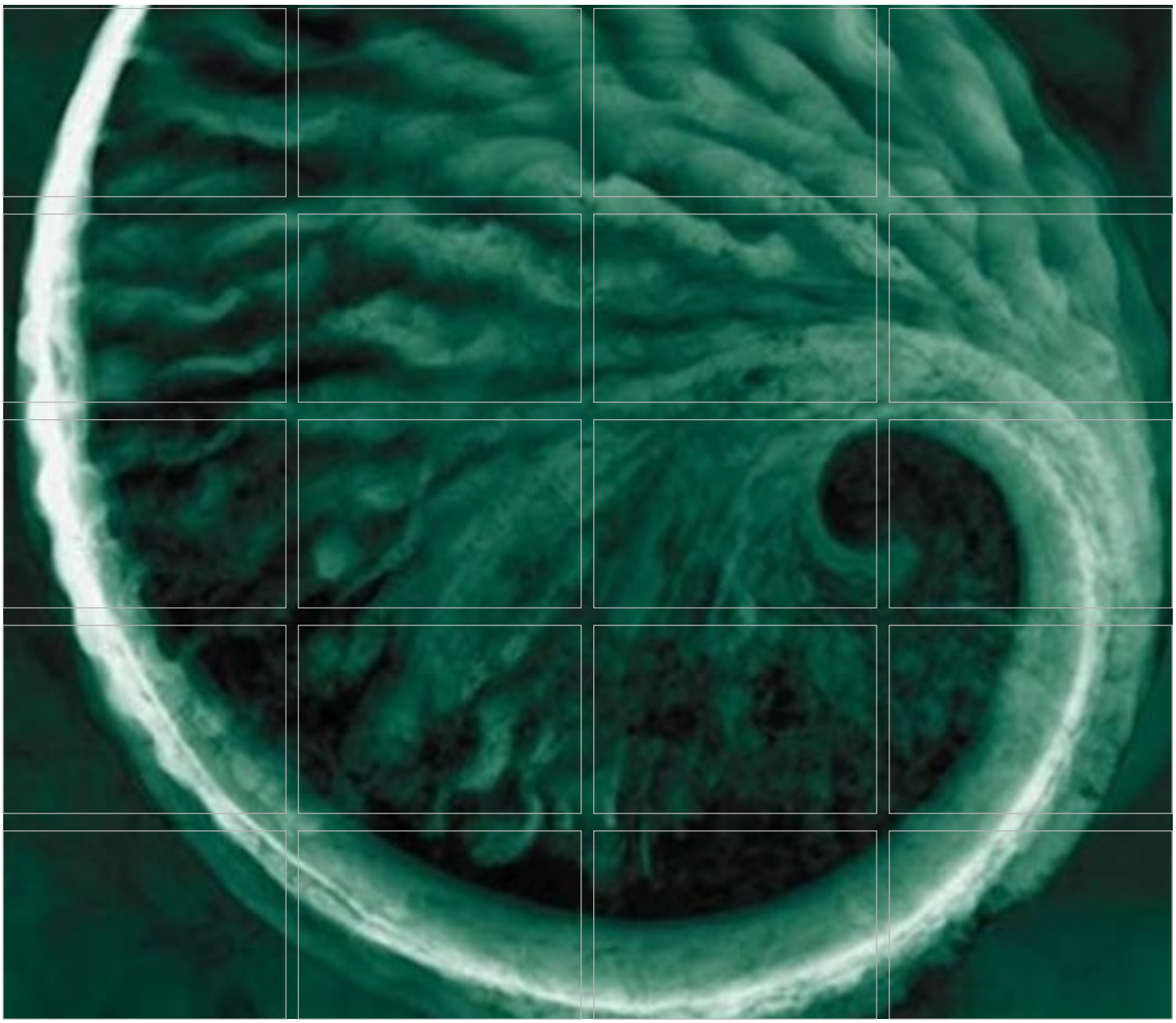

Black Mountain Mining

Waste Classification and Geochemical Assessment of Waste Rock from the Proposed Swartberg Decline

FINAL REPORT

November 2016

Delivering sustainable solutions in a more competitive world

ERM

WASTE CLASSIFICATION AND GEOCHEMICAL ASSESSMENT OF WASTE ROCK FROM THE PROPOSED SWARTBERG DECLINE

FINAL REPORT

PREPARED FOR:-

Black Mountain Mining

Report date: 3 November 2016

ERM Project Reference: 0371087

PREPARED BY:-

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1 INTRODUCTION

1.1 INTRODUCTION AND OBJECTIVES

Black Mountain Mining (Pty) Ltd (BMM) appointed Environmental Resources Management Southern Africa (Pty) Ltd (ERM) to conduct waste classification of rock samples collected from the area of the new Swartberg ore access decline. The samples were collected and provided to ERM by BMM. It is understood that the development of a decline will produce waste rock and BMM requires that this material is classified in terms of the National Environmental Management: Waste Act 2008 (NEM:WA Act No. 59 of 2008) prior to conducting an Environmental Impact Assessment (EIA) or Basic Assessment (BA). The waste classification was required to allow for BMM to assess potential stockpiling and disposal options for the waste rock that will be generated during the advancement of the decline.

The objective of the assessment was to characterise the waste rock material to determine its hazard classification in terms of NEMWA (2008) and the potential for leachate production, including acid rock drainage (ARD) considerations.

1.2 SCOPE OF WORK

As outlined in the request for proposal provided by BMM on 11 August 2016, the scope of work included the following:

- Conducting acid base accounting (ABA) analysis on four homogenized waste rock samples provided by BMM;
- Conducting total and leachable concentration analysis on subsamples of the above-mentioned waste rock samples to support the waste classification in terms of the NEMWA (2008) waste classification regulations; and
- Compiling a concise technical report on the results of the waste classification and the suitability of the material for stockpiling considering acid rock drainage potential.

2 WASTE MANAGEMENT FRAMEWORK

2.1 OVERVIEW OF NEMWA (2008) REGULATIONS

Waste in South Africa is currently regulated in accordance with the following legislation:

- NEMWA (2008). National Environmental Management: Waste Act 2008 (Act No. 59 of 2008). Department of Environmental Affairs.
- NEMWA (2008) Waste Classification and Management Regulations. 23 August 2013.

The NEMWA (2008) defines waste as:

- general waste, which does not 'pose an immediate hazard or threat to health or to the environment'; and
- hazardous waste, which is any waste that contains 'organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment'.

Waste is classified as hazardous ranked from high risk to inert (low risk) based on assessment of total concentration (TC) and leachable concentration (LC). Threshold values are published for a range of organic and inorganic chemical substances. Leachable concentrations are determined using different methods depending on the type of waste, and the disposal method, namely:

- waste that contains or is disposed of with putrescible waste (i.e. containing organic matter);
- waste to be disposed with non-putrescible waste; and
- non-putrescible waste to be disposed of without any other waste (mono-disposal).

