MT CHARLOTTE UNDERGROUND WASTE ROCK GEOCHEMICAL CHARACTERISATION

PREPARED FOR:

KALGOORLIE CONSOLIDATED GOLD MINES PTY LTD

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1. INTRODUCTION

1.1 BACKGROUND

Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) operates the Fimiston Open Pit, Mt Charlotte underground mine and the Fimiston and Gidji Processing Plants located adjacent to the City of Kalgoorlie-Boulder approximately 600 km east of Perth, Western Australia (Figure 1).

Mining and mineral processing has occurred in this area, known as the Golden Mile, since gold was first discovered in 1893. The Golden Mile is one of the world's richest gold-bearing reefs and gave rise to a multitude of mining operations. In 1989, all mines, processing plants and leases along the Golden Mile were merged into one integrated operation, KCGM.

Ore for gold production at KCGM is today sourced from two primary mining locations; the Fimiston Open Pit (commonly known as the Super Pit) and the Mt Charlotte underground mine approximately 2 km north of the Fimiston Open Pit (Figure 1). The Fimiston Open Pit mining rate is approximately 69 million tonnes per annum (Mt/a) (comprising ore and waste), of which approximately 12 Mt/a is processed at the Fimiston Mill.

In addition to the above mining locations, development at the Mt Charlotte underground is currently progressing towards two new ore sources:

- Northern Orebody (NOB), a geological extension of the fault line mineralisation seen in the Fimiston Pit.
- Lower Hidden Secret Orebody (LHSO), located approximately 400 m east of Mt Charlotte and within the steeply dipping western limb of the Kalgoorlie Anticline. Mining for LHSO will be between 215 and 440 m underground.

Waste rock generated from NOB and LHSO development will be backfilled to underground mine voids, as has historically been the practice at Mt Charlotte. Waste material will be placed both above and below the final post mining groundwater level.

Waste rock from the NOB extension will comprise almost entirely Golden Mile dolerite (GMD) with minor Black Flag shale lithologies, similar to Fimiston Pit. There is a significant amount of assay data and comprehensive waste characterisation for GMD in particular, as well as Black Flag shale from the Fimiston Pit (MBS 2016, MBS 2017). NOB waste rock is expected to be very similar in nature to these previous samples from Fimiston Pit.

The LHSO development will intercept four fresh rock lithologies: Devons Consol basalt (DCB), Williamstown dolerite (WD), Porphyry (POR) and Kapai slate (KS). The lithology identified as Hannans Lake serpentinite (HLS), which is also in the fresh rock zone, lies below the LHSO and is not part of currently proposed mining. These lithologies are not encountered to any significant degree (only minor Kapai slate is intercepted) in Fimiston Pit and as such, no previous waste characterisation data (if any has been performed), is currently available to support mine closure planning. High sulfur assays recorded for Kapai slate during drilling programs have also indicated this lithology presents a risk of generating acidic and metalliferous drainage (AMD). Although KCGM proposes to backfill waste materials from NOB and LHSO to underground mine voids, additional waste characterisation is required to assess potential impacts to the surrounding environment, particularly post closure leaching of environmentally significant metals and metalloids to the groundwater.

Figure 1: KCGM Fimiston Open Pit and Key Mine Waste Landforms

1.2 OBJECTIVE AND SCOPE OF WORK

The objectives and scope of work for the additional waste rock characterisation were to:

- Liaise with KCGM personnel for provision of drill log data including lithology, sulfur assays (percentage sulfur) and depth for a representative selection of Mt Charlotte underground waste rock types.
- Review the above data to select approximately 24 samples across the fresh waste rock lithologies relevant to Mt Charlotte underground LHSO and NOB orebodies. This includes Kapai slate, Devons Consol basalt, Hannans Lake serpentinite and Williamstown dolerite for the LHSO and the U8 and U9 sequences of Golden Mile dolerite for NOB.
- Visit the Mt Charlotte mine to collect the above samples of drill core, discuss the geology, mine waste planning, available assay results and predicted post-closure groundwater levels.
- Submit samples to a laboratory for determination of the following acid base accounting (ABA) parameters:
    - Total sulfur, sulfate sulfur and (for shale and slate lithologies) chromium reducible sulfur (CRS).
    - Acid Neutralising Capacity (ANC).
    - Total carbon.
    - Net Acid Generation (NAG) test on samples containing >0.2% total sulfur.
- Submit selected samples to the laboratory for the following:
    - Elemental analysis of four acid digest solutions (Ag, Al, As, B, Ba, Ca, Cd, Co, Cu, Cr, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Te, Th, U, V and Zn) and mercury (separate digestion required).
    - Analysis of water and dilute acid leachates of selected samples (based on expected AMD results) for pH, EC, alkalinity/acidity, major ions (Ca, Mg, Na, K, Cl, sulfate) and soluble metals and metalloids (Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cu, Cr, Fe, K, Hg, Li, Mg, Mn, Mo, Na, Ni, Nb, Pb, Sb, Se, Sn, Ta, U, V and Zn).
    - Mineralogy by X-Ray Diffraction (XRD) (one for each lithology).
- Preparation of a concise geochemical report outlining the properties of the waste rock lithologies and discussing similarities to Fimiston Pit wastes. This does not include an assessment of potential for asbestiform minerals.
- Assessment of the relative risk of neutral and acid drainage potential within waste rock from Mt Charlotte based on available information and current/intended mine practices.

2. PROJECT GEOLOGY AND HYDROLOGY

2.1 MT CHARLOTTE UNDERGROUND GEOLOGY

The Kalgoorlie-Boulder stratigraphy lies within the Archaean aged Norseman-Wiluna Greenstone Belt of WA. Intruded mafic to ultramafic sills contain gold-bearing lodes. Most gold mineralisation in the Golden Mile Deposit (including the NOB extension and Fimiston Pit) is hosted within one of these sills; the Golden Mile dolerite. The Fimiston deposit is dominated by the large Kalgoorlie Anticline/Syncline system which caused deformation of the original stratigraphic sequence. The Golden Mile Fault is the main fault occurring in this system and is directly associated with GMD (KCGM 2014). The GMD layer consisting of mafic-ultramafic rocks is further divided into ten units (designated U1 to U10) which differentiate between mineral concentration and texture of GMD.

The Central Lease area geology, which includes the LHSO deposit, is complex due to multiple overprinting folding events and later crosscutting faults. The general profile of the Central Lease deposits consists of a lower mafic-ultramafic volcanic sequence with sub volcanic sills overlain by a thick sequence of sedimentary and intermediate to felsic volcaniclastic rocks. The lower GMD stratigraphy hosts the LHSO deposit, which also holds the main Mt Charlotte-based Fimiston Deposit, and has expressions in the southern portion of the greenstone belt (Figure 2). Figure 3 is a mine cross-sectional view looking north of Mt Charlotte underground and the LHSO deposit showing drill holes for LHSO which were selected for the current study.

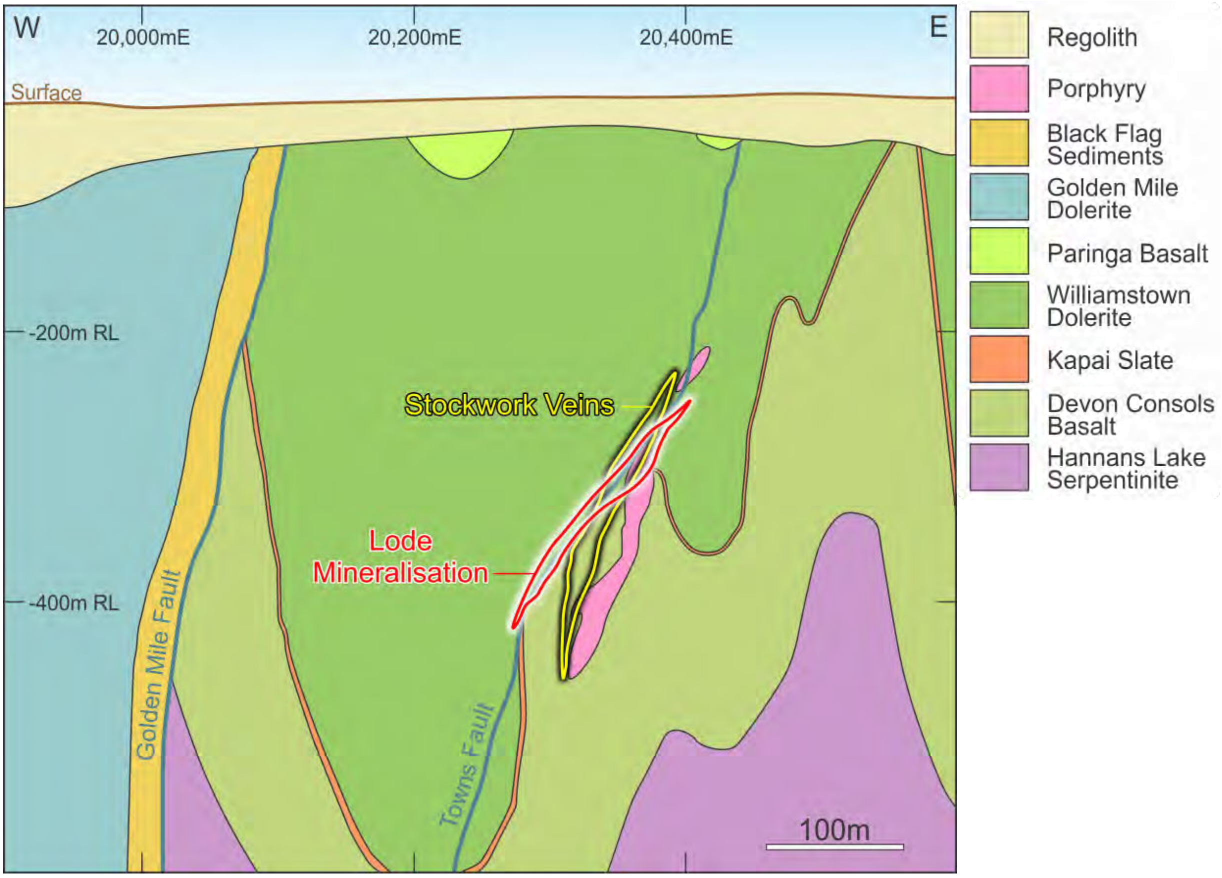

Figure 2: Lower Hidden Secret Orebody Cross-Sectional Geology Schematic

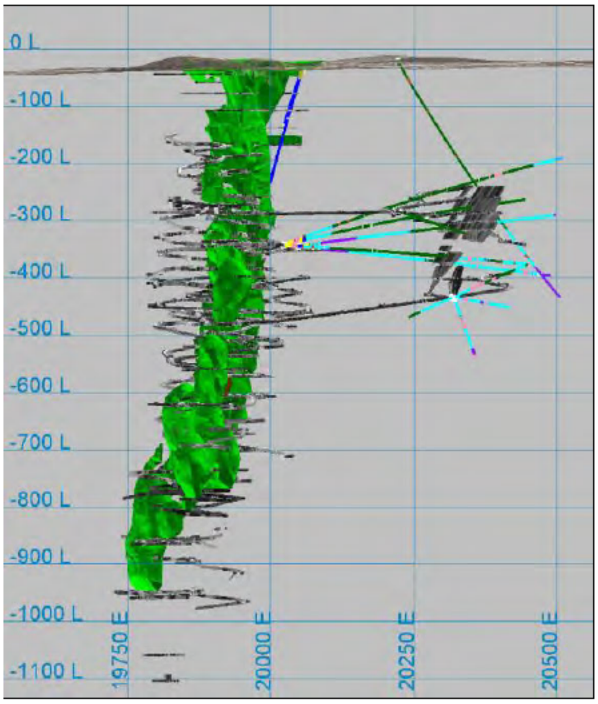

Figure 3: **Cross-Sectional View of Mt Charlotte Underground/LHSO Looking North**

The mineralising event on the Golden Mile has led to an overall geochemical enrichment in arsenic (As), tellurium (Te), mercury (Hg), lead (Pb), vanadium (V) and boron (B). This enrichment is largely confined to the main lode systems with lower levels of enrichment in the surrounding host BF shales and significantly lower enrichment in the host GMD and Paringa basalt. Gold mineralisation in the LHSO is associated with silver, tellurium, mercury, zinc and copper minerals with a significant presence of hessite (Ag_2Te) in particular (Fitzgerald and Nixon 2016 and references therein).

Estimated waste rock tonnages by lithology for each deposit are given in Table 1.

Table 1: **Mt Charlotte Waste Rock Breakdown by Lithology (KCGM Block Model)**

Deposit	Lithology (Abbreviation)	Tonnes	Percentage of Total Waste
NOB	Golden Mile dolerite (GMD)	1,961,250	98.7
	Black Flag shale (BF)	26,046	1.3
	Total	**1,987,296**	**100**
LHSO	Williamstown dolerite (WD)	388,727	64
	Devons Consul basalt (DCB)	135,043	22
	Porphyry (POR)	76,694	13
	Kapai slate (KS)	7,469	1.2
	Total	**607,932**	**100**

2.2 REGIONAL AND LOCAL HYDROGEOLOGY

The predominant rock types in the Golden Mile are GMD and Paringa basalt, which are expected to have a very low permeability and are unlikely to store or transmit large quantities of groundwater, except through major secondary structures (e.g. faults). As a result of limited flows, there is a lack of studies conducted and the hydrogeology is poorly understood (Peter Clifton & Associates 2014).

Groundwater at the greenstone deposits often occurs at shallow depths. There is a major regional paleochannel aquifer located approximately 10 km south of Kalgoorlie-Boulder, beneath Hannans Lake. Groundwater quality in the sedimentary deposits, which overlay greenstones, ranges between saline and hypersaline (20,000 to 200,000 mg/L) (Peter Clifton & Associates 2014).

The Mt Charlotte underground mine is not connected to the extensive underground water systems along Kalgoorlie's Golden Mile, which lie beneath the Fimiston Open Pit. Dewatering from Mt Charlotte underground is directed to surface where it is pumped to Fimiston Mill. Minimal (if any) dewatering will need to be carried out at LHSO as a result of dewatering at Mt Charlotte underground (Peter Clifton & Associates 2014) and the observed lack of groundwater flow in mine workings in the area.

Post-closure flood modelling for the Mt Charlotte underground mine was undertaken by Peter Clifton & Associates (2014) to predict long term changes in groundwater levels as the system adjusted to the cessation of mine dewatering. The most likely scenario considered allowed for flooded mine water in Mt Charlotte underground to overflow into the Fimiston Open Pit when the flood level reaches the portal of the Sam Pearce decline at 106 m below the surface peak of Mt Charlotte. The natural groundwater level in the area was estimated to be 87 m below the peak of Mt Charlotte. The final equilibrium flooding level predicted (with water flowing out from Sam Pearce decline into Fimiston Pit at 106 m below surface) was reached 99 years after closure of the Mt Charlotte underground mine. The minimum prediction of natural rebound was 34 years (not active diversion of water into the Mt Charlotte underground). Predicted flow rates into Fimiston Pit after this time was 33 kL/day.

3. GEOCHEMICAL CHARACTERISATION METHODS

3.1 ACID FORMING WASTE CLASSIFICATION METHODOLOGY

There is no simple method to define whether mine waste containing small quantities of sulfur will produce sulfuric acid. Sulfide minerals are variable in their behaviour under oxidising conditions and not all forms will produce sulfuric acid (H_2SO_4). Instead, a combination of approaches is often applied to more accurately classify mine waste. These approaches are listed below in order of increasing data requirements (and therefore increased reliability):

- The "Analysis Concept", which only requires data for total sulfur content. Its adoption is based on long term experience of wastes from Western Australian mine sites in arid and semi-arid conditions. Experience has shown that waste rock containing very low sulfur contents (less than 0.2 to 0.3%) rarely produces significant amounts of acidic seepage.
- The "Ratio Concept", which compares the relative proportions of acid neutralising minerals (measured by the Acid Neutralising Capacity (ANC)) to acid generating minerals (measured by the Maximum Potential Acidity (MPA)). Experience has shown that the risk of generating acidic seepage is generally low when this ratio (the Neutralisation Potential Ratio – NPR) is above a value of two.
- Acid-Base Accounting, in which the calculated value for Nett Acid Producing Potential (NAPP) is used to classify the acid generating potential of mine waste. NAPP is equal to the MPA minus the ANC.
- Procedures recommended by AMIRA (2002), which take into consideration measured values provided by the Nett Acid Generation (NAG) test and calculated NAPP values.
- Kinetic leaching column test data, which provides information for the relative rates of acid generation under controlled laboratory conditions, intended to simulate those within a waste rock dump (WRD) or tailings storage facility (TSF).

