Stiffness (kN/m)			120	217	120	< 120				
			Ultimate deformation (mm)			125 - 175	175 - 250	125 - 175	> 400 - 450				
			Peak energy (kJ)			0.5 - 1.0	2.5 - 4.0	0.5 - 1.0	4.5 - 6.0				
			Total energy (kJ)			1.0 - 4.0	6.0 - 9.0	1.0 - 4.0	15 - 18				
			Design energy (kJ)			1.0	5.0	1.0	7.0				
		WASM	Peak load (kN)			43 -130	85 - 255	43 -130	45 - 145				
			Peak deformation (mm)			130 - 165	170 - 220	130 - 165	175 - 220				
			Ultimate deformation (mm)			100	220	100	220				
			Initial deformation (mm)			> 130	130.0	> 130	> 200				
			Total energy (kJ)			0.8 - 1	2 - 2.5	0.8 - 1	1.0 - 5.1				
	Liners	Specifications	Liner thickness (mm)							50	50	8.0	8.0
			Compressive strength (MPa)							20 - 28	20 - 28	26.4	
		(Ortlepp and Stacey, 1997)	Total energy (kJ)							0.8 - 1.3	0.8 - 1.3		
			Deformation (mm)							2 - 38	2 - 38		
		Index testing (Yilmaz, 2011)	Tensile strength (MPa)							0.5	0.5	<7.5	7.5
			Tensile-bond strength (MPa)							0.3	0.3	<2.5	2.5
			Shear-bond strength (MPa)							1.0	1.0	<6.5	6.5
			Material shear strength (MPa)							1.0	1.0	<6.5	17
	Initial stiffness			1	1	6	7	6	3	9	9	8	8
	Yield capacity			8	8	4	5	4	8	2	2	1	1
	Load capacity			9	9	4	7	4	6	7	7	6	6
	Overall Strength Rating												
Resilience / Robustness	Blast resistance			7	6	3	5	3	6	7	7	6	6
	Equipment damage resistance			2	2	2	4	2	1	7	7	6	6
Practicality	Labour requirements			5	5	4	3	3	4	6	9	5	5
	Weight (kg/ m^2)			1.06	1.06	2.2	4.02	2.2	1.1				
	Installation procedure			2	2	4	3	4	3	6	6	6	6
	Handling			easy to roll, light weight, machinery not required and labour intensive installation	easy to roll, light weight, machinery not required and labour intensive installation	stiff, transported as sheets, fairly light weight, machinery not required, fairly labour intensive	very stiff, transported as sheets, fairly heavy weight, machinery not required, fairly labour intensive	stiff, transported as sheets, fairly light weight, machinery not required, fairly labour intensive	failry easy to roll, light weight, machinery not required and labour intensive installation	fairly heavy batches, transported in very large quantities, equipment difficult to manoeurver, poor visibility	fairly heavy batches, transported in very large quantities, equipment difficult to manoeurver, poor visibility	fairly heavy batches, transported in very quantities, equipment difficult to manoeurver	fairly heavy batches, transported in large quantities, equipment difficult to manoeurver
	Rating			6	6.5	5	4	4	6	4	5	5	5
	Installation time (m^2/ hr)			30	30	11	18	21	21	18	23.6	19	41
Cost	Material cost (R/m^2)			196.76	155.00	116.39	240.62	200.42	220.19	432.56	432.56	389.78	406.57
	Labour cost (R/m2)			14.38	14.38	36.61	16.78	6.07	8.65	21.09	24.13	16.65	4.93
	Total installed cost (R/m^2)			211.14	169.38	153.00	257.40	206.49	228.84	453.65	456.69	406.43	411.50

Legend	
(pink)	Not applicable
(green)	Test result
(blue)	Adjusted results

5.3.2 Conclusions from Milestone 3

The assessment tool was largely accepted by the delegates that attended the workshop - on provision of circulated feedback, which was distributed accordingly. Attempts were made to secure feedback from a broader body of industry representatives. The feedback received from parties was to the effect that there is no further adaptation to add to the assessment tool.

5.4 Milestone 4

A methodology for the selection of permanent areal support was developed and prepared in the form of a Guide Booklet (in electronic form).