2.2 NEMWA WASTE CLASSIFICATION METHODOLOGY

Total Concentration Threshold (TCT) limits have been defined in the NEMWA (2008) Waste Classification and Management Regulations, August 2013 (NEMWA Regulations, 2013) and are subdivided into three categories, as follows:

- TCT0 limits have been derived using the Department of Environmental Affairs Framework for the Management of Contaminated Land, March 2010 (DEA Framework, 2010) Soil Screening Values that are protective of water resources.
- TCT1 limits have been derived from the land remediation values for commercial/industrial land determined by the DEA Framework, 2010.

- TCT2 limits were derived by multiplying the TCT1 values by a factor of 4, as used by the Environmental Protection Agency, Australian State of Victoria.

Leachable Concentration Threshold (LCT) limits have been defined in the NEMWA Regulations (2013) and are subdivided into three categories, as follows:

- LCT0 limits have been derived from human health effects values for drinking water, as published by the Department of Water Affairs (DWA), South African National Standards (SANS), World Health Organization (WHO) or the United States Environmental Protection Agency (USEPA).
- LCT1 limits have been derived by multiplying the LCT0 values by a Dilution Attenuation Factor (DAF) of 50 as proposed by the Australian State of Victoria.
- LCT2 limits have been derived by multiplying the LCT1 values by a factor of 2.
- LCT3 limits have been derived by multiplying the LCT2 values by a factor of 4.

Using the TCT and LCT limits, wastes are classified into the following types:

- Type 0: Wastes with any chemical compound occurring at a concentration above the LCT3 or TCT2 limits;
- Type 1: Wastes with any chemical compound occurring at a concentration above LCT2 but below or equal to LCT3, or above TCT1 but below or equal to TCT2 limits;
- Type 2: Wastes with any chemical compound occurring at a concentration above LCT1 but below or equal to LCT2, and below or equal to TCT1 limits;
- Type 3: Wastes with any chemical compound occurring at a concentration above LCT0 but below or equal to LCT1, and below or equal to TCT1 limits; and
- Type 4: Wastes with any chemical compound occurring at a concentration below the LCT0 and TCT0 limits, and below the following concentrations:

Chemical Compound	**Concentration (mg/kg)**
TOC	30,000
BTEX	6
PCB	1
Mineral oil (C_{10-40})	500
Dieldrin and Aldrin	0.05
DDT, DDD and DDE	0.05
2,4-D	0.05
Chlordane	0.05
Heptachlor	0.05

Based on the classification of waste type, the waste is suitable for disposal at an appropriately designed landfill, as follows:

- Type 0 waste: Disposal to landfill is not permitted;
- Type 1 waste: Disposal at a Class A landfill (NEMWA Regulations, 2013) or a Hh:HH landfill in accordance with the Department of Water Affairs and Forestry (DWAF) Minimum Requirements for Waste Disposal by Landfill (1998);
- Type 2 waste: Disposal at a Class B landfill (NEMWA Regulations, 2013) or a GLB+ landfill (DWAF, 1998);
- Type 3 waste: Disposal at a Class C landfill (NEMWA Regulations, 2013) or a GLB+ landfill (DWAF, 1998); and
- Type 4 waste: Disposal at a Class D landfill (NEMWA Regulations, 2013) or a GLB- landfill (DWAF, 1998).

2.3 ACID BASE ACCOUNTING METHODOLOGY

Acid Base Accounting (ABA) is a set of simple analytical procedures for screening rocks to determine their potential to become acid producing, and can be summarised as follows:

- Total sulphur can be used as a first level screening parameter for acid rock drainage potential. Total sulphur concentrations below 0.25% are believed to be too low to sustain acid generation;

- Acid Potential (AP) is a measure of the potential of the rock material to produce acid. The formula for calculating AP is: AP = 31.25 x S; where S is the total sulphide concentration of the sample in weight percent, and the AP is in kg $CaCO_3$ equivalent per ton sample (Usher et al., 2003). AP can also be calculated from the total S concentration, but this assumes that all sulphur is present as sulphide and can therefore overestimate the potential for acid rock drainage (some S may be present as sulphate, which is the oxidised form of S and is not acid generating);

- Neutralising Potential (NP) is a measure of the potential of the rock material to neutralise acidity that it produces. It measures the buffering capacity present in the rock due to carbonate, alkaline earth, and base minerals. NP is expressed as kg $CaCO_3$ equivalent per ton of sample;

- Paste pH is a measure of the pH of the crushed sample (< 300 mm) in a slurry with distilled water, and gives a rapid measure of the current geochemical condition of the sample due to the presence of weathering products on the surfaces, and ion exchange (Usher *et. al.*, 2003). An acidic paste pH indicates the potential for a rock to be acid generating;

- Net neutralisation potential (NNP) is calculated by subtracting the AP from the NP, as follows:

  NNP = NP – AP

A NNP < 0 indicates that the sample has the potential to generate acid, and NNP > 0 indicates that the sample has the potential to neutralise acid produced. In reality, NNP values between -20 and 20 are indeterminate i.e. could be acid producing or acid neutralising (Usher *et. al.*, 2003); and

- The neutralising potential ratio (NPR) is the ratio of NP to AP. A NPR <1 indicates a potentially acid forming rock, and a NPR >4 indicates a non-acid forming rock. An NPR between 1 and 4 is indeterminate, and further tests would be required to establish whether there is potential for AMD.

3 ASSESSMENT APPROACH

3.1 SAMPLE COLLECTION AND PREPARATION

Following assessment by BMM's exploration geology team on the rock types that will be intersected by the Swartberg decline, composite samples were collected to represent the three rock types, and were provided to ERM for analysis and interpretation. The sample information is provided in *Table 3.1*.

Table 3.1 Summary of rock samples provided for analysis

Sample ID	From depth (mbgl)	To depth (mbgl)	Lithology
BM542-WA01	241.00	246.00	Aluminous Schist
BM542-WA02	247.00	250.50	Quartz Muscovite Schist / Pegmatite
BM498-WA03	131.50	137.50	Augen Gneiss
BM542-WA04	237.30	240.63	Augen Gneiss

3.2 LABORATORY ANALYSIS

3.2.1 Acid Base Accounting Analysis

The four rock samples were submitted to Waterlab in Pretoria for crushing and ABA analysis, according to the Modified Sobek procedure (US EPA-600). A sub-sample of each crushed sample was provided to ERM for subsequent waste classification analysis.

3.2.2 Waste Classification Analysis

Four samples of crushed rock were submitted to Jones Environmental Laboratory in the UK for analysis as per the schedule in *Table 3.2*.