A sound knowledge of geological and geochemical processes must also be employed in the application of the above methods.

Classification of wastes in this report uses procedures recommended by AMIRA (2002) based on NAPP and NAGpH results. However, results are also compared to the Analysis Concept (total sulfur) and Ratio Concept models and a modification of the AMIRA procedure by determination of the following:

- Analysis for total sulfur (Tot_S) and sulfate sulfur (SO_4_S), both reported as sulfur, as a measure of oxidisable sulfur. Alternatively, Chromium Reducible Sulfur (CRS) can be used a direct measure of oxidisable sulfur and is potentially a better method for lithologies with significant organic carbon such as shales and slates.
- Analysis for ANC (quoted in kg H_2SO_4/t).
- Calculation of carbonate neutralising potential (CarbNP) (quoted in kg H_2SO_4/t) from measured concentrations of carbon.
- Calculation of Acid Production Potential (AP) = [(Tot_S – SO_4_S) * 30.6] kg H_2SO_4/t. Chromium Reducible Sulfur (CRS) can be used in place of total sulfur minus sulfate sulfur in this calculation of AP.
- Calculation of NAPP = [AP – ANC] kg H_2SO_4/t.
- Calculation of Effective NAPP = [AP – CarbNP] kg H_2SO_4/t.
- Analysis for NAG (quoted in kg H_2SO_4/t).
- Analysis for NAGpH.
- Calculation of NPR = ANC/AP.

This AMIRA approach is more conservative than either the Analysis Concept or the Ratio Concept alone, but assumes the absence of sulfur present as barium sulfate. The AMIRA approach of using NAG testing is particularly useful for PAF-LC materials or where there is very low ANC in the host rock. A combined acid generation classification scheme based on NAPP and NAG determinations is presented in Table 2.

Table 2: Waste Classification Criteria

Primary Geochemical Waste Type Class	NAPP Value kg H_2SO_4/t	NAGpH	Sulfide S Content
Potentially Acid Forming (PAF)	≥10	< 4.5	≥ 0.3%
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	< 4.5	0.16 to 0.3%
Uncertain (UC)	0 to 5	> 4.5	Not important
Uncertain (UC)	-10 to 0	< 4.5	Not important
Non Acid Forming (NAF)	-100 to 0	> 4.5	Not important
Acid Consuming (AC)	< -100	> 4.5	Not important

Table 2 is based on the Australian Government's Guidelines on Managing Acidic and Metalliferous Drainage (DIIS 2016) and is in turn based on an earlier classification system included within the AMIRA ARD Test Handbook (AMIRA 2002), which is advocated by the Global Acid Rock Drainage Guidelines (GARD) published by the International Network for Acid Prevention (INAP 2009). This classification system, based on static acid base accounting procedures and used in conjunction with geological, geochemical and mineralogical analysis can still leave materials classified as 'uncertain' where there is conflicting NAGpH and NAPP results. Uncertain materials demonstrating a NAGpH above 4.5 may be tentatively assigned as potentially NAF and those below pH 4.5 as potentially PAF – however in such cases, further assessment, such as the use of kinetic leaching columns may be required to provide a definitive classification.

3.2 LABORATORY METHODS

Representative samples from NOB and LHSO were collected by MBS and submitted to Intertek Genalysis which holds accreditation with the National Association of Testing Authorities (NATA). Collated results of all analysis are presented in Appendix 1 and original lab reports attached in Appendix 2.

3.2.1 Acid Base Accounting

All samples collected were screened for total sulfur and carbon as well as ANC. Full ABA analysis (namely sulfate-sulfur and NAG analysis) was only conducted on samples containing greater than or equal to 0.2% total sulfur (Analysis Concept).

ANC was measured by a modified Sobek procedure (AMIRA 2002), which involves addition of dilute hydrochloric acid to the sample, followed by gentle simmering (two hours) to complete the reaction. The ABA scheme relies on measurement of oxidisable sulfur. The value of this fraction of sulfur in mine waste samples is calculated as the difference between total sulfur and sulfate-sulfur, which is present in a fully oxidised form and therefore not capable of generating additional acidity. Sulfate-sulfur content was determined by a heated hydrochloric acid extraction and Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES) finish. CRS was also measured on selected samples (Kapai slate) in conjunction with total sulfur and sulfate-sulfur. CRS provides a direct measurement of sulfide-sulfur (instead of calculation of total oxidisable sulfur (TOS) as the difference between total sulfur and sulfate sulfur). Kapai Slate samples are expected to contain organic sulfur forms which do not generate acid upon oxidation. CRS measurement therefore can provide a more accurate prediction of sulfide sulfur and hence acid generation potential compared to calculation of TOS.

When assessing data for the MPA and NAPP, it must be noted that both parameters are based on the assumption that all sulfur contained in the sample is acid producing (sourced from pyrite (FeS_2) and other iron sulfide minerals). However, this represents a worst case scenario as not all minerals containing sulfur will result in acid production. Conversely, the NAPP calculation also assumes that the acid neutralising material measured in ANC is rapid-acting. In practice, some neutralising capacity is supplied by silicate and aluminosilicate minerals which can be much slower to react. Further still, iron carbonate minerals such as siderite ($FeCO_3$) have limited or no capacity to neutralise acidity due to acid producing reactions resulting from oxidation of the dissolved ferrous iron component. Despite these assumptions, NAPP remains a suitable conservative prediction of potential acid generation when used in conjunction with mineralogical data.

The NAG test involves the addition of hydrogen peroxide, a strong oxidising agent, to a sample of mine waste to oxidise reactive sulfides. After cooling the sample pH is measured (NAGpH) and any acidity generated measured by back titrating with sodium hydroxide solution to a pH of 4.5 (NAG to pH 4.5) and pH 7 (NAG to pH 7). NAG is expressed in units of kg H_2SO_4/t. A significant NAG result (i.e. final NAGpH less than 4.5) generally indicates that the sample is PAF (Table 2) and the test provides a direct measure of the NAG potential. A NAGpH of 4.5 or more generally indicates that the sample is NAF, but may still be capable of generating metalliferous drainage following oxidation of the sulfide minerals. Results for titrations of aliquots of the NAG solution to endpoint pH values of 4.5 and 7.0 allow estimation by the difference between these results of the relative amounts of non-acid producing base metal (such as copper) and iron sulfides in the sample.

3.2.2 Water and Dilute Acid Extractable Leach

Selected samples were subjected to a water extraction (deionised, 1:5 extraction ratio) to assess potentially soluble species from waste rock. The Australian Standard Leaching Procedure (ASLP, 1:20 ratio) was also performed on selected samples using dilute acetic acid (pH 2.9) as the extraction fluid. This test was performed to simulate seepage quality expected under mild acidic conditions which may be achieved by severe oxidation of sulfide minerals.

3.2.3 Elemental Composition

Environmentally significant metals and metalloids were measured following digestion of a finely ground sample with a mixture of four acids (hydrochloric, nitric, perchloric and hydrofluoric acids) which is a near total determination for the elements measured.

From this data, the global abundance index (GAI) for each element was calculated by comparison to the average earth crustal abundance (Bowen 1979 and AIMM 2001). The main purpose of the GAI is to provide an indication of any elemental enrichment that could be of environmental significance. The GAI (based on a log-2 scale) is expressed in integer increments from zero to six (GARD Guide). A GAI of zero indicates that the content of the element is less than or up to three times the average crustal abundance; a GAI of one corresponds to a three to six fold enrichment; a GAI of two corresponds to a six to 12 fold enrichment and so forth, up to a GAI of six which corresponds to a 96-fold, or greater, enrichment above average crustal abundances. A GAI of more than three is considered significant and may warrant further investigation. Results have been truncated to show no more than a GAI of six.

3.2.4 Mineralogy

Six samples in total, from both NOB and LHSO, representing each of the fresh lithological units (Williamstown dolerite, Porphyry, Devons Consol basalt, Kapai slate, Hannans Lake serpentinite and Golden Mile dolerite) were chosen for mineralogical determination. These samples were submitted to Intertek Genalysis Laboratory Services for a quantitative powder XRD of the crystalline and amorphous contents. Samples were further ground to a very fine powder in an agate mortar and pestle and subsampled for analysis with and without addition of zinc oxide (solid dilution 10% by weight) to determine amorphous content. XRD patterns were then collected on PANalytical Cubix wavelength dispersive XRD with quantitative analysis performed using an automated Rietveld method of correction. Full experimental details are provided in the mineralogical laboratory report presented in Appendix 2

4. PREVIOUS STUDIES ON GMD AND BF SHALE

GMD and BF shale in NOB occur as part of the same mineralisation event present in Fimiston Pit and results of previous geochemical characterisations for these lithologies within Fimiston Pit are therefore relevant to this study. A summary of previous findings for GMD and BF shale is given below.

4.1 GOLDEN MILE DOLERITE

A review of three previous Fimiston Pit geochemical studies (MBS 2016) and assay data for the GMD lithology (MBS 2017) indicated GMD is geochemically benign. A summary of previous findings for this lithology in Fimiston Pit is provided below:

- Assay data from 101,751 samples indicated the majority (54%) contained total sulfur concentrations of less than 0.3%. The median was 0.26% and 90th percentile 1.81%.
- Calculated MPA based on 90th percentile concentration (1.81%) was 50 kg H_2SO_4/t, which was significantly less than the average ANC of 171 kg H_2SO_4/t measured from 27 samples.
- Mineralogical analysis by XRD identified trace/accessory levels of pyrite in four samples and significant concentrations of ankerite as the dominant carbonate mineral able to provide substantial ANC consistent with the results above.
- All GMD samples were classified as NAF, with the majority being further classified as acid consuming due to low sulfur content and high ANC. Neutral to mildly alkaline pH and low to moderate salinity levels will therefore result in any seepage water generated.
- Environmentally significant metals and metalloids were very low; with enrichment noted for gold, silver, antimony and some samples for mercury. Given the local geology, tellurium was also expected to be enriched, although it was not included in the analysis suite for these studies. Concentrations and expected solubilities of metals and metalloids were not considered a risk to the receiving environment.
- GMD was considered suitable for rock armouring or construction purposes, given its benign geochemical nature and physical competence. Results also indicated it would be suitable for PAF encapsulation on an above ground waste landform given its high ANC content.

4.2 BLACK FLAG SHALE

A review of three previous Fimiston Pit geochemical studies (MBS 2016) and additional characterisation work for the BF shale lithology (MBS 2017) indicated variable total sulfur contents, generally dependant on the material's position within the shale seam. This position therefore determines the AMD properties of this minor lithology which comprises 1.3% of the NOB waste material. A summary of findings for the BF shale lithology in Fimiston Pit is provided below:

- Assay data from 2,687 samples indicated a median sulfur content of 1.98% and 90th percentile sulfur content of 5.49%.
- Due to the presence of organic sulfur, total sulfur concentrations tend to overestimate the amount of oxidisable sulfur and CRS was found to be a better measure of oxidisable sulfur. The proportion of CRS to total sulfur was however relatively consistent for the 15 fresh rock samples assessed for CRS at an average of 84% of total sulfur.
- The ratio of oxidisable sulfur (in the form of pyrite) to ANC (in the form of ankerite) was generally dependant on the material's position within the BF Shale bed. The central six metres of the BF Shale bed was found to be the dominant sulfide/lower ANC zone, but 'fingers' of sulfides and carbonates occurred outside this zone as well. Siderite (iron carbonate) was also present in various samples, but this mineral does not contribute to ANC.

- Due to the spatial and compositional variability of the BF Shale material, some inherent variability in the potential to oxidise and generate AMD was observed across all studies. This included bulk container field trials over 11 years at KCGM.
- Overall, based on estimations from total sulfur content and measured NAGpH, it is predicted that BF shale waste with between 2 and 4% sulfur may be classified as PAF. This represents between 19 and 50% of BF shale waste which, under worst case scenario exposure conditions, may generate AMD.
- BF shale was enriched in various metals and metalloids (Au, Ag, Hg, Te, Sb, Se, Cd, Cu, Zn in particular) at levels significantly higher than present in the surrounding GMD and Paringa basalt. Concentrations were consistent with those expected for material within or approaching the lode zone. Samples of fresh rock BF shale contained low concentrations of soluble metals and metalloids and leachates were circum-neutral to alkaline, with low to moderate salinity. Extreme weathering under worst case exposure conditions of PAF-HC material still did not release soluble Hg, Te or Sb. Primary metals released with acid formation were Al, Mn, Fe, Cu, Ni, Co and Zn.
- Sulfide oxidation rates were very slow, resulting in a significant lag period before acid generation occurs. There was also significant ANC within the host rock, such that net acid generation and associated metals leaching should only be possible after very prolonged exposure.

Operating guidelines at KCGM have been implemented to treat all BF shale as PAF and ensure correct placement and encapsulation within surrounding mafic waste rock within the WRDs. Given this, prolonged exposure of BF Shale leading to acid generation is considered unlikely.

5. REVIEW OF LHSO ASSAY DATA BY LITHOLOGY

LHSO sulfur assay data measured by X-Ray Fluorescence (XRF) during drilling programs were provided to MBS for review as part of this report. A summary of this data for waste rock by lithology is outlined in Table 3. A histogram of sulfur content for key example lithologies of WD and KS are shown in Chart 1 and Chart 2, respectively. Key points noted are as follows:

- GMD assay data was very similar to or slightly lower than previous results from Fimiston Pit (Section 4.1, MBS 2017) which again indicates a low risk of AMD formation, assuming similar levels of ANC.
- HLS (logged in drilling, but not part of waste rock for LHSO) was very low in sulfur with 71% of samples recording concentrations at or below the 0.3% sulfur content (Table 3) stipulated by the 'Analysis Concept'. These samples therefore pose a very low risk of generating AMD.
- WD, DCB and POR, which are the major waste rock lithologies for LHSO, contained similar, relatively low concentrations of sulfur. Approximately 66% of WD samples, for example, contained less than or equal to 0.3 % sulfur. This lithology represents 64% of LHSO waste rock by tonnage.
- Sulfur in KS (Chart 2) was more variable with significantly higher average and 90th percentile concentrations. Although a minor lithology (1.2% of LHSO waste tonnage), this material clearly has significant potential for acid formation.