5.4.1 Results per Milestone 4

The Guide Booklet was compiled and submitted. The MHSC reviewer identified several shortcomings of the booklet – which were addressed with utmost priority by the project team. The shortcomings included sequence of the content, clarity of the descriptions contained in the content, spelling and grammar and extent of explanations. The revised Guide Booklet appears in Appendix A.

5.4.2 Conclusions from Milestone 4

The Guide Booklet had been prepared and revised, and was ready to be presented to the industry stakeholders for deliberation and discussion.

5.5 Milestone 5

Milestone 5 consists of two aspects, namely a close-out workshop and this, close-out interim report.

The workshop served to showcase the revised ranking tool and Guide Booklet layout as well as to evaluate the material for implementation in industry. Furthermore, research recommendations for Year 2 were discussed and proposed.

5.5.1 Results per Milestone 5

The close-out workshop was held on 23 November 2016, at SRK House, Johannesburg, Gauteng Province, South Africa and was well attended. Fifteen delegates, including representatives of the MHSC, DMR, SIMRAC and CoM REC participated in the evaluation of the assessment and ranking tool.

5.5.2 Conclusions from Milestone 5

In considering the work completed for Year 1 of the research project:

The feedback regarding the methodology was very positive; in principle the methodology can also be applied to temporary areal support in stopes, which all delegates considered very valuable. The approach for assessing the performance of areal support, based on support specifications and data from research testing programmes (support capacity), which are then down rated by performance factors (installation quality, blast damage, equipment damage and corrosion) was generally accepted.

All delegates accepted that consideration of the mining environment was extremely important when evaluating both the support capacity and performance factors.

In considering the work intended for Year 2 of the research project:

Research Outcome 5 was stated as "*Development of a training programme that includes, as a minimum, lesson plans, competency assessments, quality assurance assessments and a virtual reality module on the correct installation of permanent areal support in varying environments*". The delegates at the workshop did not believe that this Research Outcome would add any value and suggested the following Research Outputs instead:

1. Training of rock engineering practitioners on operations in the use of the new methodology for the selection of areal support.
2. Collation of existing test results on temporary nets.
3. Assessment of existing temporary areal support systems using the new methodology.

5.6 General Conclusions

Detailed evaluations of ten permanent areal support systems in different mining environments were carried out. The data collected from the participating mines was used to develop a methodology for selecting areal support systems in different mining environments. This methodology includes the evaluation of support performance, practicality and installed cost. The methodology provides a comprehensive, practical approach to assessing temporary and permanent areal support systems. The mining environment plays a major role in the support performance and practicality.

6. RECOMMENDATIONS FOR FURTHER RESEARCH

Further research is recommended, identified through the following research outcomes Year 2:

- Training of rock engineering practitioners on operations in the use of the new methodology for the selection of areal support.
- Collation of existing test results on temporary nets.
- Assessment of existing temporary areal support systems using the new methodology.

7. RECOMMENDATIONS FOR IMPLEMENTATION FOR THE SECTOR

It is recommended that rock engineering practitioners on operations be formally trained in the use of the new methodology for the selection of areal support.

8. TECHNOLOGY TRANSFER OPTIONS

Technology transfer options primarily take place through directed training programmes.

9. CONCLUSIONS

Detailed evaluations of ten permanent areal support systems in different mining environments were carried out including comprehensive photographic records, taking the following into consideration:

- Mining environment
  - Geology and geotechnical characteristics
  - Stress regime
  - Stoping width
  - Mining method
  - Mechanisation
- Support specifications
- Support performance

- Support installation
- Support and labour costs

The data obtained at these sites was used to develop a methodology for selecting areal support systems in different mining environments. This methodology includes the evaluation of support performance, practicality and installed cost. Support performance combines the support capacity, in terms of initial stiffness, peak load and yield, and performance factors (installation quality, equipment damage, blast damage and corrosion). Practical aspects of transport and installation can be assessed using the methodology and the installed support cost can be determined. The methodology provides a comprehensive, practical approach to assessing temporary and permanent areal support systems. The mining environment plays a major role in the support performance and practicality.