Table 3.2 Schedule of analysis for waste rock samples

Analyses	Total concentration	Leachable concentration
Metals:		
As, B, Ba, Cd, Co, Cr $_{(total)}$, Cr $_{(VI)}$, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, V and Zn	4	4
Inorganics:		
Sulphate, sulphide	4	4

The samples were analysed for total and leachable concentrations as required by NEMWA (2008). Leachates were analysed by the Australian Standard Leaching Procedure (ASLP) (reference AS4439.3) using reagent water, in accordance with NEMWA regulations.

4 ASSESSMENT RESULTS

4.1 ACID BASE ACCOUNTING RESULTS

Based on the ABA results, the samples were classified according to their potential to be acid-generating. The NNP and NPR were determined from the AP and NP results. The paste pH value provided an additional indication of the potential for acid generation.

4.1.1 Limitations of the ABA Analysis

It should be noted that ABA is a screening tool, and may not be conclusive. Additional testing may be recommended should test results indicate uncertainty regarding the acid generation potential of the materials. Typically, the more samples collected, the greater the confidence in the data. The number of samples collected for this study allowed only for a qualitative screening assessment to be completed. A more thorough investigation, with significantly more samples, would allow for the statistical evaluation of the likelihood and severity of potential ARD from occurring. In addition, as ERM did not collect the samples, it is not known to what extent the samples can be considered representative.

The ABA tests described above have limitations and should be interpreted with care. Smaller grain sizes will result in more rapid reaction due to the larger surface area, and the rock will react more completely as crushing exposes surfaces that may not be exposed in the waste material. The relative grain sizes of the sulphide minerals and neutralising minerals are also important. Dust particles will react initially, while boulder size material may contribute very little to ARD. A common reaction process is the formation of reaction rims (armouring) on the edge of particles. Pyrite can be oxidized and the resultant iron and sulphate may precipitate as reaction products such as jarosite, ferrihydrite or gypsum on the surface of the mineral. This product will then protect the remaining pyrite grain from further reaction, resulting in less ARD than may be predicted from laboratory tests where reactions are forced to completion.

A single duplicate test was completed on sample BM542-WA04 for ABA in order to assess precision (refer to laboratory certificate in *Annex A*). The paste pH was identical in the two samples; however a difference of 1 kg/t was measured in the NP, which did not affect the interpretation of the results. The measured total sulphur content was below detection limits in both samples.

4.1.2 Analytical Results and Interpretation

Results from ARD screening are presented in *Table 4.1*, and the laboratory certificate is attached in *Annex A*.

Table 4.1 Acid Base Accounting results of Swartberg waste rock samples

Parameter	BM542-WA01	BM542-WA02	BM498-WA03	BM542-WA04	Screening criteria: Low risk	Un-certain	High risk
Paste pH	8.8	9.1	9.6	8.9	<4.5		>4.5
Total Sulphur (%)	<0.01	<0.01	0.07	<0.01	<0.3		>0.3
AP (kg as $CaCO_3$/t)	<0.31	<0.31	2.13	<0.31			
NP (kg as $CaCO_3$/t)	4.5	3.75	2.75	2.25			
NNP (kg as $CaCO_3$/t)	>4.2	>3.4	0.63	>1.9	>20	-20 to 20	<-20
NPR (NP : AP)	>14.5	>12.1	1.29	>5.6	>4	1 to 4	<1

Colour key:
Green – low risk of ARD
Orange – uncertainty as to whether ARD may develop
Red – high risk of ARD

The paste pH of all samples was reported to be >8.8, indicating that weathering products on the surface of the rocks will tend to produce an alkaline, rather than an acidic, pH in leachate. This suggests a low potential for ARD. The total sulphur content of the samples is also low, resulting in a low AP. Although the NP for the samples is low, it exceeds the AP, which means that the rocks contain sufficient neutralising potential to neutralise any acid produced by oxidation of sulphide minerals. The NNP values are within a range which could be classified as indeterminate, however this is because of the low total NP values, and in the context of the paste pH and total sulphur concentrations, and the low risk NPR values, the NNP values are not believed to be of concern for ARD generation.

Apart from sample BM498-WA03 (augen gneiss), the NPR values all indicate a low risk for ARD. Although the NPR from BH498-WA03 suggests uncertainty in terms of the potential ARD risk, the high paste pH and low total sulphur content suggest that this sample is not likely to be acid generating.

4.2 NEMWA WASTE CLASSIFICATION RESULTS

4.2.1 Assessment Criteria

For waste classification purposes, the total and leachable concentration results were compared to the TCT and LCT threshold values, as defined by the waste regulations (GN 634 and 635) promulgated under NEMWA (2008). The total metals results were compared to the TCT limits and the leachable metals results (i.e. ASLP results) were compared to the LCT limits.

The relevant TCT and LCT limits for the waste samples collected for this assessment are presented in *Table 4.2*.

Table 4.2 Total and Leachable Concentration Threshold Limits

COPC	Total Concentration Thresholds (mg/kg)			Leachable Concentration Thresholds (mg/l)			
	TCT0	TCT1	TCT2	LCT0	LCT1	LCT2	LCT3
Antimony (Sb)	10	75	300	0.02	1.0	2	8
Arsenic (As)	5.8	500	2,000	0.01	0.5	1	4
Barium (Ba)	62.5	6,250	25,000	0.7	35	70	280
Boron (Bo)	150	15,000	60,000	0.5	25	50	200
Cadmium (Cd)	7.5	260	1,040	0.003	0.15	0.3	1.2
Chromium (Cr total)	46,000	800,000	N/A	0.1	5	10	40
Chromium VI	6.5	500	2,000	0.05	2.5	5	20
Cobalt (Co)	50	5,000	20,000	0.5	25	50	200
Copper (Cu)	16	19,500	78,000	2.0	100	200	800
Lead (Pb)	20	1,900	7,600	0.01	0.5	1	4
Manganese (Mn)	1,000	25,000	100,000	0.5	25	50	200
Mercury (Hg)	0.93	160	640	0.006	0.3	0.6	2.4
Molybdenum (Mo)	40	1,000	4,000	0.07	3.5	7	28
Nickel (Ni)	91	10,600	42,400	0.07	3.5	7	28
Selenium (Se)	10	50	200	0.01	0.5	1	4
Vanadium (V)	150	2,680	10,720	0.2	10	20	80
Zinc (Zn)	240	160,000	640,000	5.0	250	500	2,000
Sulphate	-	-	-	250	12,500	25,000	100,000

4.2.2 Waste Classification

A summary of the waste classification results are presented in *Table 4.3* and *Table 4.4* for compounds that were detected in the samples. The results have been compared respectively with the relevant TCT and LCT values (NEMWA Regulations, 2013).

The waste classification results for the samples from the site indicate the following:

- The total concentrations are below the TCT1 limits for all compounds; and
- The leachable concentrations are below the LCT0 limits for all compounds.