Table 3: Sulfur (%) Summary for LHSO Drilling Assays

Lithology	# Samples	Average	Median	90th Percentile	Maximum	% At or Below 0.3 %S of Analysis Concept
WD	11,609	0.66	0.11	1.69	36	66
DCB	11,828	0.83	0.13	2.00	58	61
POR	2,918	0.85	0.46	2.03	30	44
KS	601	7.39	6.73	17.9	35	31
HLS	433	0.37	0.08	1.0	5.7	71
GMD	3,395	0.46	0.05	1.3	22	76

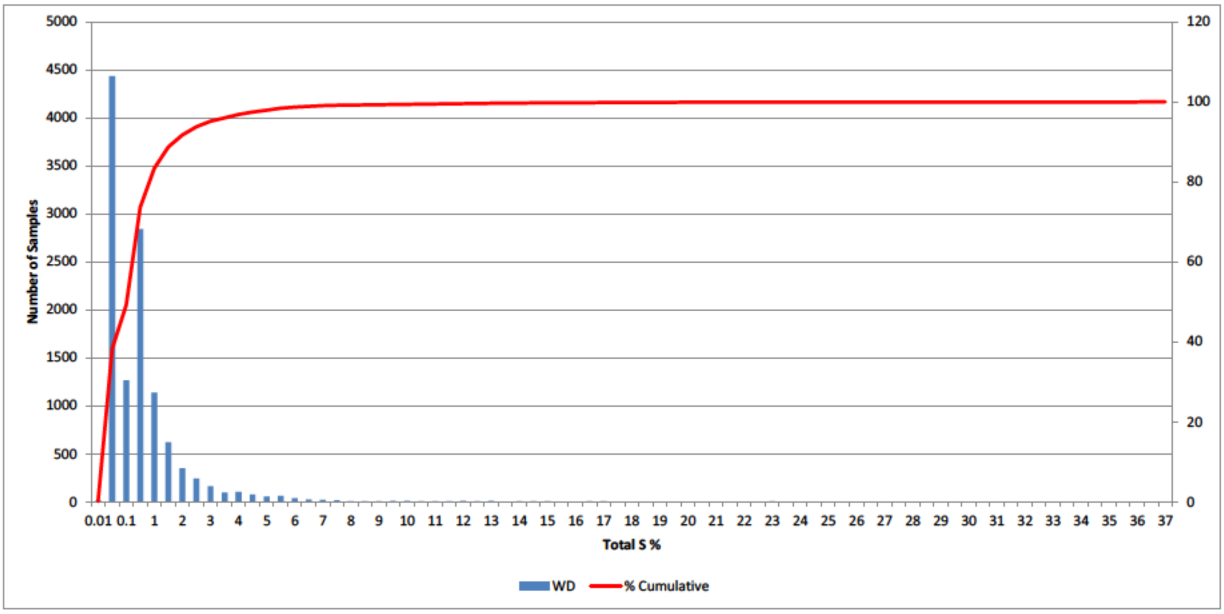

Chart 1: Frequency Histogram of Total Sulfur in WD Assay Samples

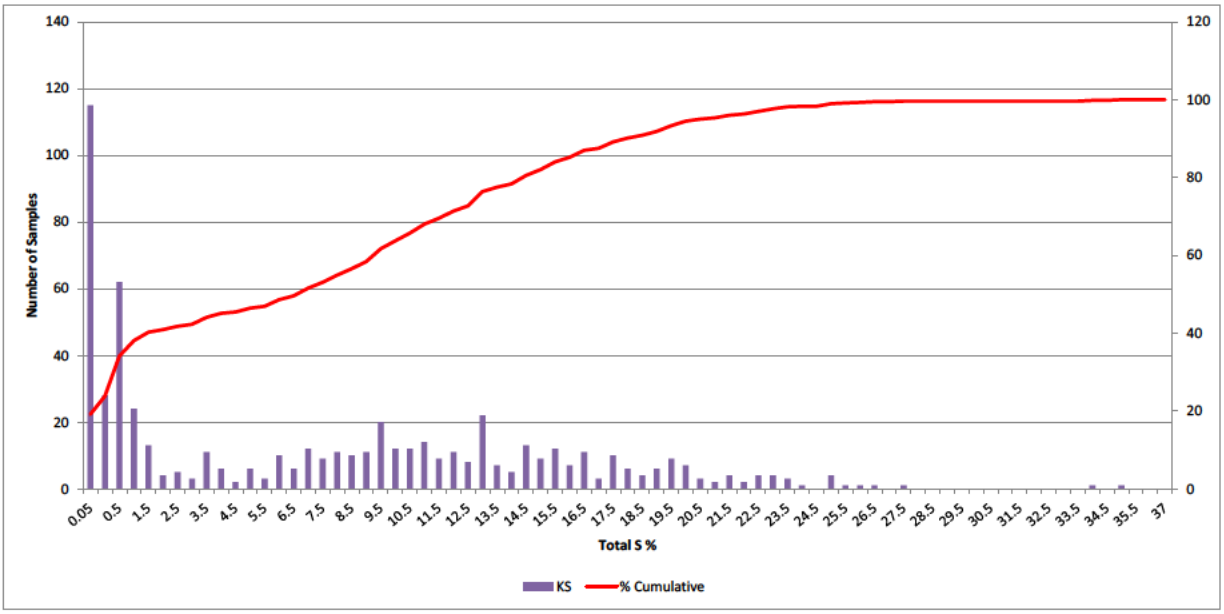

Chart 2: Frequency Histogram of Total Sulfur in KS Assay Samples

6. DESCRIPTION OF SAMPLES

Following a desktop review of available drill log and assay data provided by KCGM personnel, MBS collected 27 representative core samples representing various waste lithologies associated with the LHSO and NOB orebodies at the Mt Charlotte underground mine. Hannans Lake serpentinite, although outside current planned mining zones, was also sampled so as to include all lithologies in the area. NOB waste rock consists entirely of GMD and minor (1.3%) BF shale and is considered geochemically similar to waste rock from Fimiston Pit, properties of which were outlined in Section 4. Consideration of these previous study results thus influenced sampling for current Mt Charlotte waste characterisation with only four samples of GMD from the NOB extension sampled in order to confirm consistency of properties with Fimiston Pit studies. One of these samples (NOBREG), represented weathered regolith – all other samples for the study of NOB and LHSO were of fresh rock consistent with the proposed mining zone. Samples were selected across the range of mining depths, lithologies and sulfur contents considered to be representative of waste rock. A summary of samples collected from the LHSO and NOB by lithology is given in Table 4. Full descriptions are provided in Table A1-1 of Appendix 1.

Table 4: Sample Descriptions

Lithology	Depth Range (m)	Total Samples Collected
Lower Hidden Secret Orebody (LHSO)		
Williamstown dolerite (WD)	28 to 373	5
Porphyry (POR)	55 to 398	4
Devons Consol basalt (DCB)	31 to 330	5
Kapai slate (KS)	70.5 to 502	5
Hannans Lake serpentinite (HLS)	52 to 481	4
Total samples collected from LHSO		**23**
Northern Orebody (NOB)		
Golden Mile dolerite (GMD)	12 to 230	4
Total samples collected from NOB		**4**

7. RESULTS AND DISCUSSION

7.1 ACID BASE ACCOUNTING

Laboratory results for total sulfur, CRS, ANC, NAG testing and calculated acid base accounting parameters of the NOB and LHSO samples are collated in Table A1-2 of Appendix 1. The original laboratory reports are included in Appendix 2.

7.1.1 Sulfur Forms

A summary of results for the three sulfur forms assessed is provided in Table 5.

Table 5: Sulfur (%) Forms Summary

Lithology	# Samples	SO_4_S Range	SO_4_S Mean	Total S Range	Total S Mean	CRS Mean*
WD	5	<0.01 to 0.01	<0.01	0.13 to 3.6	1.1	N/A
DCB	5	<0.01	<0.01	0.55 to 1.4	1.1	N/A
POR	4	<0.01	<0.01	0.12 to 1.4	0.80	N/A
KS	5	0.03 to 0.15	0.07	6.2 to 21.6	12.6	10.0
HLS	4	<0.01	<0.01	0.24 to 1.1	0.50	N/A
NOB GMD	4	<0.01 to 0.02	<0.01	0.02 to 1.09	0.40	N/A

**N/A Indicates not analysed.*

As CRS is considered a better indicator of oxidisable sulfide content for KS samples, the ABA parameters AP and NAPP were calculated from CRS for these samples rather than as total sulfur minus sulfate sulfur in Table A1-2.

Based on the data in Table 5, and Tables A1-1 and A1-2 (Appendix 1), the following are noted as key points:

- CRS, on average, accounted for 79% of the total sulfur present in KS, which was very similar to the 84% observed in BF shale samples (MBS 2017). Total sulfur in these samples includes organic sulfur which does not oxidise to form acid and can therefore result in misleading ABA parameters (high bias).
- Consistent with samples being from the fresh rock zone (apart from NOB REG), levels of sulfate were generally very low to non-detectable.
- Levels of total sulfur were approximately consistent with the overall trends seen from assay analysis (Section 5), with KS having significantly higher total sulfur contents and noted field reactivity versus the others which was reflected in higher sulfate levels for these samples.

7.1.2 Acid Neutralisation Capacity

ANC was measured directly by acid addition, heating and back-titration. Results are provided in Table 6 together with acid production potentials for each lithology, calculated from overall mean sulfur assays (Table 3). Carb-NP results (calculated from the measured total carbon analysis), are given in Table A1-2 (Appendix 1).

Table 6: ANC Versus Mean AP From Total Sulfur Assays (kg H_2SO_4/t)

Lithology	# Samples	ANC Minimum	ANC Maximum	ANC Mean	AP Mean
WD	5	204	422	299	20
DCB	4	216	419	310	16
POR	5	74	179	104	26
KS	5	10	145	84	226
HLS	4	243	480	350	11
NOB GMD	4	21	228	132	14

Based on the data in Table 6, and Table A1-2 (Appendix 1), the following are noted as key points:

- ANC levels were high to very high in all samples from all lithologies, but in particular WD, DCB and HLS. WD and DCB are the dominant waste lithologies by tonnage from LHSO (Table 1).
- KS had the lowest levels of ANC and was the only lithology to have mean ANC levels below the calculated AP from sulfur assay data. For other lithologies, the mean ANC of samples from this work were between 4 and 32 times the level of AP calculated from sulfur assays in the KCGM database.
- For most samples there was very good agreement between the measured ANC and the calculated Carb-NP, which is consistent with readily available carbonates contributing to the ANC. The KS lithology showed marginally more variation which is considered to be due to the presence of organic carbon.

7.1.3 Acid Drainage Classification

AMD classifications based on criteria in Table 2 are outlined in Table A1-2 of Appendix 1. Classifications for samples with more than 0.2% sulfur are represented as a plot of NAPP (CRS used for KS) versus NAGpH for the samples grouped by lithology in Chart 3. The four quadrants are labelled as NAF, PAF and two UC (uncertain) according to the classification criteria in Table 2.

Based on examination of these results, the following can be noted:

- All lithologies other than KS (and BF shale which was previously discussed in section 4.2), from Mt Charlotte were classified as NAF with measured NAGpH values of greater than 4.5 for those measured (more than 0.2% total sulfur). In addition due, to the very high levels of ANC relative to oxidisable sulfur, many were further classified as 'acid consuming' (AC). All samples of WD, DCB and HLS were thus classified as AC. Two of the three fresh rock GMD samples and one of the four POR samples were also classified as AC.
- Four out of the five KS samples were classified as PAF – high capacity. This was a result of high levels of oxidisable sulfur and somewhat lower levels of ANC. One KS sample (KS 2), had a conflicting slightly positive NAPP (35 kg H_2SO_4/t), but a reported NAGpH value of 7.4, resulting in an uncertain classification (UC). As indicated previously, the reactive nature of KS was noted in oxidation and visible acid formation in the drill core trays exposed at KCGM.

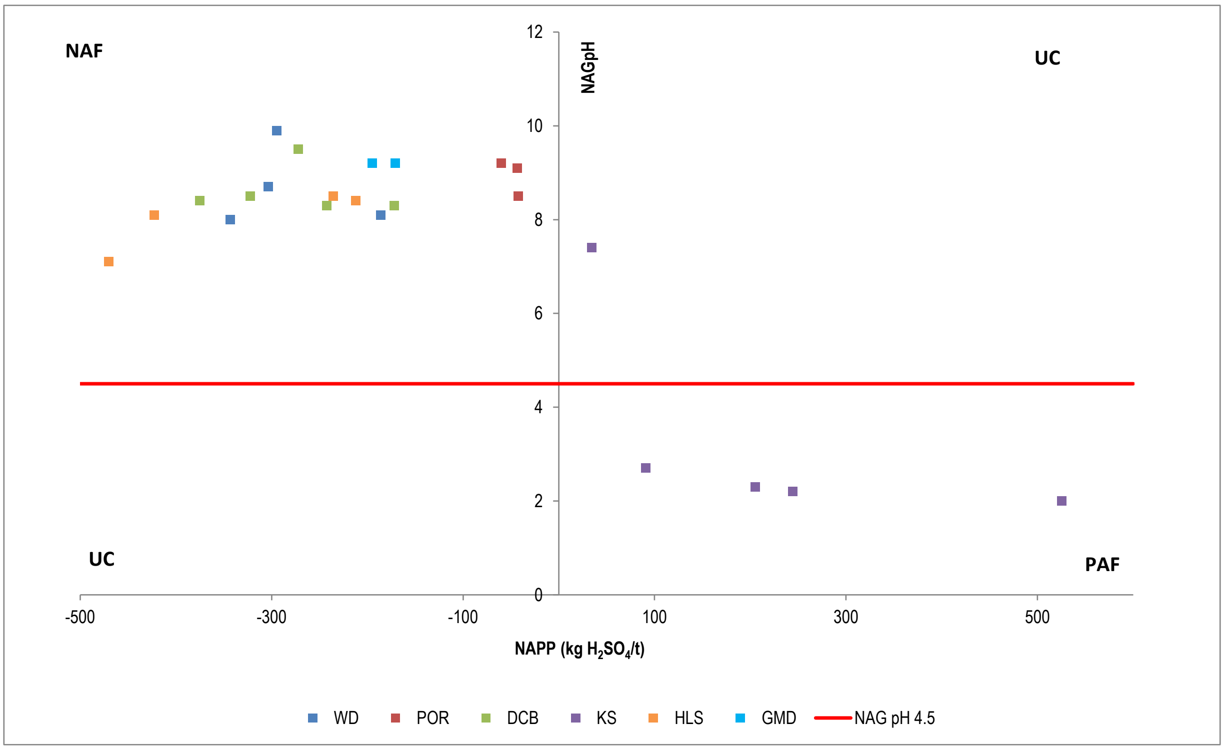

Chart 3: AMD Plot Classifications of Mt Charlotte Lithologies

7.2 ELEMENTAL COMPOSITION

Total elemental composition of selected (, Mt Charlotte waste rock samples (four of each lithology) is presented in Table A1-3 of Appendix 1. Tables A1-4 of Appendix 1 presents calculated GAI values for these samples, as outlined in Section 3.2.3. A summary of results for enriched (GAI of three or more) samples is provided in Table 7.

Key points noted are as follows:

- Consistent with previously discussed observations regarding LHSO mineralisation (Section 2.1), silver, tellurium and antimony were found to be generally enriched across most to all samples. Hessite (Ag_2Te), which is a key mineral associated with gold mineralisation in LHSO (Section 2.1), accounts for the enrichment in silver and tellurium. Gold was not assessed in the current work and lode zone samples were not targeted, but it is expected that concentrations of these and other elements would also be correlated with gold concentration and increase with proximity to the lode zone.
- Mercury, zinc and copper were not found to be enriched within LHSO waste lithologies, indicating these elements are closely associated with the mineralisation event versus the host rock.
- KS was enriched in a number of elements at concentrations generally similar to those observed for BF shale in Fimiston Pit studies. This included arsenic (one sample), cadmium, copper, mercury, selenium and tin. Mercury in BF shale and Fimiston ore is present primarily as coloradoite (HgTe) which is highly insoluble (CSIRO 2013). Coloradoite is also expected to be the dominant form of mercury in KS.
- Consistent with the mafic lithology, chromium and nickel were marginally enriched in HLS samples. Chromium was also elevated in two of the four WD samples (WD 2 and WD 3) and one DCB sample (DCB 2). Cadmium was also enriched in sample WD 1.

Overall, all waste lithologies were generally enriched in silver, tellurium and antimony. KS was geochemically enriched in a similar series of elements to BF shale. With the exception of the KS lithology and minor enrichment in chromium for mafic lithologies, enrichment in other metals and metalloids is closely associated with proximity to mineralisation. As an example, copper and zinc are almost absent in waste rock other than KS.

Table 7: Mt Charlotte Enriched Metals and Metalloids

Metal	Maximum Concentration (mg/kg)	Maximum GAI	Enriched Lithology
Silver	6.9	6	All except HLS
Arsenic	487	4	KS (1 sample)
Cadmium	16	6 (3 in WD)	KS and WD (1 sample)
Chromium	1,889	4	WD, DCB, HLS
Copper	2,524	5	KS
Mercury	23	3	KS
Nickel	1,030	3	HLS
Antimony	17	6	All
Selenium	17	6	KS
Tin	17	3	KS
Tellurium	5.9		All
Zinc	7,256	6	KS and WD

7.3 WATER LEACHATE CHARACTERISATION

7.3.1 Soluble Salts, Alkalinity and pH

Results for pH, EC, alkalinity and major ions in the 1:5 water extracts of selected samples are given in Table A1-5 of Appendix 1. Results for 1:5 extract pH and EC of all samples are also shown in Table A1-2 of Appendix 1.