The ten support systems were ranked according to this methodology and the results are presented in a table format. In many cases, the support capacity is penalised due to performance factors. Scraper damage plays a major role in narrow stopes and in gullies that are full of broken rock. The method of attaching the areal support can severely impact the quality of installation and overall performance. In conventional mines, the transport and installation of permanent areal support is often a challenge. In these mining environments, temporary nets may provide a more appropriate solution. In the ten permanent areal support systems evaluated, only two are installed routinely at the stope face, one was installed routinely in stope gullies and the remainder are ad hoc installations. This represents current practice.

Further research is recommended and implementation in the sector, through formal training programmes, is required for Year 2.

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11. LIST OF APPENDICES

Appendix A Guide Booklet

12. FINANCIAL SUMMARY

Table 12-1: Financial summary

Date	Invoice number	Professional Costs (exc. VAT)	VAT (14%)	Total (incl. VAT)	Cumulative Total (exc. VAT)	Budget Remaining (exc. VAT)
30-Jun-15	71306	61,050.80	8,547.12	69,597.92	61,050.80	2,180,905.20
30-Jun-15	71307	113,283.19	15,859.65	129,142.84	174,333.99	2,067,622.01
17-Nov-15	73506	150,758.02	21,106.12	171,864.14	325,092.01	1,916,863.99
16-Nov-15	73742	215,042.00	30,105.88	245,147.88	389,375.99	1,852,580.01
29-Jan-16	74549	215,041.99	30,105.89	245,147.88	604,417.98	1,637,538.02
14-Apr-16	75392	215,042.00	30,105.88	245,147.88	819,459.98	1,422,496.02
19-Apr-16	75399	215,042.00	30,105.88	245,147.88	1,034,501.98	1,207,454.02
23-Sep-16	77531	162,466.80	22,745.35	185,212.15	1,196,968.78	1,044,987.22
23-Sep-16	77532	174,002.00	24,360.28	198,362.28	1,370,970.78	870,985.22

13. PROJECT CLOSURE

MHSC RESEARCH PROJECT CLOSE OUT			
Description			
Project Number	SIM 15 02 02; Year 1		
Project Description	Designing a feasible methodology for selecting permanent areal support for varying environments in underground mines		
timelines			
Planned Project Start	2015/04/01	Actual Project Start	2015/08/01
Planned Project End	2016/03/31	Actual Project End	2016/11/30
deliverables			
Project Aim	The aims of the project were to develop a feasible methodology to guide mining operations on their selection of permanent areal support.		
Outcome of Project	A methodology to guide the selection of permanent areal support for varying mining environments has been developed and described in a Guide Booklet. The methodology is to be demonstrated, implemented and practically evaluated.		
Issues			
Administrative and Research issues encountered	One of the pertinent research discoveries during the project revealed that established methodologies are largely absent on the participating mines. This generated the situation that there was no option to hybridise and optimise existing methodologies, but rather, a methodology had to be developed from first principles. The research therefore took slightly longer than originally anticipated. Several issues were encountered which affected achievement of the project schedule. These are centred on availability of resources, namely operational availability and untimely response from stakeholders to correspondence. An unexpected issue was encountered which compromised achievement of the project schedule, namely the project manager fell ill with malaria (which is out of the control of any person). Changes in the administrative structure of the project team were encountered – but the research agency assigned additional resources in order to minimise disruption and ensure satisfactory completion of the project aims.		
Recommendations for future projects			
Research assets			
RESEARCHER INPUT		OFFICE USE	
List Capital Assets obtained during the project >R10 000	Are these assets redundant?	If redundant have they been approved to be removed from MHSC asset register?	Have the assets been disposed off and how?
None			
Financials			

Contracted amounts	R 2,241,956.00	
Amount paid	R 1,370,970.78	
Any savings on project		
Approvals and recommendations		
Advisory note to SIMRAC	Date	
Recommendations to MHSC		
Report on MHSC Website		
Approval		
Research project Leader	date	signature
MHSC Programme Manager	date	signature
MHSC Chief Research and Operations Officer	date	signature
Notification		
MHSC Chief Executive Officer	date	signature
MHSC Chief Financial Officer	date	signature

Appendix A

Guide Booklet (attached separately)