On the basis of these results, the samples from the site are classified as *Type 3: Low risk waste* (NEMWA Regulation, 2013). Type 3 waste can be disposed of at a **Class C** landfill in terms of the NEMWA Regulations (2013) or a **GLB+** landfill in terms of the DWAF (1998) requirements.

Various GLB+ landfills exist within South Africa. However, the specification for Class C landfills has only recently been promulgated and these sites have yet to be constructed. A Class C landfill requires a 1.5 mm HDPE geo-membrane and two 150 mm clay layers, but does not require a stone leachate collection system. The NEMWA (2013) regulations provide no limit to the volume of waste that can be accepted by the landfill.

Table 4.3 Waste classification results for total concentrations

COPC	*TCT0 (mg/kg)*	*TCT1 (mg/kg)*	Total Concentrations Threshold (mg/kg)			
			BM542-WA01	BM542-WA02	BM498-WA03	BM542-WA04
Antimony (Sb)	10	75	2	2	<1	<1
Arsenic (As)	5.8	500	1.7	<0.5	1.4	1.1
Barium (Ba)	**62.5**	6,250	**134**	**236**	27	**71**
Boron (Bo)	150	15,000	9.66	8.84	4.66	5.85
Cadmium (Cd)	7.5	260	<0.1	0.5	<0.1	<0.1
Chromium (Cr total)	46,000	800,000	40.9	46.4	47.9	46.6
Chromium (VI)	6.5	500	<0.3	<0.3	<0.3	<0.3
Cobalt (Co)	50	5,000	19.3	16.5	6.5	9.6
Copper (Cu)	**16**	19,500	**28**	**46**	**27**	<1
Lead (Pb)	**20**	1,900	**145**	**170**	<5	**68**
Manganese (Mn)	**1,000**	25,000	**1,530**	**1,180**	317	**1,290**
Molybdenum (Mo)	40	1,000	1.3	2.4	4.3	2.9
Nickel (Ni)	91	10,600	24.1	15.6	4.8	8.9
Selenium (Se)	10	50	1	1	<1	<1
Vanadium (V)	150	2,680	59	47	23	19
Zinc (Zn)	**240**	160,000	**337**	**351**	53	**303**
Sulphate	-	-	<50	<50	<50	64

Note:
Concentrations in **bold face** exceed TCT0 limits
<LOD Concentration is below laboratory limit of detection (LOD)

Table 4.4 Waste classification results for leachate concentrations

COPC	*LCT0 (mg/l)*	*LCT1 (mg/l)*	Total Leachate Threshold (mg/l)			
			BM542-WA01	BM542-WA02	BM498-WA03	BM542-WA04
Barium (Ba)	0.7	35	0.035	<0.003	<0.003	0.013
Manganese (Mn)	0.5	25	0.003	0.002	<0.002	0.006
Vanadium (V)	0.2	10	<0.0015	0.0019	<0.0015	<0.0015
Zinc (Zn)	5.0	250	<0.003	0.003	<0.003	0.005
Sulphate	250	12,500	1.74	1.26	1.38	1.41

Note:
<LOD Concentration is below laboratory limit of detection (LOD)

5 CONCLUSIONS

5.1 ACID BASE ACCOUNTING

The samples provided by BMM for ABA analysis indicate a generally low risk of ARD due to low sulphur content. This is supported by the alkaline paste pH measured in these samples. Assuming that the samples are representative of the waste material, the risk of ARD from the waste is considered to be negligible.

5.2 WASTE CLASSIFICATION

The rock waste samples retrieved from the site were classified in accordance with current waste management legislation (i.e. NEMWA, 2008 and NEMWA Regulations, 2013). Based on the waste classification results, the rock waste samples are classified as Type 3 waste and can be disposed of at a Class C landfill. In the absence of a suitable designed Class C landfill, the waste can be disposed of at a GLB+ landfill. The regulations provide no limit to the volume of waste that can be accepted by the landfill.

It is noted that this waste classification applies to the samples that were submitted for laboratory analysis. As ERM did not collect the samples, it is not known to what extent the samples are representative of the waste.

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Annex A

Laboratory Analytical Reports

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CERTIFICATE OF ANALYSES
ACID – BASE ACCOUNTING
EPA-600 MODIFIED SOBEK METHOD

Date received: 2016-09-09 **Date completed: 2016-09-27**

Project number: 183 **Report number: 61996** **Order number:**

Client name: ERM Southern Africa (Pty) Ltd
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Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification				
	BM542-WA01 Aluminous Schist	BM542-WA02 Quartz Muscovite Schist / Pegmatite	BM498-WA03 Augen Gneiss	BM542-WA04 Augen Gneiss	BM542-WA04 Augen Gneiss
Sample Number	**17513**	**17514**	**17515**	**17516**	**17516 D**
Paste pH	8.8	9.1	9.6	8.9	8.9
Total Sulphur (%) (LECO)	<0.01	<0.01	0.07	<0.01	<0.01
Acid Potential (AP) (kg/t)	0.031	0.031	2.13	0.031	0.031
Neutralization Potential (NP)	4.50	3.75	2.75	1.75	2.75
Nett Neutralization Potential (NNP)	4.47	3.72	0.625	1.72	2.72
Neutralising Potential Ratio (NPR) (NP : AP)	144	120	1.29	56	88
Rock Type	III	III	II	III	III

*** Negative NP values are obtained when the volume of NaOH (0.1N) titrated (pH: 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 – 2.5 Any negative NP values are corrected to 0.00.**

Please refer to Appendix **(p.2)** for a Terminology of terms and guidelines for rock classification

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APPENDIX: TERMINOLOGY AND ROCK CLASSIFICATION

TERMINOLOGY (SYNONYMS)

- Acid Potential (AP) ; *Synonyms*: Maximum Potential Acidity (MPA)
  Method: Total S(%) (Leco Analyzer) x 31.25
- Neutralization Potential (NP) ; *Synonyms:* Gross Neutralization Potential (GNP) ; *Syn*: Acid Neutralization Capacity (ANC) (The capacity of a sample to consume acid)
  Method: Fizz Test ; Acid-Base Titration (Sobek & Modified Sobek (Lawrence) Methods)
- Nett Neutralization Potential (NNP) ; *Synonyms:* Nett Acid Production Potential (NAPP)
  Calculation: NNP = NP – AP ; NAPP = ANC – MPA
- Neutralising Potential Ratio (NPR)
  Calculation: NPR = NP : AP

CLASSIFICATION ACCORDING TO NETT NEUTRALISING POTENTIAL (NNP)

If NNP (NP – AP) < 0, the sample has the potential to generate acid
If NNP (NP – AP) > 0, the sample has the potential to neutralise acid produced

Any sample with NNP < 20 is potentiall acid-generating, and any sample with NNP > -20 might not generate acid (Usher *et al*., 2003)