Samples of fresh waste rock from Mt Charlotte underground were found to have:

- Generally alkaline pH values, ranging from 8.6 to 9.4 in 1:5 extracts of fresh rock. The only exceptions were samples of partially oxidised KS, where pH values ranged from 4.9 to 8.3.
- Moderate to high levels of soluble alkalinity in most samples, with DCB having the highest levels (up to 128 mg/L as $CaCO_3$). Again, the only exception was KS, which contained low concentrations (3 to 30 mg/L as $CaCO_3$).
- Relatively low levels of salinity and soluble salts in fresh rock waste samples with most samples having 1:5 EC values below 200 µS/cm.
- Slightly higher levels of salinity were found in the sample of weathered GMD (GMD REG) with 434 µS/cm and KS 1 and KS 2 (maximum 578 µS/cm), both of which had visible signs of oxidation from field exposure.
- Sulfate was the dominant anion rather than chloride, with significant calcium and magnesium as well as sodium present as the dominant cations.

Overall, results suggest that with the exception of isolated pockets of minor KS lithology, the salinity of waste rock placed underground post mining will remain low and any leachate will be alkaline in nature.

7.3.2 Soluble Metals and Metalloids

Results for water soluble metals and metalloids in the 1:5 extracts of samples are given in Table A1-6 of Appendix 1. ANZECC livestock drinking water guidelines (cattle) are provided for comparison, although it is noted that groundwater is far too saline for use other than as process water.

Key observations are summarised below.

- Despite geochemical enrichment in a variety of elements, no metal or metalloid concentrations in the 1:5 extracts of fresh (non-oxidised) waste rock samples exceeded livestock drinking water guidelines. Concentrations of silver and tellurium which were enriched in the waste rock samples, but have no livestock drinking water guideline, were also very low or not detectable.
- Only low concentrations of antimony were noted in 1:5 extracts (maximum 12 µg/L), despite geochemical enrichment of this element of most samples. There is no corresponding guideline for antimony, but it has a similar or slightly higher toxicity than arsenic, for which the livestock guideline is 500 µg/L. Measured concentrations therefore are not considered to pose any risk to the receiving environment.
- Sample KS 1 which was already partially oxidised by field exposure in the core yard for several years recorded a pH of 4.9 and the 1:5 extract slightly exceeded the ANZECC livestock drinking water guidelines for cadmium (23.6 µg/L) and zinc (28.7 mg/L). However these results:
    - Would not exceed guidelines of 10 µg/L (cadmium) and 20 mg/L (zinc) using the ASLP dilution ratio of 1:20 instead of 1:5. The 1:5 dilution ratio is commonly used to provide better sensitivity for minor elemental concentrations, but obviously magnifies results.
    - Represent samples after several years of exposure to weathering. Such conditions are unlikely to be replicated for such periods of time in the Mt Charlotte underground.
    - Do not reflect placement conditions in the Mt Charlotte underground where surrounding high ANC rock will control pH, generating more alkaline conditions and hence limit solubility of cadmium in particular.

Overall, minimising the rate of oxidation of the minor volume of KS waste rock by placement underground, in conjunction with the high ANC waste rock of other LHSO lithologies, should control any risk to receiving groundwater of soluble metals and metalloids.

7.4 DILUTE ACID LEACHATE CHARACTERISATION

Dilute acetic acid leachate tests provide an indication of the acid neutralising minerals and metals which may be released if management measures for control of oxidation of sulfides and acid formation were not applied. Results for selected samples of Mt Charlotte waste rock are presented in Table A1-7 of Appendix 1.

Under the acidic conditions of this test (starting pH 2.9, final pH 4.1 to 5.2) the following was noted:

- Calcium, iron and magnesium were the major cations solubilised by contact with acid which is consistent with the presence of reactive carbonate minerals such as ankerite, dolomite and calcite. Calcite and ankerite are often observed to be slightly more reactive than dolomite under laboratory conditions and hence will be the first to react to neutralise acid.
- Despite geochemical enrichment in various elements and the acidic conditions of the extract, soluble concentrations of all metals and metalloids of environmental concern were very low. All concentrations were below the livestock drinking water guidelines with the exception of lead in sample KS 2 (148 µg/L versus livestock guideline of 100 µg/L).
- Lead (148 µg/L) and antimony (14 µg/L) in KS 2 were the main notably elevated elements for the acetic acid leachates of samples. However, such concentrations from isolated amounts of KS are considered unlikely given the underground disposal regime, limited exposure to oxygen and buffering capacity of surrounding rock.

Results suggest the most significant metals and metalloids which may be released as a result of uncontrolled oxidation without neutralisation of KS waste rock will be lead, zinc, cadmium and antimony. Mercury was not significantly soluble which is consistent with observations from BF shale (MBS 2017). It is important to reiterate the fact that elemental concentrations presented in Table A1-7 are not a prediction of net expected concentrations of actual seepage, but an indication of acid neutralisation reactions and species that may be solubilised under acid conditions prior to any neutralisation and precipitation by interactions with surrounding rock.

7.5 MINERALOGICAL ASSESSMENT

Results for the mineralogical assessment of the crystalline and amorphous content of six samples from the fresh rock zone are summarised in Table 8. The quantitative X-ray diffraction analysis report is provided in Appendix 2.

Results indicate the following key points:

- Pyrite was the only acid forming mineral present which confirms the validity of AP calculations based on oxidisable sulfur contents.
- Very high amounts of readily available acid neutralising carbonate minerals were present, namely as ankerite, ferroan magnesite, dolomite and calcite, depending on the lithology (refer Glossary Section 10). With the exception of KS, quantities of these carbonate materials far exceeded the pyrite content which is consistent with the NAF and often acid consuming classification of WD, POR, DCB, HLS and GMD lithologies.
- Other minerals present in significant concentrations included quartz, plagioclase and chlorite which are either non-reactive or mildly acid neutralising (chlorite).

Table 8: Mineralogical Summary

Sample	AMD Class	Mineral Content (%)
WD 3	NAF (AC)	Quartz (29), ferroan magnesite (35), sodium calcium plagioclase (10), chlorite (6), ankerite (13), pyrite (4), illite/muscovite (1), potassium feldspar (1). Amorphous content 3%
POR 1	NAF	Quartz (29), sodium calcium plagioclase (35), dolomite (7), pyrite (2), illite/muscovite (24). Amorphous content 2%
DCB 2	NAF (AC)	Quartz (28), ferroan magnesite (40), sodium calcium plagioclase (9), chlorite (3), dolomite (12), pyrite (2), illite/muscovite (4), potassium feldspar (1). Amorphous content 1%
KS 2	UC	Quartz (67), sodium calcium plagioclase (2), ankerite (14), siderite (4), pyrite (9). Amorphous content 4%
HLS 3	NAF (AC)	Quartz (24), sodium calcium plagioclase (1), chlorite (14), ankerite (27), pyrite (2), paragonite (12), illite/muscovite (7). Amorphous content 12%
NOB GMD 3	NAF (AC)	Quartz (25), sodium calcium plagioclase (17), chlorite (25), calcite (10), ankerite (4), pyrite (1), ilmenite (2). Amorphous content 17%

8. CONCLUSIONS

Results of geochemical characterisation and a review of sulfur assay data for Mt Charlotte underground waste rock lithologies indicated:

- Total sulfur concentrations measured in LHSO samples selected for geochemical characterisation were consistent with those measured by XRF during drilling programs, indicating that samples selected were representative of waste rock to be mined at the site.
- Fresh mafic rock lithologies GMD, WD, DCB, POR and HLS are all classified as NAF with alkaline pH, moderate levels of soluble alkalinity and low salinity levels. WD, DCB, HLS and two of the four GMD samples were further classified as being acid consuming, with very high levels of readily reactive carbonate based ANC relative, to oxidisable sulfur concentrations.
- A general enrichment in silver, tellurium and antimony, which is typical of Golden Mile mineralisation and/or the presence of minerals like hessite within LHSO mineralisation. Fresh mafic rock lithologies GMD, WD, DCB, POR and HLS were low in most environmentally significant metals and metalloids and produced very low concentrations of soluble metals and metalloids in both water and acidic leachates. These materials are considered geochemically benign and seepage from them does not pose a risk to the receiving hypersaline groundwater at KCGM.
- Fresh mafic rock lithologies GMD, WD, DCB and POR are considered suitable for use in construction or rock armouring purposes, given the benign geochemical nature and physical competence of this material. The acid consuming nature of the dominant lithologies of LHSO (WD and DCB) which together account for 86% of LHSO waste rock by mass, is also of note when co-disposed underground as backfill with KS.
- Although a minor lithology (1.2% of LHSO waste mass), KS waste rock contained significant levels of oxidisable sulfur and slightly lower levels of ANC and as such was classified as PAF – high capacity (one sample was uncertain). Levels of CRS KS (5.3 to 17.5%) were significantly higher than those in BF shale from Fimiston Pit (0.51 to 10.7 %), although the proportion of oxidisable sulfur to total sulfur was similar for both (approximately 80%).
- KS was the most geochemically enriched Mt Charlotte waste lithology with enrichment in silver, tellurium, antimony (as for mafics), but also mercury, copper, arsenic, selenium, tin, cadmium and zinc. The concentrations and distribution of enriched elements was broadly similar to BF shale from previous studies (MBS 2017). Despite this enrichment, levels of soluble species released during leaching with both water and weak acid were still comparatively low – likely due to insoluble mineral forms being present such as tellurides. It is noted that extreme weathering of geochemically similar PAF BF shale enriched in mercury, tellurium and antimony still did not release soluble fractions of these three elements.
- Overall, co-disposal of the minor portion of KS lithology (1.2% of LHSO waste mass) with surrounding high ANC lithologies from LHSO underground is considered to pose negligible risk of significant oxidation and metals release to groundwater. The potential for surface oxidation of KS material during the operational phase of mining will likely be constrained by limited air flow in backfilled underground stopes away from active ventilation areas and be readily neutralised by the much larger proportion of highly reactive acid consuming waste rock with moderate to high levels of soluble alkalinity. All oxidisation potential will cease after cessation of mining and the recovery of the water table which is expected to cover all such underground waste rock.

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10. GLOSSARY OF TECHNICAL TERMS

Term	Explanation
AC	Acid consuming material.
ANC	Acid Neutralising Capacity. A process where a sample is reacted with excess 0.5 m HCl at a pH of about 1.5, for 2-3 hours at 80-90ºC followed by back-titration to pH=7 with sodium hydroxide. This determines the acid consumed by soluble materials in the sample.
ankerite	A calcium, iron, magnesium, manganese carbonate mineral of general formula $Ca(Fe,Mg,Mn)(CO_3)_2$. In composition it is closely related to dolomite, but differs from this in having magnesium replaced by varying amounts of iron(II) (ferroan ankerite) and manganese(II).
AP	Acid Potential. Similar to MPA, but only is based on the amount of sulfide-sulfur (calculated as the difference between total sulfur and sulfate-sulfur (SO_4-S), or directly as CRS) rather than total sulfur. AP (kg H_2SO_4/t) = (Total S – SO_4-S) x 30.6
Basalt	A dark coloured fine grained mafic extrusive igneous rock composed chiefly of calcium plagioclase and pyroxene. Extrusive equivalent of gabbro, underlies the ocean basins and comprises oceanic crust.
Carb NP	Carbon Neutralising Potential. The amount of ANC provided by carbonate minerals. Carb NP (kg H_2SO_4/t) = TIC (%) x 81.7
CIL	Carbon in Leach – the process of extracting gold from crushed rock by extraction with sodium cyanide solution and adsorption onto activated charcoal.
Circum-neutral pH	pH value near 7.
CRS	Chromium Reducible Sulfur. A measurement of reactive sulfide sulfur normally applied to acid sulfate soils using reaction with metallic chromium and hydrochloric acid to liberate hydrogen sulfide gas which is trapped and then measured by iodometric titration. For certain sample types, it is considered to be a more accurate estimate of oxidisable sulfur for iron sulfides than the difference between total sulfur and sulfate-sulfur (SO_4-S) for calculating Acid potential (AP).
Dolerite	A mafic, holocrystalline, subvolcanic rock equivalent to volcanic basalt or plutonic gabbro
dolomite	Calcium magnesium carbonate $CaMg(CO_3)_2$.
EC	Electrical conductivity. A measurement of solution salinity. Conversion: 1000 µS/cm = 1 dS/m = 1 mS/cm
felsic	Silicate minerals, magma, and rocks which are enriched in the lighter elements such as silicon, oxygen, aluminium, sodium, and potassium.
mafic	Descriptive of igneous rock containing a high content of ferromagnesian silicate minerals, but less than those present in ultramafic rocks. Common mafic rocks include basalt, dolerite and gabbro.
magnesite	Magnesium carbonate ($Mg(CO_3)_2$) or magnesium iron carbonate ($Mg, Fe(CO_3)_2$), the latter is termed ferroan magnesite.
MPA	Maximum Potential Acidity. A calculation where the total sulfur in the sample is assumed to all be present as pyrite. This value is multiplied by 30.6 to produce a value known as the Maximum Potential Acidity reported in units of kg H_2SO_4/t. MPA should include only the non-sulfate sulfur to avoid over-estimation of acid production in which case it may be referred to as AP.
NAF	Non Acid Forming

Term	Explanation
NAG	Net Acid Generation. A process where a sample is reacted with 15% hydrogen peroxide solution at pH = 4.5 to oxidise all sulfides and then time allowed for the solution to react with acid soluble materials. This is a direct measure of the acid generating capacity of the sample but can be affected by the presence of organic materials.
NAPP	Net Acid Producing Potential. NAPP (kg H_2SO_4/t) = AP – ANC. NAPP (kg H_2SO_4/t) = AP – ANC
effective NAPP	NAPP calculated using CarbNP rather than traditional ANC. Effective NAPP (kg H_2SO_4/t) = AP – CarbNP
PAF	Potentially Acid Forming. A sample is classified as PAF if the NAGpH is less than 4.5 and NAPP is positive (i.e. AP is greater than ANC).
PAF-LC	Potentially Acid Forming – Low Capacity. Waste rock classification for samples with NAPP values less than or equal to 10 kg H_2SO_4/t.
PAF-HC	Potentially Acid Forming – High Capacity. Waste rock classification for samples with NAPP values greater than 10 kg H_2SO_4/t.
pyrite	Iron (II) sulfide, FeS_2. Pyrite is the most common sulfide minerals and the major acid forming mineral oxidising to produce sulfuric acid.
siderite	Iron (II) carbonate $FeCO_3$. Siderite reacts with acid to release ferrous ions (pale green) which then oxidise to ferric (brown) and this in turn generates acidity equal to the initial acid consumption by carbonate. It therefore does not overall contribute to ANC.
TIC	Total Inorganic Carbon.
XRD	X-Ray Diffraction. A laboratory technique used to identify and quantify crystalline mineral phases in geological materials measuring diffraction angles and patterns from a finely ground sample.
XRF	X-Ray Fluorescence. An analytical technique that measures elemental composition by the detection of fluorescent (or secondary) X-rays emitted from the elements after irradiation by an X-ray source.

APPENDICES

APPENDIX 1: COLLATED RESULTS

LIST OF APPENDIX TABLES

Table A1-1: Sample Descriptions

Sample ID	Orebody	Lithology	Grouping	Drill Hole ID	Depth (m)
WD 1	LHSO	Willamstown Dolerite	WD	UGHS144	28-30
WD 2	LHSO	Willamstown Dolerite	WD	UGHS012	280-282
WD 3	LHSO	Willamstown Dolerite	WD	UGHS154	87-89
WD 4	LHSO	Willamstown Dolerite	WD	UGHS007	325-327
WD 5	LHSO	Willamstown Dolerite	WD	UGHS012	371-373
POR 1	LHSO	Porphyry	POR	UGHS012	330-333
POR 2	LHSO	Porphyry	POR	UGHS140	55-57
POR 3	LHSO	Porphyry	POR	UGHS132	56-58
POR 4	LHSO	Porphyry	POR	UGHS010	395-398
DCB 1	LHSO	Devon Consols Basalt	DCB	UGHS012	313-316
DCB 2	LHSO	Devon Consols Basalt	DCB	UNGD010	329-330
DCB 3	LHSO	Devon Consols Basalt	DCB	UGHS140	31-33
DCB 4	LHSO	Devon Consols Basalt	DCB	UGHS140	66-69
DCB 5	LHSO	Devon Consols Basalt	DCB	UGHS132	92-94
KS 1	LHSO	Kapai Slate	KS	UGHS012	356-358
KS 2	LHSO	Kapai Slate	KS	UGHS092	151-154
KS 3	LHSO	Kapai Slate	KS	UGHS010	90-92
KS 4	LHSO	Kapai Slate	KS	UGHS010	500-502
KS 5	LHSO	Kapai Slate	KS	UGHS144	70.5-72
HLS 1	LHSO	Hannans Lake Serpentinite	HLS	UGHS038A	432-434
HLS 2	LHSO	Hannans Lake Serpentinite	HLS	UGHS039	52-54

Sample ID	Orebody	Lithology	Grouping	Drill Hole ID	Depth (m)
HLS 3	LHSO	Hannans Lake Serpentinite	HLS	UGHS039	74-77
HLS 4	LHSO	Hannans Lake Serpentinite	HLS	CKD13m	474-481
GMD REG	NOB	Golden Mile Dolerite Regolith (Transition)	GMD	MC044273	12-13
GMD 1	NOB	Golden Mile Dolerite	GMD	MC04272	40-45
GMD 2	NOB	Golden Mile Dolerite	GMD	MC04273	201-206
GMD 3	NOB	Golden Mile Dolerite	GMD	MC04273	225-230

Table A1-2: Acid Base Accounting

Sample	pH (1:5)	EC (1:5)	Total C	Total-S	CRS	SO4-S	AP	ANC	NAPP	Carb NP	NAG$_{pH4.5}$	NAG$_{pH7}$	NAGpH	NPR Ratio	Classification
	pH Units	µS/cm	%	%	%	%	kg H_2SO_4/t						pH units		
WD 1	9.4	82	2.61	0.75	N/A	<0.01	23	209	-186	213	0	0	8.1	9	NAF (AC)
WD 2	9.4	129	1.86	0.13	N/A	N/A	4.0	204	-200	152	N/A	N/A	N/A	51	NAF (AC)
WD 3	9.2	87	5.7	2.57	N/A	0.01	78	422	-343	466	0	0	8.0	5	NAF (AC)
WD 4	9.1	159	4.6	0.77	N/A	<0.01	23	318	-294	376	0	0	9.9	13	NAF (AC)
WD 5	9.1	143	4.46	1.29	N/A	<0.01	39	343	-304	364	0	0	8.7	9	NAF (AC)
POR 1	9.3	115	1.18	1.43	N/A	<0.01	44	86	-42	96	0	0	8.5	2	NAF
POR 2	9.2	134	1.15	0.45	N/A	<0.01	14	74	-60	94	0	0	9.2	5	NAF
POR 3	8.6	800	2.33	0.12	N/A	N/A	3.7	179	-175	190	N/A	N/A	N/A	49	NAF (AC)
POR 4	9.0	146	1.1	1.13	N/A	<0.01	34	78	-43	90	0	0	9.1	2	NAF
DCB 1	9.0	187	3.36	1.44	N/A	<0.01	44	216	-172	275	0	0	8.3	5	NAF (AC)
DCB 2	9.2	117	6.06	1.44	N/A	<0.01	44	419	-375	495	0	0	8.4	10	NAF (AC)
DCB 3	9.2	146	4.11	0.55	N/A	<0.01	17	289	-272	336	0	0	9.5	17	NAF (AC)
DCB 4	9.1	139	4.4	1.11	N/A	<0.01	34	276	-242	359	0	0	8.3	8	NAF (AC)
DCB 5	9.1	181	4.88	0.91	N/A	<0.01	28	350	-322	399	0	0	8.5	13	NAF (AC)
KS 1	4.9	578	0.36	21.6	17.5	0.15	536	10	526	29	337	412	2.0	0.0	PAF-HC
KS 2	8.3	114	2.24	6.19	5.32	0.03	163	128	35	183	0	0	7.4	0.7	UC
KS 3	8.3	291	2.49	10.1	7.71	0.03	236	145	91	203	72	102	2.7	0.5	PAF-HC
KS 4	7.6	562	1.54	11.9	8.44	0.11	258	53	205	126	185	232	2.3	0.1	PAF-HC
KS 5	8.1	292	1.62	13.4	10.8	0.04	330	86	244	132	218	242	2.2	0.2	PAF-HC
HLS 1	9.0	206	6.09	0.32	N/A	<0.01	9.6	480	-470	498	0	0	7.1	49	NAF (AC)
HLS 2	9.2	196	3.92	0.24	N/A	<0.01	7.2	243	-236	320	0	0	8.5	33	NAF (AC)

Sample	pH (1:5)	EC (1:5)	Total C	Total-S	CRS	SO4-S	AP	ANC	NAPP	Carb NP	NAG$_{pH4.5}$	NAG$_{pH7}$	NAGpH	NPR Ratio	Classification
	pH Units	µS/cm	%	%	%	%	kg H_2SO_4/t						pH units		
HLS 3	9.1	172	3.53	1.10	N/A	<0.01	34	246	-212	288	0	0	8.4	7	NAF (AC)
HLS 4	9.2	151	5.42	0.27	N/A	<0.01	8.1	431	-423	443	0	0	8.1	52	NAF (AC)
GMD REG	9.6	434	0.05	0.02	N/A	N/A	0.6	21	-20	4	N/A	N/A	N/A	34	NAF
GMD 1	9.0	198	2.91	1.09	N/A	<0.01	33	228	-195	238	0	0	9.2	7	NAF (AC)
GMD 2	9.3	159	1.02	0.06	N/A	N/A	1.8	100	-98	83	N/A	N/A	N/A	54	NAF
GMD 3	8.9	86	2.12	0.30	N/A	<0.01	9.0	180	-171	173	0	0	9.2	20	NAF (AC)

**As NAGpH is equal to the original pH this samples is already fully oxidised.*
N/A denotes Not Analysed

🟥	Denotes PAF classification
🟨	Denotes Uncertain classification
🟩	Denotes NAF/AC classification

Table A1-3: Total Metals and Metalloids

Sample	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
	mg/kg	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	%
WD 1	0.36	6.9	7.2	278	0.31	4.5	1.3	59	379	95	8.7	0.1	0.1
WD 2	0.27	4.0	1.7	199	0.50	3.2	0.06	62	1,270	99	7.3	<0.1	1.5
WD 3	5.4	2.4	23	572	1.3	3.0	0.16	57	906	117	6.8	0.1	0.2
WD 4	0.28	7.0	5.1	207	0.66	8.3	0.13	35	348	48	5.0	<0.1	3.8
POR 1	1.2	7.6	22	1,272	1.6	2.1	0.16	7.3	23	88	2.5	0.3	1.9
POR 2	0.15	8.1	4.1	1,183	1.5	2.0	0.07	7.6	22	4	2.4	<0.1	2.2
POR 3	<0.05	7.4	4.0	1,121	1.5	4.2	0.06	28	61	11	4.9	<0.1	1.6
POR 4	1.4	7.8	5.5	1,238	2.2	1.9	0.23	10	37	28	2.3	<0.1	2.4
DCB 1	6.9	7.1	71	227	0.72	4.0	0.65	52	428	61	5.6	0.1	1.9
DCB 2	2.1	2.5	3.5	137	1.2	3.1	0.06	55	1,098	44	6.5	<0.1	0.7
DCB 3	0.24	6.4	1.8	123	0.62	7.0	0.06	48	367	37	7.0	<0.1	1.9
DCB 4	0.47	6.5	9.4	380	0.87	6.2	0.29	45	324	85	6.4	<0.1	2.9
KS 1	1.4	3.9	487	121	0.42	0.2	16	150	119	2,062	23	1.1	1.0
KS 2	1.4	0.2	38	10	0.25	3.2	0.56	11	83	407	9.2	0.6	0.03
KS 4	2.6	5.7	166	234	0.65	1.4	9.6	153	205	2,524	19	1.0	2.2
KS 5	1.9	4.3	179	409	0.97	2.0	2.2	76	184	458	14.9	0.5	2.1
HLS 1	0.13	3.3	67	48	0.15	7.2	0.22	59	1,143	47	6.3	<0.1	0.6
HLS 2	<0.05	7.4	7.7	148	0.46	6.8	0.09	25	157	68	5.2	<0.1	1.2
HLS 3	0.13	7.2	36	189	0.31	6.1	0.13	53	308	100	7.7	<0.1	1.3
HLS 4	0.06	3.6	36	22	0.16	6.0	0.05	75	1,889	32	6.8	<0.1	0.2
GMD REG	<0.05	9.4	20	9.3	0.27	2.8	0.08	50	46	104	7.9	<0.1	0.02
GMD 1	0.13	7.5	24	12	0.31	6.3	0.12	42	28	89	8.8	<0.1	0.3
GMD 2	0.6	7.2	4.7	42	0.53	3.5	0.06	39	29	27	10	<0.1	0.1

Sample	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
	mg/kg	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	%
GMD 3	0.08	6.0	3.8	12	0.52	6.1	0.07	39	15	36	12	<0.1	0.03
Crustal Average	**0.07**	**8.2**	**25**	**425**	**2.8**	**4.1**	**0.11**	**20**	**100**	**50**	**4.1**	**0.08**	**2.1**

Table A1-3: Total Metals and Metalloids, continued

Sample	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Te	Th	U	V	Zn
	%	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
WD 1	4.3	2,139	0.5	2.7	150	12	1.8	0.6	0.1	<0.2	0.60	0.15	175	671
WD 2	10.8	1,338	0.3	0.2	291	2.1	0.80	<0.5	0.3	0.3	0.99	0.23	118	60
WD 3	10.2	1,207	0.2	1.0	279	3.0	1.0	0.9	<0.1	5.9	0.78	0.18	126	54
WD 4	3.5	1,151	0.4	0.1	105	3.3	1.2	<0.5	0.3	1.1	1.2	0.27	127	50
POR 1	1.0	316	1.6	3.1	10	13	5.7	<0.5	0.8	0.7	8.9	2.2	60	77
POR 2	0.8	337	0.3	3.1	8	6.5	2.2	<0.5	0.7	<0.2	9.3	2.1	53	64
POR 3	2.7	559	0.1	2.8	69	4.6	2.7	<0.5	0.7	<0.2	6.7	1.4	133	47
POR 4	0.9	343	1.2	2.7	7	21	2.9	<0.5	0.8	0.4	9.7	2.3	52	75
DCB 1	4.0	2,067	0.5	2.1	220	33	4.2	<0.5	1.8	5.6	0.62	0.16	193	304
DCB 2	10.0	1,251	0.2	0.9	257	2.4	1.4	0.5	0.1	2.9	0.81	0.19	106	50
DCB 3	4.3	1,125	0.2	0.8	159	4.2	3.0	<0.5	0.3	<0.2	0.49	0.11	159	55
DCB 4	4.0	1,599	0.6	0.7	170	7.6	3.5	<0.5	0.3	<0.2	0.48	0.13	171	208
KS 1	1.0	511	6.7	0.2	210	99	14	17	12	3.1	4.8	1.3	53	7,256
KS 2	1.5	441	1.9	0.1	11	19	14	4.5	0.3	1.5	0.23	0.07	6	221
KS 4	1.1	708	5.0	0.2	182	45	12	15.1	17	4.5	4.6	1.3	100	4789
KS 5	1.2	452	4.3	0.1	140	33	17	7.2	2.2	4.4	4.2	1.2	69	994
HLS 1	9.8	1,159	0.2	0.1	702	3.3	0.76	<0.5	<0.1	<0.2	0.15	0.05	107	141
HLS 2	2.3	1,227	0.5	1.3	55	3.8	3.4	<0.5	0.7	<0.2	0.63	0.18	201	67
HLS 3	3.9	2,083	0.4	0.6	126	5.3	1.7	0.7	0.3	0.3	0.53	0.15	189	90
HLS 4	11.0	1,129	<0.1	0.04	1,030	0.8	0.44	<0.5	<0.1	<0.2	0.14	0.03	117	68
GMD REG	3.0	1,557	0.1	2.6	55	<0.5	3.5	<0.5	0.2	<0.2	0.26	0.04	247	63
GMD 1	3.3	1,431	0.3	2.3	50	3	4.3	<0.5	0.2	<0.2	0.20	0.05	281	71
GMD 2	3.2	1,468	0.6	2.4	36	1.1	0.61	<0.5	0.2	<0.2	0.56	0.11	326	95

Sample	**Mg**	**Mn**	**Mo**	**Na**	**Ni**	**Pb**	**Sb**	**Se**	**Sn**	**Te**	**Th**	**U**	**V**	**Zn**
	%	**mg/kg**	**mg/kg**	**%**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
GMD 3	2.5	1,819	0.7	1.7	24	1.1	0.76	<0.5	1.4	<0.2	0.57	0.14	358	90
Crustal Average	**2.3**	**950**	**1.5**	**2.3**	**75**	**14**	**0.2**	**0.2**	**2**	**0.001**	**10**	**2.7**	**135**	**70**

Table A1-4: Global Abundance Index (GAI)

Sample	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
WD 1	2	0	0	0	0	0	3	1	1	0	1	0	0
WD 2	1	0	0	0	0	0	0	1	3	0	0	0	0
WD 3	6	0	0	0	0	0	0	1	3	1	0	0	0
WD 4	1	0	0	0	0	0	0	0	1	0	0	0	0
POR 1	4	0	0	1	0	0	0	0	0	0	0	1	0
POR 2	1	0	0	1	0	0	0	0	0	0	0	0	0
POR 3	0	0	0	1	0	0	0	0	0	0	0	0	0
POR 4	4	0	0	1	0	0	0	0	0	0	0	0	0
DCB 1	6	0	1	0	0	0	2	1	2	0	0	0	0
DCB 2	4	0	0	0	0	0	0	1	3	0	0	0	0
DCB 3	1	0	0	0	0	0	0	1	1	0	0	0	0
DCB 4	2	0	0	0	0	0	1	1	1	0	0	0	0
KS 1	4	0	4	0	0	0	6	2	0	5	2	3	0
KS 2	4	0	0	0	0	0	2	0	0	2	1	2	0
KS 4	5	0	2	0	0	0	6	2	0	5	2	3	0
KS 5	4	0	2	0	0	0	4	1	0	3	1	2	0
HLS 1	0	0	1	0	0	0	0	1	3	0	0	0	0
HLS 2	0	0	0	0	0	0	0	0	0	0	0	0	0
HLS 3	0	0	0	0	0	0	0	1	1	0	0	0	0
HLS 4	0	0	0	0	0	0	0	1	4	0	0	0	0
GMD REG	0	0	0	0	0	0	0	1	0	0	0	0	0
GMD 1	0	0	0	0	0	0	0	0	0	0	1	0	0
GMD 2	3	0	0	0	0	0	0	0	0	0	1	0	0
GMD 3	0	0	0	0	0	0	0	0	0	0	1	0	0