ROCK CLASSIFICATION

TYPE I	Potentially Acid Forming	Total S(%) > 0.25% and NP:AP ratio 1:1 or less
TYPE II	Intermediate	Total S(%) > 0.25% and NP:AP ratio 1:3 or less
TYPE III	Non-Acid Forming	Total S(%) < 0.25% and NP:AP ratio 1:3 or greater

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CLASSIFICATION ACCORDING TO NEUTRALISING POTENTIAL RATIO (NPR)

Guidelines for screening criteria based on ABA (Price *et al*., 1997 ; Usher *et al*., 2003)

Potential for ARD	Initial NPR Screening Criteria	Comments
Likely	**< 1:1**	Likely AMD generating
Possibly	**1:1 – 2:1**	Possibly AMD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	**2:1 – 4:1**	Not potentially AMD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	**>4:1**	No further AMD testing required unless materials are to be used as a source of alkalinity

CLASSIFICATION ACCORDING TO SULPHUR CONTENT (%S) AND NEUTRALISING POTENTIAL RATIO (NPR)

For sustainable long-term acid generation, at least 0.3% Sulphide-S is needed. Values below this can yield acidity but it is likely to be only of short-term significance. From these facts, and using the NPR values, a number of rules can be derived:

1) Samples with less than 0.3% Sulphide-S are regarded as having insufficient oxidisable Sulphide-S to sustain acid generation.
2) NPR ratios of >4:1 are considered to have enough neutralising capacity.
3) NPR ratios of 3:1 to 1:1 are consider inconclusive.
4) NPR ratios below 1:1 with Sulphide-S above 3% are potentially acid-generating. (Soregaroli & Lawrence, 1998 ; Usher *et al*., 2003)

E. Pelser
Geochemistry Project Manager (Acting)

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CERTIFICATE OF ANALYSES
ACID – BASE ACCOUNTING
EPA-600 MODIFIED SOBEK METHOD

Date received: 2016-09-09 **Date completed: 2016-09-27**

Project number: 183 **Report number: 61996** **Order number:**

Client name: ERM Southern Africa (Pty) Ltd
Address: 1st Floor, Building 32, The Woodlands Office Park, Woodlands Drive, Woodmead, 2148, JHB
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Contact person: Stephen Mc Keown
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REFERENCES

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ENVIRONMENT AUSTRALIA. 1997. **Managing Sulphidic Mine Wastes and Acid Drainage**.

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Geochemistry Project Manager (Acting)

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ERM South Africa
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Attention :	Steve McKeown
Date :	6th October, 2016
Your reference :	0371087
Our reference :	Test Report 16/15111 Batch 1
Location :	Swartberg, Black Mountain
Date samples received :	30th September, 2016
Status :	Final report
Issue :	1

Four samples were received for analysis on 30th September, 2016 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

All analysis was undertaken at Jones Environmental Laboratory in the UK, which is ISO 17025 accredited under UKAS (4225).

NOTE: Under International Laboratory Accreditation Cooperation (ILAC), ISO 17025 (UKAS) accreditation is recognised as equivalent to SANAS (South Africa) accreditation.

Compiled By:

Paul Lee-Boden BSc
Project Manager

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown
JE Job No.: 16/15111

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	1-2	3-4	5-6	7-8							LOD/LOR	Units	Method No.
Sample ID	BM542-WA01	BM542-WA02	BM498-WA03	BM542-WA04									
Depth													
COC No / misc													
Containers	B	B	B	B									
Sample Date	06/09/2016	06/09/2016	06/09/2016	06/09/2016									
Sample Type	Solid	Solid	Solid	Solid									
Batch Number	1	1	1	1									
Date of Receipt	30/09/2016	30/09/2016	30/09/2016	30/09/2016									
Antimony	2	2	<1	<1							<1	mg/kg	TM30/PM15
Arsenic	1.7	<0.5	1.4	1.1							<0.5	mg/kg	TM30/PM15
Barium	134	236	27	71							<1	mg/kg	TM30/PM15
Cadmium	<0.1	0.5	<0.1	<0.1							<0.1	mg/kg	TM30/PM15
Chromium	40.9	46.4	47.9	46.6							<0.5	mg/kg	TM30/PM15
Cobalt	19.3	16.5	6.5	9.6							<0.5	mg/kg	TM30/PM15
Copper	28	46	27	<1							<1	mg/kg	TM30/PM15
Lead	145	170	<5	68							<5	mg/kg	TM30/PM15
Manganese	1530	1180	317	1290							<1	mg/kg	TM30/PM15
Mercury	<0.1	<0.1	<0.1	<0.1							<0.1	mg/kg	TM30/PM15
Molybdenum	1.3	2.4	4.3	2.9							<0.1	mg/kg	TM30/PM15
Nickel	24.1	15.6	4.8	8.9							<0.7	mg/kg	TM30/PM15
Selenium	1	1	<1	<1							<1	mg/kg	TM30/PM15
Total Sulphate	<50	<50	<50	64							<50	mg/kg	TM50/PM29
Vanadium	59	47	23	19							<1	mg/kg	TM30/PM15
Boron (Aqua Regia Soluble)	9.66	8.84	4.66	5.85							<0.25	mg/kg	TM30/PM15
Zinc	337	351	53	303							<5	mg/kg	TM30/PM15
Natural Moisture Content	<0.1	<0.1	<0.1	<0.1							<0.1	%	PM4/PM0
Hexavalent Chromium	<0.3	<0.3	<0.3	<0.3							<0.3	mg/kg	TM38/PM20
Sulphide	<10	<10	<10	<10							<10	mg/kg	TM106/PM45
pH	9.01	9.25	9.74	9.33							<0.01	pH units	TM73/PM11

Please see attached notes for all abbreviations and acronyms

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown
JE Job No.: 16/15111

Report : ASLP (20:1) - Reagent Water

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	1-2	3-4	5-6	7-8							LOD/LOR	Units	Method No.
Sample ID	BM542-WA01	BM542-WA02	BM498-WA03	BM542-WA04									
Depth													
COC No / misc													
Containers	B	B	B	B									
Sample Date	06/09/2016	06/09/2016	06/09/2016	06/09/2016									
Sample Type	Solid	Solid	Solid	Solid									
Batch Number	1	1	1	1									
Date of Receipt	30/09/2016	30/09/2016	30/09/2016	30/09/2016									
Dissolved Antimony	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Arsenic	<2.5	<2.5	<2.5	<2.5							<2.5	ug/l	TM30/PM14
Dissolved Barium	35	<3	<3	13							<3	ug/l	TM30/PM14
Dissolved Boron	<12	<12	<12	<12							<12	ug/l	TM30/PM14
Dissolved Cadmium	<0.5	<0.5	<0.5	<0.5							<0.5	ug/l	TM30/PM14
Dissolved Chromium	<1.5	<1.5	<1.5	<1.5							<1.5	ug/l	TM30/PM14
Dissolved Cobalt	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Copper	<7	<7	<7	<7							<7	ug/l	TM30/PM14
Dissolved Lead	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Manganese	3	2	<2	6							<2	ug/l	TM30/PM14
Dissolved Mercury	<1	<1	<1	<1							<1	ug/l	TM30/PM14
Dissolved Molybdenum	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Nickel	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Selenium	<3	<3	<3	<3							<3	ug/l	TM30/PM14
Dissolved Vanadium	<1.5	1.9	<1.5	<1.5							<1.5	ug/l	TM30/PM14
Dissolved Zinc	<3	3	<3	5							<3	ug/l	TM30/PM14
Sulphate	1.74	1.26	1.38	1.41							<0.05	mg/l	TM38/PM0
Sulphide	<0.01	<0.01	<0.01	<0.01							<0.01	mg/l	TM106/PM0
Hexavalent Chromium	<0.006	<0.006	<0.006	<0.006							<0.006	mg/l	TM38/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: ERM South Africa **Solid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