Table A1-4: Global Abundance Index (GAI) continued

Sample	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Te	Th	U	V	Zn
WD 1	0	1	0	0	0	0	3	1	0	6	0	0	0	3
WD 2	2	0	0	0	1	0	1	1	0	6	0	0	0	0
WD 3	2	0	0	0	1	0	2	2	0	6	0	0	0	0
WD 4	0	0	0	0	0	0	2	1	0	6	0	0	0	0
POR 1	0	0	0	0	0	0	4	1	0	6	0	0	0	0
POR 2	0	0	0	0	0	0	3	1	0	6	0	0	0	0
POR 3	0	0	0	0	0	0	3	1	0	6	0	0	0	0
POR 4	0	0	0	0	0	0	3	1	0	6	0	0	0	0
DCB 1	0	1	0	0	1	1	4	1	0	6	0	0	0	1
DCB 2	2	0	0	0	1	0	2	1	0	6	0	0	0	0
DCB 3	0	0	0	0	0	0	3	1	0	6	0	0	0	0
DCB 4	0	0	0	0	1	0	4	1	0	6	0	0	0	1
KS 1	0	0	2	0	1	2	6	6	2	6	0	0	0	6
KS 2	0	0	0	0	0	0	6	4	0	6	0	0	0	1
KS 4	0	0	1	0	1	1	5	6	3	6	0	0	0	5
KS 5	0	0	1	0	0	1	6	5	0	6	0	0	0	3
HLS 1	2	0	0	0	3	0	1	1	0	6	0	0	0	0
HLS 2	0	0	0	0	0	0	3	1	0	6	0	0	0	0
HLS 3	0	1	0	0	0	0	2	1	0	6	0	0	0	0
HLS 4	2	0	0	0	3	0	1	1	0	6	0	0	0	0
GMD REG	0	0	0	0	0	0	4	1	0	6	0	0	0	0
GMD 1	0	0	0	0	0	0	4	1	0	6	0	0	0	0
GMD 2	0	0	0	0	0	0	1	1	0	6	0	0	1	0
GMD 3	0	0	0	0	0	0	1	1	0	6	0	0	1	0

Table A1-5: Water Leachate (1:5), Major Ions

Sample	pH	EC	Ca	Mg	Na	K	Cl	SO_4	Total Alkalinity	HCO_3 Alkalinity	CO_3 Alkalinity
		mS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg $CaCO_3$/L		
WD 1	9.4	82	11	4.4	3.2	0.3	4	9.8	34	8	26
WD 3	9.2	87	5.7	7.5	1.7	1.2	2	22	28	5	23
POR 1	9.3	115	13	4.9	7.6	4.9	8	22	65	39	26
DCB 2	9.2	117	6.9	8.1	5.0	2.8	8	20	128	102	26
DCB 4	9.1	139	12	6.1	3.7	8	5	14	114	88	26
KS 1	4.9	578	50	21	7.9	2.8	32	265	3	3	<1
KS 2	8.3	114	17	7.0	1.6	0.4	10	34	30	30	<1
HLS 3	9.1	172	12	5.5	15	5.4	8	19	62	34	28
GMD 3	8.9	86	10	2.7	5.6	0.4	<2	5.0	40	25	15

Table A1-6: Water Leachate (1:5), Metals and Metalloids

Sample	**Ag**	**Al**	**As**	**B**	**Ba**	**Be**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**Li**
	µg/L	**mg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**mg/L**	**µg/L**	**µg/L**
WD 1	0.03	0.27	0.3	0.12	7.9	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	1.1
WD 3	0.06	0.06	8.7	0.11	175	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	1.1
POR 1	<0.01	0.36	3.0	0.12	9.5	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	1.9
DCB 2	0.02	0.13	1.2	0.11	183	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	1.7
DCB 4	0.01	0.36	2.9	0.12	24	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	2.0
KS 1	<0.01	0.41	7.8	0.14	6.2	0.2	23.6	35	<0.01	0.17	29	<0.1	5.8
KS 2	0.10	<0.01	0.2	0.12	0.90	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	1.0
HLS 3	<0.01	0.43	1.7	0.14	0.93	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	2.7
GMD 3	0.07	0.47	0.4	0.11	0.68	<0.1	<0.02	<0.1	<0.01	<0.01	<0.01	<0.1	0.55
Livestock (ANZECC 2000)	**N/G**	**5**	**500**	**5**	**N/G**	**N/G**	**10**	**1000**	**1**	**1**	**N/G**	**2**	**N/G**

N/G No guideline

Table A1-6: Water Leachate, Metals and Metalloids, continued

Sample	Mn	Mo	Nb	Ni	Pb	Sb	Se	Sn	Ta	Te	Th	U	V	Zn
	mg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L
WD 1	0.009	0.21	<0.005	<0.01	<0.5	2.6	<0.5	<0.1	0.002	<0.1	<0.005	<0.005	<0.01	<0.01
WD 3	0.001	0.12	<0.005	<0.01	<0.5	2.8	0.6	<0.1	0.002	<0.1	<0.005	<0.005	<0.01	<0.01
POR 1	0.004	2.4	<0.005	<0.01	<0.5	9.2	<0.5	<0.1	0.002	<0.1	<0.005	0.11	<0.01	<0.01
DCB 2	0.001	0.28	<0.005	<0.01	<0.5	4.8	<0.5	<0.1	0.002	<0.1	<0.005	<0.005	<0.01	<0.01
DCB 4	0.002	0.29	<0.005	<0.01	<0.5	6.9	<0.5	<0.1	0.002	<0.1	<0.005	<0.005	<0.01	<0.01
KS 1	1.9	<0.05	<0.005	0.17	11	0.02	3.1	<0.1	0.002	<0.1	<0.005	0.19	<0.01	28.7
KS 2	0.004	1.3	<0.005	<0.01	<0.5	12	1.7	<0.1	0.002	<0.1	<0.005	0.01	<0.01	<0.01
HLS 3	0.004	0.49	<0.005	<0.01	<0.5	3.6	0.5	<0.1	0.003	<0.1	<0.005	<0.005	<0.01	<0.01
GMD 3	0.008	2.6	<0.005	<0.01	<0.5	0.64	<0.5	<0.1	0.003	<0.1	<0.005	<0.005	<0.01	<0.01
Livestock (ANZECC 2000)	**N/G**	**150**	**N/G**	**1**	**100**	**N/G**	**20**	**N/G**	**N/G**	**N/G**	**N/G**	**200**	**N/G**	**20**

Table A1-7: Dilute Acid (1:20 Acetic) Leachate, Major Ions, Metals and Metalloids

Sample	pH	Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li
	pH units	µg/L	mg/L	µg/L	mg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	µg/L
WD 1	4.4	<0.01	2.8	1.7	0.02	112	1.1	372	3.5	32	0.07	<0.01	144	<0.1	0.20	8.7
WD 3	4.3	0.28	0.79	11	0.03	1528	4.0	284	1.2	17	0.14	0.02	49	<0.1	1.1	4.2
POR 1	4.1	0.03	2.0	2.3	0.02	210	1.3	234	0.42	9.3	0.01	0.01	90	<0.1	2.3	3.6
DCB 2	4.3	0.05	1.1	2.2	0.02	847	2.4	280	0.58	25	0.11	<0.01	48	<0.1	1.5	3.2
DCB 4	4.5	0.12	2.0	2.1	0.01	383	3.0	412	1.0	62	0.03	<0.01	136	<0.1	3.8	8.0
KS 2	4.2	0.04	0.29	7.5	0.02	18	1.8	239	1.0	2.4	0.05	0.06	108	<0.1	0.20	3.3
HLS 3	4.5	0.31	2.7	1.0	0.03	37	0.7	401	0.68	37	0.04	<0.01	157	<0.1	2.2	10
GMD 3	5.2	0.03	0.73	0.3	0.02	15	1.1	1,441	1.7	8.1	<0.01	<0.01	58	<0.1	0.20	3.4

Table A1-7: Dilute Acid (1:20 Acetic) Leachate, Major Ions, Metals and Metalloids, continued

Sample	Mg	Mn	Mo	Na	Nb	Ni	Pb	S	Sb	Se	Sn	Ta	Te	Th	U	V	Zn
	mg/L	mg/L	µg/L	mg/L	µg/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L
WD 1	141	16	<0.05	1.6	<0.005	0.04	87	0.55	0.73	<0.5	<0.1	<0.001	<0.1	0.098	0.19	<0.01	0.37
WD 3	180	6.0	0.12	0.7	<0.005	0.11	13	1.8	1.3	0.7	<0.1	0.001	2.6	0.182	0.11	<0.01	0.04
POR 1	96	3.6	0.58	2.3	<0.005	0.01	49	1.0	2.3	0.7	<0.1	<0.001	0.3	0.33	0.55	0.02	0.32
DCB 2	182	4.2	0.14	5.4	<0.005	0.11	11	1.5	1.4	<0.5	<0.1	<0.001	0.8	0.104	0.12	<0.01	0.14
DCB 4	185	8.8	<0.05	1.2	<0.005	0.15	19	0.75	1.2	0.6	<0.1	<0.001	<0.1	0.06	0.05	<0.01	0.30
KS 2	98	2.4	0.6	0.8	<0.005	<0.01	148	2.2	14	0.7	<0.1	<0.001	0.8	0.18	0.06	<0.01	0.60
HLS 3	159	12	<0.05	3.8	<0.005	0.04	3.4	0.62	0.53	0.8	<0.1	<0.001	<0.1	0.072	0.08	<0.01	0.23
GMD 3	19	24	<0.05	1.9	<0.005	<0.01	1.9	0.36	0.19	3.8	<0.1	<0.001	<0.1	<0.005	0.01	<0.01	0.03

APPENDIX 2: LABORATORY REPORTS

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QUANTITATIVE X-RAY DIFFRACTION ANALYSIS

REPORT PREPARED FOR	MARTINICK BOSCH SELL PTY LTD [redacted]
CLIENT CODE	
JOB CODE	1710818
No. of SAMPLES	6
CLIENT O/N	M. NORTH
SAMPLE SUBMISSION No.	N/A
PROJECT	KCGM MT CHARLOTTE KCGMMCG
STATE	PULPS
DATE RECEIVED	21/08/2017
DATE COMPLETED	13/09/2017
DATE WRITTEN	13/09/2017
WRITTEN BY	[redacted]
ANALYSING LABORATORY	Perth

SAMPLE DETAILS

DISCLAIMER

This report relates specifically to the sample(s) that were drawn and/or provided by the client or their nominated third party. The reported results(s) provide no warranty or verification on the sample(s) representing any specific goods and/or shipment and only relate to the sample(s) as received and tested. This report is prepared solely for the use of the client named in this report. Intertek accepts no responsibility for any loss, damage or laibility suffered by a third party as a result of any reliance upon or use of this report.

The results provided are not intended for commercial settlement purposes.

SIGNIFICANT FIGURES

The method detection limit is approximately 1 wt% for most phases.

Uncertainty in the analysis should reflect errors (absolute) of no greater than: +/- 10% for phases 50-95%, +/- 5% for phases 10-50% and +/- 2% for phases 3-10%. Phases of < 3% are approaching detection limit and normally no refinements are made on these.

Please note that results are rounded off to integer values

LEGEND

ND	Not Detected

JOB INFORMATION

PREPARATION

XRD16 (dry 50C, mill < 60um, micronised)

ANALYTICAL METHOD

XRDQUANT02 - Quantitative analysis, crystalline and amorphous content, double scan

SAMPLING

Sample(s) coned and quartered, then grab(s) taken

AMORPHOUS CONTENT DETERMINATION

Internal standard double scan

ADDITIONS

Internal standard ZnO (zincite)

SAMPLE PRESENTATION

Sample(s) packed and presented as unoriented powder mount(s) of the total sample

JOB INFORMATION

INSTRUMENTATION AND PARAMETERS

INSTRUMENT:

PANalytical Cubix^3 XRD
Copper radiation (operating at 45 kV and 40 mA)
Graphite monochromator (diffracted beam)

PARAMETERS:

Parameter	Setting
Start angle (deg 2θ)	4
End angle (deg 2θ)	65
Step size (deg 2θ)	0.02
Time/active length (secs)	150
Active length (deg 2θ)	4.01

SOFTWARE:

Qualitative analysis:	Bruker Diffrac.EVA 4.2 Search/Match ICDD PDF-2 (2015) database
Quantitative analysis:	SIROQUANT Version 4

RESULTS

The quantitative analysis of the crystalline and amorphous content of each sample is given in the file, **282.00_1710818 XRD RESULTS.xlsx**, attached to the report email.

Calculation of the phase abundances has been based on the Brindley contrast corrections using a particle diameter of 4 µm.

NOTES

NONE

QUALITY CONTROL

NIST STANDARD REFERENCE MATERIAL (SRM) 656

This standard is used for quality control on the instrument and software.

The standard reference material is a powder which consists of sub-micrometer, equi-axial, non-aggregated grains that do not display the effects of absorption contrast, extinction or preferred orientation.

An aliquot of this SRM, spiked with 10% Al2O3 (SRM 676a) for the amorphous content determination, was prepared as un-oriented powder mount of the total sample and the pattern analysed with SIROQUANT^{TM}.

Sample ID **α 656 (High α Phase Powder)**

		1710818	method	SRM	SRM
			std dev	certified	uncert
Phase	Formula	wt%	wt%	wt%	wt%
Amorphous content		10.0	0.6	9.5	0.61
Si3N4, alpha	Si3N4	87.0	0.6	87.5	0.59
Si3N4, beta	Si3N4	3.0	0.1	3.0	0.05

Each interval defined by the certified value and its uncertainty is a 95% confidence interval for the true value of the mean in the absence of systematic error.

METHOD DESCRIPTION

Quantification is determined from the chosen software package: this uses the full-profile Rietveld method of refining the profile of the calculated XRD pattern against the profile of the measured XRD pattern. The total calculated pattern is the sum of the calculated patterns of the individual phases.

Results are given as weight % of the total crystalline phases and amorphous content.

The amorphous content quantifies the amorphous material and unknown minerals or known minerals for which there is not a suitable crystal structure.

Corrections are incorporated into the process that allows for a more accurate description of the mineral’s contribution to the measured pattern and to allow for variation due to atomic substitution, layer disordering, preferred orientation, and other factors that affect the acquisition of the XRD scan.

The limitations of qualitative XRD analysis are as follows:

There is a limit of detection of approximately 1 wt% on the crystalline phases.
The detection of a phase may be dependent on its crystallinity.
Where there exist multiple phases, overlap of diffracted reflections can occur, thus rendering some ambiguity into the interpretation.
Overlapping reflections of a major phase can mask the presence of minor or trace phases.

Some phases cannot be unambiguously identified as they are present in minor or trace amounts.

The limitations of quantitative XRD analysis by a full-profile Rietveld method are as follows:

The limitations for qualitative XRD analysis apply.
The method as described is standardless: it relies solely on the published crystallographic data available for each phase. Some data may not exactly describe the phases present.

Particle size is important with respect to the absorption of the X-rays by the sample. Micronising reduces the particle size to that more suitable for quantitative analysis.

The accuracy of the analysis is dependent on sampling and sample preparation in addition to the calculated profiles being exactly representative of the chemistry of the component phases and their crystallinity. Some preferred orientation effects and reflection overlaps may occur which cannot be adequately resolved.

AMORPHOUS CONTENT

INTERNAL STANDARD METHOD

Single scan (SIROQUANT™ and TOPAS)

The amorphous content is determined from the addition of a known spike of a well-crystalline internal standard to each sample.

When amorphous material is present, the weight percentage of the spike found is larger than actually weighed out. The amount of amorphous material that causes the difference in the spike weight percentages is then calculated and all weight percentages are normalised to include the amorphous content.

Double scan (SIROQUANT only)

SIROQUANT™ also allows the choice of using the spiked pattern completely, or combining the run with a previous unspiked pattern result. This choice is given because the weight percentages from an unspiked pattern are more accurate since the intensities are not diluted by the spike addition. The percentages from the unspiked sample are normalised to the amorphous content calculated from the spiked sample pattern.

EXTERNAL STANDARD METHOD

The amorphous content is determined from the external standard method[1].

The normalisation constant is determined from the external standard which allows the calculated weight fractions to be placed on an absolute scale.

Reference:

1. O’Connor, B.H., and Raven, M.D., “Application of the Rietveld refinement procedure in assaying powdered mixtures”, Powder Diffraction 3(1), (1988), 2-6.