AQS Spike Results	Worksheet					Analyte	Method No	Method Name	Result	ControlLimit	
	529079					pH (% recovery)	TM73/PM11	pH by Metrohm	91.28	92-97%	
Method Blank Results		No non-conformances identified.									
Frequency of QC Samples		Please refer to the QC Sample Frequency individual reports.									
Holding Time Compliance		No non-conformances identified.									
Deviating Samples		No non-conformances identified.									

This summary report highlights non conformances associated with the Quality Control Sample Results provided in the subsequent sections.

Client Name: ERM South Africa **Liquid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

AQS Spike Results		No non-conformances identified.						
Method Blank Results	Worksheet		Analyte	Method No	Method Name	Result	ControlLimit	
	529818		Sulphate	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	1.4	<0.5mg/l	
Deviating Samples		No non-conformances identified.						

This summary report highlights non conformances associated with the Quality Control Sample Results provided in the subsequent sections.

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

ASLP (20:1) - Reagent Water

Frequency of QC Samples		No non-conformances identified.
Holding Time Compliance		No non-conformances identified.

This summary report highlights non conformances associated with the Quality Control Sample Results provided in the subsequent sections.

Client Name: ERM South Africa **Matrix : Solid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Method No	Method Name	Sampled Date	Received Date	Extraction Date	Leachate Date	Analysis Date	Holding Time (Days)	Within Holding Time
16/15111	1	BM542-WA01		1	PM4/PM0	Moisture Content	06/09/2016	30/09/2016			03/10/2016		n/a
16/15111	1	BM542-WA01		1	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	168	Y
16/15111	1	BM542-WA01		1	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		05/10/2016	168	Y
16/15111	1	BM542-WA01		1	TM38/PM20	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016	04/10/2016		05/10/2016	28	Y
16/15111	1	BM542-WA01		1	TM50/PM29	Total Sulphate by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	28	Y
16/15111	1	BM542-WA01		1	TM73/PM11	pH by Metrohm	06/09/2016	30/09/2016	03/10/2016		05/10/2016	28	Y
16/15111	1	BM542-WA01		1	TM106/PM45	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016	03/10/2016		04/10/2016		n/a
16/15111	1	BM542-WA02		3	PM4/PM0	Moisture Content	06/09/2016	30/09/2016			03/10/2016		n/a
16/15111	1	BM542-WA02		3	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	168	Y
16/15111	1	BM542-WA02		3	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		05/10/2016	168	Y
16/15111	1	BM542-WA02		3	TM38/PM20	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016	04/10/2016		05/10/2016	28	Y
16/15111	1	BM542-WA02		3	TM50/PM29	Total Sulphate by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	28	Y
16/15111	1	BM542-WA02		3	TM73/PM11	pH by Metrohm	06/09/2016	30/09/2016	03/10/2016		05/10/2016	28	Y
16/15111	1	BM542-WA02		3	TM106/PM45	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016	03/10/2016		04/10/2016		n/a
16/15111	1	BM498-WA03		5	PM4/PM0	Moisture Content	06/09/2016	30/09/2016			03/10/2016		n/a
16/15111	1	BM498-WA03		5	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	168	Y
16/15111	1	BM498-WA03		5	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		05/10/2016	168	Y
16/15111	1	BM498-WA03		5	TM38/PM20	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016	04/10/2016		05/10/2016	28	Y
16/15111	1	BM498-WA03		5	TM50/PM29	Total Sulphate by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	28	Y
16/15111	1	BM498-WA03		5	TM73/PM11	pH by Metrohm	06/09/2016	30/09/2016	03/10/2016		05/10/2016	28	Y
16/15111	1	BM498-WA03		5	TM106/PM45	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016	03/10/2016		04/10/2016		n/a
16/15111	1	BM542-WA04		7	PM4/PM0	Moisture Content	06/09/2016	30/09/2016			03/10/2016		n/a
16/15111	1	BM542-WA04		7	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	168	Y
16/15111	1	BM542-WA04		7	TM30/PM15	Metals by ICP-OES	06/09/2016	30/09/2016	03/10/2016		05/10/2016	168	Y
16/15111	1	BM542-WA04		7	TM38/PM20	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016	04/10/2016		05/10/2016	28	Y
16/15111	1	BM542-WA04		7	TM50/PM29	Total Sulphate by ICP-OES	06/09/2016	30/09/2016	03/10/2016		04/10/2016	28	Y
16/15111	1	BM542-WA04		7	TM73/PM11	pH by Metrohm	06/09/2016	30/09/2016	03/10/2016		05/10/2016	28	Y

Client Name: ERM South Africa **Matrix : Solid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Method No	Method Name	Sampled Date	Received Date	Extraction Date	Leachate Date	Analysis Date	Holding Time (Days)	Within Holding Time
16/15111	1	BM542-WA04		7	TM106/PM45	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016	03/10/2016		04/10/2016		n/a

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Matrix : ASLP (20:1) - Reagent Water

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Method No	Method Name	Sampled Date	Received Date	Extraction Date	Leachate Date	Analysis Date	Holding Time (Days)	Within Holding Time
16/15111	1	BM542-WA01		1	TM30/PM14	Metals by ICP-OES	06/09/2016	30/09/2016	06/10/2016	04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA01		1	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016		04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA01		1	TM106/PM0	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016		04/10/2016	05/10/2016		n/a
16/15111	1	BM542-WA02		3	TM30/PM14	Metals by ICP-OES	06/09/2016	30/09/2016	06/10/2016	04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA02		3	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016		04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA02		3	TM106/PM0	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016		04/10/2016	05/10/2016		n/a
16/15111	1	BM498-WA03		5	TM30/PM14	Metals by ICP-OES	06/09/2016	30/09/2016	06/10/2016	04/10/2016	06/10/2016		n/a
16/15111	1	BM498-WA03		5	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016		04/10/2016	06/10/2016		n/a
16/15111	1	BM498-WA03		5	TM106/PM0	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016		04/10/2016	05/10/2016		n/a
16/15111	1	BM542-WA04		7	TM30/PM14	Metals by ICP-OES	06/09/2016	30/09/2016	06/10/2016	04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA04		7	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	06/09/2016	30/09/2016		04/10/2016	06/10/2016		n/a
16/15111	1	BM542-WA04		7	TM106/PM0	Sulphide by Continuous Flow Analyser	06/09/2016	30/09/2016		04/10/2016	05/10/2016		n/a