Modelling

A pattern representing a poorly crystalline form of silica is used in the SIROQUANT program.[2]

Reference:

2. Ward, C.R. and French, D., "Determination of glass content and estimation of glass composition in fly ash using quantitative X-ray diffractometry." Fuel 85 (2006), 2268-2277.

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b) the cost of having those services supplied again.

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MINERALS
TEST REPORT

CLIENT

MARTINICK BOSCH SELL PTY LTD
4 Cook Street
WEST PERTH, W.A. 6005
AUSTRALIA

JOB INFORMATION

JOB CODE	:	282.0/1709783
NO. SAMPLES	:	27
NO. ELEMENTS	:	49
CLIENT ORDER NO.	:	[redacted] (Job 1 of 0)
SAMPLE SUBMISSION NO.	:	
PROJECT	:	KCGM MT CHARLOTTE KCGMMCG
DATE RECEIVED	:	13/07/2017
DATE REPORTED	:	27/09/2017
DATE PRINTED	:	27/09/2017

REPORT NOTES

TESTED BY

Intertek
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
[redacted]
[redacted]

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that figures beyond the least significant digit have significance.

For more information on the uncertainty on individual reported values, please contact the laboratory.

SAMPLE STORAGE

All solid samples (assay pulps, bulk pulps and residues will be stored for 60 days without charge. Following this samples will be stored at a daily rate until clients written advice regarding return, collection or disposal is received. If storage information is not supplied on the submission, or arranged with the laboratory in writing the default will be to store the samples with the applicable charges. Storage is charged at $4.00 per m3 per day, expenses related to the return or disposal of samples will be charged at cost. Current disposal cost is charged at $150.00 per m3.

Samples received as liquids, waters or solutions will be held for 60 days free of charge then disposed of, unless written advice fo return or collection is received.

LEGEND

X = Less than Detection Limit
SNR = Sample Not Received
* = Result Checked
DTF = Result still to come
IS = Insufficient Sample for Analysis

NA = Not Analysed
UA = Unable to Assay
> = Value beyond Limit of Method
\+ = Extra Sample Received Not Listed

ELEMENTS	Ag	Ag	Al	Al	ANC	As
UNITS	ppm	ug/l	ppm	mg/l	kgH2SO4/t	ppm
DETECTION LIMIT	0.05	0.01	50	0.01	1	0.5
DIGEST	4A/	Ws/	4A/	Ws/	ANCx/	4A/
ANALYTICAL FINISH	MS	MS	OE	OE	VOL	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	0.36	0.03	6.91%	0.27	209	7.2
0002 WD2 UGHS012 280-282m	0.27		4.04%		204	1.7
0003 WD3 UGHS154 87-89m	5.44	0.06	2.41%	0.06	422	23.2
0004 WD4 UGHS007 325-327m	0.28		7.02%		318	5.1
0005 WD5- UGHS012 371-373m					343	
0006 POR1 - UGHS012 330-333m	1.20	X	7.62%	0.36	86	21.8
0007 POR2 UGHS140 55-57m	0.15		8.13%		74	4.1
0008 POR3 UGHS132 56-58m	X		7.44%		179	4.0
0009 POR4 UGHS010 395-398m	1.37		7.83%		78	5.5
0010 DCB1 UGHS012 313-316m	6.90		7.10%		216	70.6
0011 DCB2 UNGD010 329-330m	2.05	0.02	2.55%	0.13	419	3.5
0012 DCB3 UGHS140 31-33m	0.24		6.37%		289	1.8
0013 DCB4 UGHS140 66-69m	0.47	0.01	6.50%	0.36	276	9.4
0014 DCB5 UGHS132 92-94m					350	
0015 KS1 UGHS012 356-358m	1.43	X	3.90%	0.41	10	487.0
0016 KS2 UGHS092 151-154m	1.37	0.10	2299	X	128	38.3
0017 KS3 UGHS010 90-92m					145	
0018 KS4 UGHS010 500-502m	2.64		5.67%		53	166.0
0019 KS5 UGHS144 70.5-72m	1.92		4.33%		86	179.2
0020 HLS1 UGHS038A 432-434m	0.13		3.26%		480	66.7
0021 HLS2 UGHS039 52-54m	X		7.41%		243	7.7
0022 HLS3 UGHS039 74-77m	0.13	X	7.18%	0.43	246	36.0
0023 HLS4 CKD13 474-481m	0.06		3.65%		431	36.3
0024 NOB REG MC044273 12-13m	X		9.43%		21	20.0
0025 NOB GMD1 MC04272 40-45m	0.13		7.50%		228	23.8
0026 NOB GMD2 MC04273 201-206m	0.60		7.16%		100	4.7
0027 NOB GMD3 MC04273 225-230m	0.08	0.07	6.00%	0.47	180	3.8
STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905	0.55		7.68%			34.9
0004 NAG Std 3						
BLANKS						
0001 Control Blank	X	X	X	X	0	X

ELEMENTS	As	B	Ba	Ba	Be	Be
UNITS	ug/l	mg/l	ppm	ug/l	ppm	ug/l
DETECTION LIMIT	0.1	0.01	0.1	0.05	0.05	0.1
DIGEST	Ws/	Ws/	4A/	Ws/	4A/	Ws/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	0.3	0.12	277.5	7.93	0.31	X
0002 WD2 UGHS012 280-282m			199.4		0.50	
0003 WD3 UGHS154 87-89m	8.7	0.11	572.4	175.18	1.31	X
0004 WD4 UGHS007 325-327m			206.7		0.66	
0005 WD5- UGHS012 371-373m						
0006 POR1 - UGHS012 330-333m	3.0	0.12	1272.2	9.47	1.57	X
0007 POR2 UGHS140 55-57m			1183.0		1.51	
0008 POR3 UGHS132 56-58m			1120.8		1.49	
0009 POR4 UGHS010 395-398m			1238.0		2.20	
0010 DCB1 UGHS012 313-316m			227.3		0.72	
0011 DCB2 UNGD010 329-330m	1.2	0.11	136.9	182.61	1.15	X
0012 DCB3 UGHS140 31-33m			123.2		0.62	
0013 DCB4 UGHS140 66-69m	2.9	0.12	380.1	23.84	0.87	X
0014 DCB5 UGHS132 92-94m						
0015 KS1 UGHS012 356-358m	7.8	0.14	121.2	6.15	0.42	0.2
0016 KS2 UGHS092 151-154m	0.2	0.12	10.3	0.90	0.25	X
0017 KS3 UGHS010 90-92m						
0018 KS4 UGHS010 500-502m			233.6		0.65	
0019 KS5 UGHS144 70.5-72m			409.0		0.97	
0020 HLS1 UGHS038A 432-434m			48.2		0.15	
0021 HLS2 UGHS039 52-54m			147.9		0.46	
0022 HLS3 UGHS039 74-77m	1.7	0.14	188.6	0.93	0.31	X
0023 HLS4 CKD13 474-481m			21.6		0.16	
0024 NOB REG MC044273 12-13m			9.3		0.27	
0025 NOB GMD1 MC04272 40-45m			11.5		0.31	
0026 NOB GMD2 MC04273 201-206m			41.7		0.53	
0027 NOB GMD3 MC04273 225-230m	0.4	0.11	12.0	0.68	0.52	X
STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905			2841.6		3.12	
0004 NAG Std 3						
BLANKS						
0001 Control Blank	X	0.06	X	X	X	X

ELEMENTS	C	CO3	Ca	Ca	Cd	Cd
UNITS	%	mgCaCO3/L	ppm	mg/l	ppm	ug/l
DETECTION LIMIT	0.01	1	50	0.01	0.02	0.02
DIGEST		Ws/	4A/	Ws/	4A/	Ws/
ANALYTICAL FINISH	/CSA	VOL	OE	OE	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	2.61	26	4.48%	11.27	1.32	X
0002 WD2 UGHS012 280-282m	1.86		3.18%		0.06	
0003 WD3 UGHS154 87-89m	5.70	23	3.02%	5.74	0.16	X
0004 WD4 UGHS007 325-327m	4.60		8.35%		0.13	
0005 WD5- UGHS012 371-373m	4.46					
0006 POR1 - UGHS012 330-333m	1.18	26	2.10%	12.57	0.16	X
0007 POR2 UGHS140 55-57m	1.15		2.01%		0.07	
0008 POR3 UGHS132 56-58m	2.33		4.21%		0.06	
0009 POR4 UGHS010 395-398m	1.10		1.95%		0.23	
0010 DCB1 UGHS012 313-316m	3.36		4.01%		0.65	
0011 DCB2 UNGD010 329-330m	6.06	26	3.07%	6.85	0.06	X
0012 DCB3 UGHS140 31-33m	4.11		6.96%		0.06	
0013 DCB4 UGHS140 66-69m	4.40	26	6.24%	11.83	0.29	X
0014 DCB5 UGHS132 92-94m	4.88					
0015 KS1 UGHS012 356-358m	0.36	X	1500	49.59	15.83	23.61
0016 KS2 UGHS092 151-154m	2.24	X	3.17%	17.46	0.56	X
0017 KS3 UGHS010 90-92m	2.49					
0018 KS4 UGHS010 500-502m	1.54		1.37%		9.57	
0019 KS5 UGHS144 70.5-72m	1.62		2.04%		2.16	
0020 HLS1 UGHS038A 432-434m	6.09		7.23%		0.22	
0021 HLS2 UGHS039 52-54m	3.92		6.81%		0.09	
0022 HLS3 UGHS039 74-77m	3.53	28	6.08%	12.12	0.13	X
0023 HLS4 CKD13 474-481m	5.42		6.03%		0.05	
0024 NOB REG MC044273 12-13m	0.05		2.85%		0.08	
0025 NOB GMD1 MC04272 40-45m	2.91		6.33%		0.12	
0026 NOB GMD2 MC04273 201-206m	1.02		3.51%		0.06	
0027 NOB GMD3 MC04273 225-230m	2.12	15	6.08%	10.38	0.07	X

STANDARDS						
0001 DS-1	3.21					
0002 OREAS 502b						
0003 OREAS 905			6018		0.37	
0004 NAG Std 3						

BLANKS						
0001 Control Blank	X	X	X	X	X	X

ELEMENTS	Cl	Co	Co	ColourChange	Cr	Cr
UNITS	mg/l	ppm	ug/l	NONE	ppm	mg/l
DETECTION LIMIT	2	0.1	0.1	0	5	0.01
DIGEST	Ws/	4A/	Ws/	ANCx/	4A/	Ws/
ANALYTICAL FINISH	COL	MS	MS	QUAL	OE	OE
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	4	58.6	X	Yes	379	X
0002 WD2 UGHS012 280-282m		61.8		Yes	1270	
0003 WD3 UGHS154 87-89m	2	57.4	X	Yes	906	X
0004 WD4 UGHS007 325-327m		34.9		Yes	348	
0005 WD5- UGHS012 371-373m				Yes		
0006 POR1 - UGHS012 330-333m	8	7.3	X	Yes	23	X
0007 POR2 UGHS140 55-57m		7.6		Yes	22	
0008 POR3 UGHS132 56-58m		28.4		Yes	61	
0009 POR4 UGHS010 395-398m		10.3		Yes	37	
0010 DCB1 UGHS012 313-316m		52.1		Yes	428	
0011 DCB2 UNGD010 329-330m	8	55.1	X	Yes	1098	X
0012 DCB3 UGHS140 31-33m		47.6		Yes	367	
0013 DCB4 UGHS140 66-69m	5	44.9	X	Yes	324	X
0014 DCB5 UGHS132 92-94m				Yes		
0015 KS1 UGHS012 356-358m	32	150.0	34.6	Yes	119	X
0016 KS2 UGHS092 151-154m	10	11.1	X	No	83	X
0017 KS3 UGHS010 90-92m				Yes		
0018 KS4 UGHS010 500-502m		153.2		Yes	205	
0019 KS5 UGHS144 70.5-72m		75.6		No	184	
0020 HLS1 UGHS038A 432-434m		58.5		Yes	1143	
0021 HLS2 UGHS039 52-54m		25.1		Yes	157	
0022 HLS3 UGHS039 74-77m	8	53.2	X	Yes	308	X
0023 HLS4 CKD13 474-481m		75.1		Yes	1889	
0024 NOB REG MC044273 12-13m		50.0		No	46	
0025 NOB GMD1 MC04272 40-45m		42.0		Yes	28	
0026 NOB GMD2 MC04273 201-206m		38.5		Yes	29	
0027 NOB GMD3 MC04273 225-230m	X	39.2	X	Yes	15	X
STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905		15.2			26	
0004 NAG Std 3						
BLANKS						
0001 Control Blank	X	X	X		X	X

ELEMENTS	Cu	Cu	EC	Fe	Fe	Final-pH
UNITS	ppm	mg/l	uS/cm	%	mg/l	NONE
DETECTION LIMIT	1	0.01	10	0.01	0.01	0.1
DIGEST	4A/	Ws/	Ws/	4A/	Ws/	ANCx/
ANALYTICAL FINISH	OE	OE	MTR	OE	OE	MTR
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	95	X	82	8.71	X	1.6
0002 WD2 UGHS012 280-282m	99		129	7.25		1.2
0003 WD3 UGHS154 87-89m	117	X	87	6.79	X	0.3
0004 WD4 UGHS007 325-327m	48		159	5.03		1.4
0005 WD5- UGHS012 371-373m			143			1.7
0006 POR1 - UGHS012 330-333m	88	X	115	2.51	X	1.3
0007 POR2 UGHS140 55-57m	4		134	2.42		1.3
0008 POR3 UGHS132 56-58m	11		800	4.93		1.1
0009 POR4 UGHS010 395-398m	28		146	2.34		1.3
0010 DCB1 UGHS012 313-316m	61		187	5.55		1.2
0011 DCB2 UNGD010 329-330m	44	X	117	6.46	X	0.3
0012 DCB3 UGHS140 31-33m	37		146	6.97		1.5
0013 DCB4 UGHS140 66-69m	85	X	139	6.39	X	1.4
0014 DCB5 UGHS132 92-94m			181			0.3
0015 KS1 UGHS012 356-358m	2062	0.17	578	23.18	28.70	1.4
0016 KS2 UGHS092 151-154m	407	X	114	9.19	X	0.9
0017 KS3 UGHS010 90-92m			291			1.3
0018 KS4 UGHS010 500-502m	2524		562	19.15		1.1
0019 KS5 UGHS144 70.5-72m	458		292	14.94		1.4
0020 HLS1 UGHS038A 432-434m	47		206	6.34		0.3
0021 HLS2 UGHS039 52-54m	68		196	5.15		1.3
0022 HLS3 UGHS039 74-77m	100	X	172	7.66	X	1.4
0023 HLS4 CKD13 474-481m	32		151	6.79		0.3
0024 NOB REG MC044273 12-13m	104		434	7.94		1.7
0025 NOB GMD1 MC04272 40-45m	89		198	8.75		1.3
0026 NOB GMD2 MC04273 201-206m	27		159	10.42		1.6
0027 NOB GMD3 MC04273 225-230m	36	X	86	11.87	X	1.2

STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905	1510			4.30		
0004 NAG Std 3						