Client Name: ERM South Africa **Type:AQC**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Method	Compound	Cas Number	Extraction Date	Analysis Date	Spike Concentration	Result	Units	Spike Recovery (%)	Status	Recovery Limits (%)	
										Low	High
QC Lot : W529079											
TM73/PM11	pH (% recovery)		03/10/2016	05/10/2016	8.95			91.28	Fail	92	97
QC Lot : W529580											
TM30/PM15	Arsenic	7440-38-2	03/10/2016	05/10/2016	20.91	21.03	mg/kg	100.57	Pass	91	109
TM30/PM15	Barium	7440-39-3	03/10/2016	05/10/2016	90.70	89.26	mg/kg	98.41	Pass	89	111
TM30/PM15	Cadmium	7440-43-9	03/10/2016	05/10/2016	1.69	1.76	mg/kg	104.14	Pass	90	109
TM30/PM15	Chromium	7440-47-3	03/10/2016	05/10/2016	85.87	89.10	mg/kg	103.76	Pass	91	109
TM30/PM15	Cobalt	7440-48-4	03/10/2016	05/10/2016	13.45	13.94	mg/kg	103.64	Pass	89	111
TM30/PM15	Copper	7440-50-8	03/10/2016	05/10/2016	124.39	129.70	mg/kg	104.27	Pass	90	110
TM30/PM15	Lead	7439-92-1	03/10/2016	05/10/2016	41.26	43.30	mg/kg	104.94	Pass	86	114
TM30/PM15	Manganese	7439-96-5	03/10/2016	05/10/2016	313.28	314.30	mg/kg	100.33	Pass	87	113
TM30/PM15	Mercury	7439-97-6	03/10/2016	05/10/2016	0.78	0.865	mg/kg	110.897	Pass	82	118
TM30/PM15	Molybdenum	7439-98-7	03/10/2016	05/10/2016	40.674	40.68	mg/kg	100.01	Pass	93	107
TM30/PM15	Nickel	7440-02-0	03/10/2016	05/10/2016	194.54	205.30	mg/kg	105.53	Pass	89	111
TM30/PM15	Selenium	7782-49-2	03/10/2016	05/10/2016	103.024	99.10	mg/kg	96.19	Pass	82	118
TM30/PM15	Zinc	7440-66-6	03/10/2016	05/10/2016	350.66	378.00	mg/kg	107.80	Pass	87	113
QC Lot : W529642											
TM50/PM15	Total Sulphate		03/10/2016	04/10/2016	415	396.80	mg/kg	95.61	Pass	79	121

The percentage recovery result for the AQC should be between the recovery limits to be statistically in control.

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Type:AQC

Method	Compound	Cas Number	Extraction Date	Analysis Date	Spike Concentration	Result	Units	Spike Recovery (%)	Status	Recovery Limits (%)	
										Low	High
QC Lot : W529818											
TM38/PM0	Sulphate		04/10/2016	06/10/2016	50	50.78	mg/l	101.56	Pass	87	113

The percentage recovery result for the AQC should be between the recovery limits to be statistically in control.

Client Name: ERM South Africa **Type: BLANK**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Method	Compound	Cas Number	Extraction Date	Analysis Date	Result	LOD	Units	Status
QC Lot : W529580								
TM30/PM15	Arsenic	7440-38-2	03/10/2016	05/10/2016	<0.5	<0.5	mg/kg	Pass
TM30/PM15	Barium	7440-39-3	03/10/2016	05/10/2016	<1	<1	mg/kg	Pass
TM30/PM15	Cadmium	7440-43-9	03/10/2016	05/10/2016	<0.1	<0.1	mg/kg	Pass
TM30/PM15	Chromium	7440-47-3	03/10/2016	05/10/2016	<0.5	<0.5	mg/kg	Pass
TM30/PM15	Cobalt	7440-48-4	03/10/2016	05/10/2016	<0.5	<0.5	mg/kg	Pass
TM30/PM15	Copper	7440-50-8	03/10/2016	05/10/2016	<1	<1	mg/kg	Pass
TM30/PM15	Lead	7439-92-1	03/10/2016	05/10/2016	<5	<5	mg/kg	Pass
TM30/PM15	Manganese	7439-96-5	03/10/2016	05/10/2016	<1	<1	mg/kg	Pass
TM30/PM15	Mercury	7439-97-6	03/10/2016	05/10/2016	<0.1	<0.1	mg/kg	Pass
TM30/PM15	Molybdenum	7439-98-7	03/10/2016	05/10/2016	<0.1	<0.1	mg/kg	Pass
TM30/PM15	Nickel	7440-02-0	03/10/2016	05/10/2016	<0.7	<0.7	mg/kg	Pass
TM30/PM15	Selenium	7782-49-2	03/10/2016	05/10/2016	<1	<1	mg/kg	Pass
TM30/PM15	Zinc	7440-66-6	03/10/2016	05/10/2016	<5	<5	mg/kg	Pass
QC Lot : W529642								
TM50/PM15	Total Sulphate		03/10/2016	04/10/2016	<50	<50	mg/kg	Pass

Where analysis is blank corrected, blank data, although available, is not routinely supplied.

Client Name: ERM South Africa **Type: BLANK**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Method	Compound	Cas Number	Extraction Date	Analysis Date	Result	LOD	Units	Status
QC Lot : W529818								
TM38/PM0	Sulphate		04/10/2016	06/10/2016	1.4	<0.5	mg/l	Fail

Where analysis is blank corrected, blank data, although available, is not routinely supplied.

Client Name: ERM South Africa **Matrix: Solid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

QC Sample Type	Method	Method Name	No Of Client Samples	No of QA Samples	Ratio of QC to Client Samples (%)		Status
					Actual	Method Minimum	
AQC Spiked Sample	TM30/PM15	Metals by ICP-OES	4	2	50	10.5	Pass
	TM50/PM29	Total Sulphate by ICP-OES	4	1	25	5.3	Pass
Method Blank	TM30/PM15	Metals by ICP-OES	4	1	25	5.3	Pass
	TM73/PM11	pH by Metrohm	4	0	0	5.3	Fail
	TM50/PM29	Total Sulphate by ICP-OES	4	1	25	5.3	Pass

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Matrix: ASLP (20:1) - Reagent Water

QC Sample Type	Method	Method Name	No Of Client Samples	No of QA Samples	Ratio of QC to Client Samples (%)		Status
					Actual	Method Minimum	
AQC Spiked Sample	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	4	1	25	5	Pass
Method Blank	TM38/PM0	SO4, Cl, NO3, NO2, PO4, Amm N2, Thiocyanate, Hex Cr by Aquakem	4	1	25	5	Pass

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
No deviating sample report results for job 16/15111						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

Client Name: ERM South Africa **Matrix : Solid**
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	QA Type	Method No	Worksheet No
16/15111	1	BM542-WA01		1	N	PM4/PM0	529068
16/15111	1	BM542-WA02		3	N	PM4/PM0	529068
16/15111	1	BM498-WA03		5	N	PM4/PM0	529068
16/15111	1	BM542-WA04		7	N	PM4/PM0	529068
05/261	1	A7230534		A7230534	BS	TM73/PM11	529079
16/15111	1	BM542-WA01		1	N	TM73/PM11	529079
16/15111	1	BM542-WA02		3	N	TM73/PM11	529079
16/15111	1	BM498-WA03		5	N	TM73/PM11	529079
16/15111	1	BM542-WA04		7	N	TM73/PM11	529079
16/15111	1	BM542-WA01		1	N	TM106/PM45	529176
16/15111	1	BM542-WA02		3	N	TM106/PM45	529176
16/15111	1	BM498-WA03		5	N	TM106/PM45	529176
16/15111	1	BM542-WA04		7	N	TM106/PM45	529176
16/15111	1	BM542-WA01		1	N	TM30/PM15	529579
16/15111	1	BM542-WA02		3	N	TM30/PM15	529579
16/15111	1	BM498-WA03		5	N	TM30/PM15	529579
16/15111	1	BM542-WA04		7	N	TM30/PM15	529579
05/261	1	A7233365		A7233365	BS	TM30/PM15	529580
05/261	1	A7233366		A7233366	BS	TM30/PM15	529580
05/261	1	A7233364		A7233364	LB	TM30/PM15	529580
16/15111	1	BM542-WA01		1	N	TM30/PM15	529580
16/15111	1	BM542-WA02		3	N	TM30/PM15	529580
16/15111	1	BM498-WA03		5	N	TM30/PM15	529580
16/15111	1	BM542-WA04		7	N	TM30/PM15	529580
05/261	1	A7234199		A7234199	BS	TM50/PM15	529642
05/261	1	A7234198		A7234198	LB	TM50/PM15	529642
16/15111	1	BM542-WA01		1	N	TM50/PM29	529642
16/15111	1	BM542-WA02		3	N	TM50/PM29	529642
16/15111	1	BM498-WA03		5	N	TM50/PM29	529642
16/15111	1	BM542-WA04		7	N	TM50/PM29	529642
16/15111	1	BM542-WA01		1	N	TM38/PM20	530028
16/15111	1	BM542-WA02		3	N	TM38/PM20	530028
16/15111	1	BM498-WA03		5	N	TM38/PM20	530028
16/15111	1	BM542-WA04		7	N	TM38/PM20	530028

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

Matrix : Liquid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	QA Type	Method No	Worksheet No
06/261	1	A7236482		A7236482	BS	TM38/PM0	529818
06/261	1	A7236483		A7236483	LB	TM38/PM0	529818

Client Name: ERM South Africa
Reference: 0371087
Location: Swartberg, Black Mountain
Contact: Steve McKeown

ɕ : ASLP (20:1) - Reagent Water

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	QA Type	Method No	Worksheet No
16/15111	1	BM542-WA01		1	N	TM38/PM0	529818
16/15111	1	BM542-WA02		3	N	TM38/PM0	529818
16/15111	1	BM498-WA03		5	N	TM38/PM0	529818
16/15111	1	BM542-WA04		7	N	TM38/PM0	529818
16/15111	1	BM542-WA01		1	N	TM106/PM0	529821
16/15111	1	BM542-WA02		3	N	TM106/PM0	529821
16/15111	1	BM498-WA03		5	N	TM106/PM0	529821
16/15111	1	BM542-WA04		7	N	TM106/PM0	529821
16/15111	1	BM542-WA01		1	N	TM30/PM14	530534
16/15111	1	BM542-WA02		3	N	TM30/PM14	530534
16/15111	1	BM498-WA03		5	N	TM30/PM14	530534
16/15111	1	BM542-WA04		7	N	TM30/PM14	530534

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 16/15111

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 (UKAS) accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS) accredited - UK.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

JE Job No: 16/15111

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7 and 6010B	PM14	Analysis of waters and leachates for metals by ICP OES. Samples are filtered for dissolved metals and acidified if required.			AR	No
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7 and 6010B	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM0	No preparation is required.			AR	No
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM20	Extraction of dried and ground samples with deionised water in a 2:1 water to solid ratio for anions. Extraction of as received samples with deionised water in a 2:1 water to solid ratio for ammoniacal nitrogen and hydrazine. Samples are extracted using an orbital shaker.			AR	Yes
TM50	Acid soluble sulphate (Total Sulphate) analysed by ICP-OES	PM29	Dried and ground solid sample is boiled with dilute hydrochloric acid, the resulting liquor is then analysed.			AD	Yes
TM73	Modified US EPA methods 150.1 and 9045D. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.			AR	No
TM106	Determination of Sulphide by Skalar Continuous Flow Analyser	PM0	No preparation is required.			AR	No
TM106	Determination of Sulphide by Skalar Continuous Flow Analyser	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide and Thiocyanate analysis.			AR	Yes

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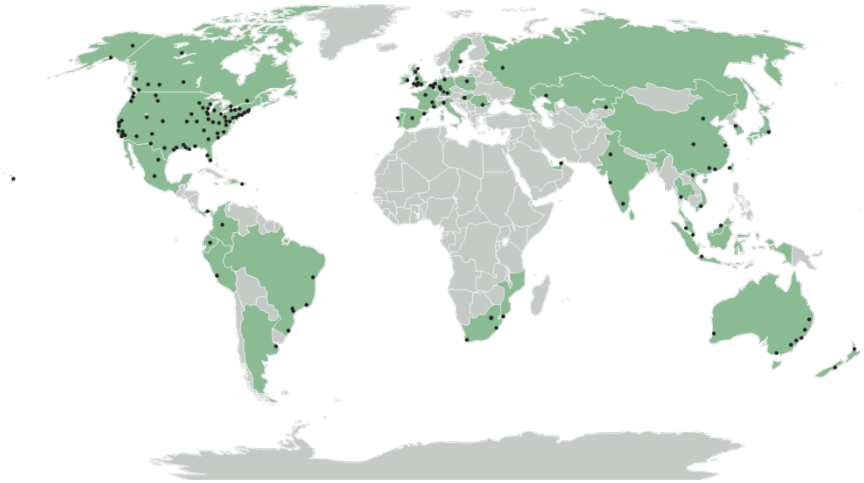

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