BLANKS						
0001 Control Blank	X	X	X	X	X	

ELEMENTS	Fizz-Rate	HCO3	Hg	Hg	K	K
UNITS	NONE	mgCaCO3/L	ppm	ug/l	ppm	mg/l
DETECTION LIMIT	1	2	0.1	0.1	20	0.1
DIGEST	ANCx/	Ws/	AR1/	Ws/	4A/	Ws/
ANALYTICAL FINISH	QUAL	VOL	MS	MS	OE	OE
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	2	8	0.1	X	695	0.3
0002 WD2 UGHS012 280-282m	2		X		1.49%	
0003 WD3 UGHS154 87-89m	2	5	0.1	X	2457	1.2
0004 WD4 UGHS007 325-327m	2		X		3.75%	
0005 WD5- UGHS012 371-373m	3					
0006 POR1 - UGHS012 330-333m	3	39	0.3	X	1.95%	4.9
0007 POR2 UGHS140 55-57m	2		X		2.22%	
0008 POR3 UGHS132 56-58m	2		X		1.63%	
0009 POR4 UGHS010 395-398m	2		X		2.41%	
0010 DCB1 UGHS012 313-316m	2		0.1		1.88%	
0011 DCB2 UNGD010 329-330m	3	102	X	X	7234	2.8
0012 DCB3 UGHS140 31-33m	3		X		1.86%	
0013 DCB4 UGHS140 66-69m	2	88	X	X	2.93%	8.0
0014 DCB5 UGHS132 92-94m	3					
0015 KS1 UGHS012 356-358m	1	3	1.1	X	1.02%	2.8
0016 KS2 UGHS092 151-154m	3	30	0.6	X	328	0.4
0017 KS3 UGHS010 90-92m	3					
0018 KS4 UGHS010 500-502m	3		1.0		2.19%	
0019 KS5 UGHS144 70.5-72m	3		0.5		2.13%	
0020 HLS1 UGHS038A 432-434m	3		X		6088	
0021 HLS2 UGHS039 52-54m	3		X		1.16%	
0022 HLS3 UGHS039 74-77m	3	34	X	X	1.28%	5.4
0023 HLS4 CKD13 474-481m	3		X		2006	
0024 NOB REG MC044273 12-13m	X		X		234	
0025 NOB GMD1 MC04272 40-45m	3		X		2569	
0026 NOB GMD2 MC04273 201-206m	3		X		871	
0027 NOB GMD3 MC04273 225-230m	3	25	X	X	275	0.4

STANDARDS						
0001 DS-1						
0002 OREAS 502b			X			
0003 OREAS 905					3.05%	
0004 NAG Std 3						

BLANKS						
0001 Control Blank		4	X	X	X	X

ELEMENTS	Li	Mg	Mg	Mn	Mn	Mo
UNITS	ug/l	ppm	mg/l	ppm	mg/l	ppm
DETECTION LIMIT	0.05	20	0.01	1	0.001	0.1
DIGEST	Ws/	4A/	Ws/	4A/	Ws/	4A/
ANALYTICAL FINISH	MS	OE	OE	OE	OE	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	1.05	4.30%	4.41	2139	0.009	0.5
0002 WD2 UGHS012 280-282m		10.82%		1338		0.3
0003 WD3 UGHS154 87-89m	1.13	10.22%	7.52	1207	0.001	0.2
0004 WD4 UGHS007 325-327m		3.55%		1151		0.4
0005 WD5- UGHS012 371-373m						
0006 POR1 - UGHS012 330-333m	1.94	9593	4.89	316	0.004	1.6
0007 POR2 UGHS140 55-57m		8294		337		0.3
0008 POR3 UGHS132 56-58m		2.66%		559		0.1
0009 POR4 UGHS010 395-398m		8552		343		1.2
0010 DCB1 UGHS012 313-316m		4.02%		2067		0.5
0011 DCB2 UNGD010 329-330m	1.70	10.00%	8.14	1251	0.001	0.2
0012 DCB3 UGHS140 31-33m		4.28%		1125		0.2
0013 DCB4 UGHS140 66-69m	2.01	4.05%	6.14	1599	0.002	0.6
0014 DCB5 UGHS132 92-94m						
0015 KS1 UGHS012 356-358m	5.75	9611	20.75	511	1.938	6.7
0016 KS2 UGHS092 151-154m	0.96	1.50%	6.95	441	0.004	1.9
0017 KS3 UGHS010 90-92m						
0018 KS4 UGHS010 500-502m		1.06%		708		5.0
0019 KS5 UGHS144 70.5-72m		1.23%		452		4.3
0020 HLS1 UGHS038A 432-434m		9.81%		1159		0.2
0021 HLS2 UGHS039 52-54m		2.29%		1227		0.5
0022 HLS3 UGHS039 74-77m	2.73	3.92%	5.54	2083	0.004	0.4
0023 HLS4 CKD13 474-481m		10.99%		1129		X
0024 NOB REG MC044273 12-13m		2.96%		1557		0.1
0025 NOB GMD1 MC04272 40-45m		3.32%		1431		0.3
0026 NOB GMD2 MC04273 201-206m		3.25%		1468		0.6
0027 NOB GMD3 MC04273 225-230m	0.55	2.47%	2.73	1819	0.008	0.7
STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905		2878		392		3.3
0004 NAG Std 3						
BLANKS						
0001 Control Blank	0.08	X	X	X	X	X

ELEMENTS	Mo	Na	Na	NAG	NAGpH	NAG(4.5)
UNITS	ug/l	ppm	mg/l	kgH2SO4/t	NONE	kgH2SO4/t
DETECTION LIMIT	0.05	20	0.1	1	0.1	1
DIGEST	Ws/	4A/	Ws/	NAGx/	NAGx/	NAGx/
ANALYTICAL FINISH	MS	OE	OE	VOL	MTR	VOL
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	0.21	2.75%	3.2	0	8.1	0
0002 WD2 UGHS012 280-282m		1579				
0003 WD3 UGHS154 87-89m	0.12	9969	1.7	0	8.0	0
0004 WD4 UGHS007 325-327m		943		0	9.9	0
0005 WD5- UGHS012 371-373m				0	8.7	0
0006 POR1 - UGHS012 330-333m	2.37	3.10%	7.6	0	8.5	0
0007 POR2 UGHS140 55-57m		3.12%		0	9.2	0
0008 POR3 UGHS132 56-58m		2.81%				
0009 POR4 UGHS010 395-398m		2.67%		0	9.1	0
0010 DCB1 UGHS012 313-316m		2.11%		0	8.3	0
0011 DCB2 UNGD010 329-330m	0.28	9213	5.0	0	8.4	0
0012 DCB3 UGHS140 31-33m		8464		0	9.5	0
0013 DCB4 UGHS140 66-69m	0.29	6705	3.7	0	8.3	0
0014 DCB5 UGHS132 92-94m				0	8.5	0
0015 KS1 UGHS012 356-358m	X	1591	7.9	412	2.0	337
0016 KS2 UGHS092 151-154m	1.26	1277	1.6	0	7.4	0
0017 KS3 UGHS010 90-92m				102	2.7	72
0018 KS4 UGHS010 500-502m		1979		232	2.3	185
0019 KS5 UGHS144 70.5-72m		875		242	2.2	218
0020 HLS1 UGHS038A 432-434m		931		0	7.1	0
0021 HLS2 UGHS039 52-54m		1.34%		0	8.5	0
0022 HLS3 UGHS039 74-77m	0.49	6325	15.4	0	8.4	0
0023 HLS4 CKD13 474-481m		357		0	8.1	0
0024 NOB REG MC044273 12-13m		2.57%				
0025 NOB GMD1 MC04272 40-45m		2.28%		0	9.2	0
0026 NOB GMD2 MC04273 201-206m		2.36%				
0027 NOB GMD3 MC04273 225-230m	2.63	1.69%	5.6	0	9.2	0
STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905		2.44%				
0004 NAG Std 3				22	2.5	19
BLANKS						
0001 Control Blank	X	X	X	6	4.4	0

ELEMENTS	Nb	Ni	Ni	OH	Pb	Pb
UNITS	ug/l	ppm	mg/l	mgCaCO3/L	ppm	ug/l
DETECTION LIMIT	0.005	1	0.01	0	0.5	0.5
DIGEST	Ws/	4A/	Ws/	Ws/	4A/	Ws/
ANALYTICAL FINISH	MS	OE	OE	VOL	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	X	150	X	0.0000000	12.2	X
0002 WD2 UGHS012 280-282m		291			2.1	
0003 WD3 UGHS154 87-89m	X	279	X	0.0000000	3.0	X
0004 WD4 UGHS007 325-327m		105			3.3	
0005 WD5- UGHS012 371-373m						
0006 POR1 - UGHS012 330-333m	X	10	X	0.0000000	13.3	X
0007 POR2 UGHS140 55-57m		8			6.5	
0008 POR3 UGHS132 56-58m		69			4.6	
0009 POR4 UGHS010 395-398m		7			20.9	
0010 DCB1 UGHS012 313-316m		220			33.0	
0011 DCB2 UNGD010 329-330m	X	257	X	0.0000000	2.4	X
0012 DCB3 UGHS140 31-33m		159			4.2	
0013 DCB4 UGHS140 66-69m	X	170	X	0.0000000	7.6	X
0014 DCB5 UGHS132 92-94m						
0015 KS1 UGHS012 356-358m	X	210	0.17	0.0000000	98.8	10.6
0016 KS2 UGHS092 151-154m	X	11	X	0.0000000	18.7	X
0017 KS3 UGHS010 90-92m						
0018 KS4 UGHS010 500-502m		182			45.3	
0019 KS5 UGHS144 70.5-72m		140			32.5	
0020 HLS1 UGHS038A 432-434m		702			3.3	
0021 HLS2 UGHS039 52-54m		55			3.8	
0022 HLS3 UGHS039 74-77m	X	126	X	0.0000000	5.3	X
0023 HLS4 CKD13 474-481m		1030			0.8	
0024 NOB REG MC044273 12-13m		55			X	
0025 NOB GMD1 MC04272 40-45m		50			3.0	
0026 NOB GMD2 MC04273 201-206m		36			1.1	
0027 NOB GMD3 MC04273 225-230m	X	24	X	0.0000000	1.1	X

STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905		10			30.7	
0004 NAG Std 3						

BLANKS						
0001 Control Blank	X	1	X	0.0000000	X	X

ELEMENTS	pH	pH Drop	S	S	S	S
UNITS	NONE	NONE	%	mg/l	%	%
DETECTION LIMIT	0.1	0.1	0.01	0.05	0.01	0.02
DIGEST	Ws/	ANCx/		Ws/	SHCl/	SCR/
ANALYTICAL FINISH	MTR	MTR	/CSA	OE	OE	VOL
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	9.4	3.1	0.75	3.27	X	
0002 WD2 UGHS012 280-282m	9.4	3.3	0.13			
0003 WD3 UGHS154 87-89m	9.2	3.0	2.57	7.38	0.01	
0004 WD4 UGHS007 325-327m	9.1	3.1	0.77		X	
0005 WD5- UGHS012 371-373m	9.1	3.2	1.29		X	
0006 POR1 - UGHS012 330-333m	9.3	3.4	1.43	7.44	X	
0007 POR2 UGHS140 55-57m	9.2	3.4	0.45		X	
0008 POR3 UGHS132 56-58m	8.6	3.1	0.12			
0009 POR4 UGHS010 395-398m	9.0	3.5	1.13		X	
0010 DCB1 UGHS012 313-316m	9.0	3.0	1.44		X	
0011 DCB2 UNGD010 329-330m	9.2	2.9	1.44	6.51	X	
0012 DCB3 UGHS140 31-33m	9.2	3.1	0.55		X	
0013 DCB4 UGHS140 66-69m	9.1	3.0	1.11	4.77	X	
0014 DCB5 UGHS132 92-94m	9.1	3.0	0.91		X	
0015 KS1 UGHS012 356-358m	4.9	2.8	21.59	88.20	0.15	17.50
0016 KS2 UGHS092 151-154m	8.3	2.9	6.19	11.47	0.03	5.32
0017 KS3 UGHS010 90-92m	8.3	3.0	10.08		0.03	7.71
0018 KS4 UGHS010 500-502m	7.6	2.8	11.87		0.11	8.44
0019 KS5 UGHS144 70.5-72m	8.1	3.1	13.39		0.04	10.80
0020 HLS1 UGHS038A 432-434m	9.0	3.0	0.32		X	
0021 HLS2 UGHS039 52-54m	9.2	3.1	0.24		X	
0022 HLS3 UGHS039 74-77m	9.1	3.1	1.10	6.33	X	
0023 HLS4 CKD13 474-481m	9.2	3.0	0.27		X	
0024 NOB REG MC044273 12-13m	9.6	2.9	0.02			
0025 NOB GMD1 MC04272 40-45m	9.0	3.1	1.09		X	
0026 NOB GMD2 MC04273 201-206m	9.3	3.4	0.06			
0027 NOB GMD3 MC04273 225-230m	8.9	3.1	0.30	1.67	X	

STANDARDS						
0001 DS-1			2.53			
0002 OREAS 502b						
0003 OREAS 905						
0004 NAG Std 3						

BLANKS						
0001 Control Blank	7.1		X	X	X	

ELEMENTS	SO4	Sb	Sb	Se	Se	Sn
UNITS	%	ppm	ug/l	ppm	ug/l	ppm
DETECTION LIMIT	0.03	0.05	0.01	0.5	0.5	0.1
DIGEST		4A/	Ws/	4A/	Ws/	4A/
ANALYTICAL FINISH	/CALC	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	2.25	1.78	2.61	0.6	X	0.1
0002 WD2 UGHS012 280-282m	0.40	0.80		X		0.3
0003 WD3 UGHS154 87-89m	7.71	1.00	2.79	0.9	0.6	X
0004 WD4 UGHS007 325-327m	2.31	1.15		X		0.3
0005 WD5- UGHS012 371-373m	3.86					
0006 POR1 - UGHS012 330-333m	4.27	5.67	9.17	X	X	0.8
0007 POR2 UGHS140 55-57m	1.36	2.19		X		0.7
0008 POR3 UGHS132 56-58m	0.35	2.73		X		0.7
0009 POR4 UGHS010 395-398m	3.40	2.90		X		0.8
0010 DCB1 UGHS012 313-316m	4.31	4.17		X		1.8
0011 DCB2 UNGD010 329-330m	4.33	1.36	4.78	0.5	X	0.1
0012 DCB3 UGHS140 31-33m	1.65	3.00		X		0.3
0013 DCB4 UGHS140 66-69m	3.33	3.52	6.94	X	X	0.3
0014 DCB5 UGHS132 92-94m	2.73					
0015 KS1 UGHS012 356-358m	64.67	13.88	0.02	17.0	3.1	12.4
0016 KS2 UGHS092 151-154m	18.54	14.22	12.40	4.5	1.7	0.3
0017 KS3 UGHS010 90-92m	30.19					
0018 KS4 UGHS010 500-502m	35.56	12.06		15.1		17.1
0019 KS5 UGHS144 70.5-72m	40.12	16.60		7.2		2.2
0020 HLS1 UGHS038A 432-434m	0.97	0.76		X		X
0021 HLS2 UGHS039 52-54m	0.73	3.39		X		0.7
0022 HLS3 UGHS039 74-77m	3.29	1.65	3.62	0.7	0.5	0.3
0023 HLS4 CKD13 474-481m	0.82	0.44		X		X
0024 NOB REG MC044273 12-13m	0.05	3.52		X		0.2
0025 NOB GMD1 MC04272 40-45m	3.25	4.32		X		0.2
0026 NOB GMD2 MC04273 201-206m	0.17	0.61		X		0.2
0027 NOB GMD3 MC04273 225-230m	0.89	0.76	0.64	X	X	1.4

STANDARDS						
0001 DS-1	7.58					
0002 OREAS 502b						
0003 OREAS 905		2.10		2.9		4.0
0004 NAG Std 3						

BLANKS						
0001 Control Blank	X	X	X	X	X	X

ELEMENTS	Sn	Ta	Te	Te	Th	Th
UNITS	ug/l	ug/l	ppm	ug/l	ppm	ug/l
DETECTION LIMIT	0.1	0.001	0.2	0.1	0.01	0.005
DIGEST	Ws/	Ws/	4A/	Ws/	4A/	Ws/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	X	0.002	X	X	0.60	X
0002 WD2 UGHS012 280-282m			0.3		0.99	
0003 WD3 UGHS154 87-89m	X	0.002	5.9	X	0.78	X
0004 WD4 UGHS007 325-327m			1.1		1.17	
0005 WD5- UGHS012 371-373m						
0006 POR1 - UGHS012 330-333m	X	0.002	0.7	X	8.91	X
0007 POR2 UGHS140 55-57m			X		9.29	
0008 POR3 UGHS132 56-58m			X		6.69	
0009 POR4 UGHS010 395-398m			0.4		9.74	
0010 DCB1 UGHS012 313-316m			5.6		0.62	
0011 DCB2 UNGD010 329-330m	X	0.002	2.9	X	0.81	X
0012 DCB3 UGHS140 31-33m			X		0.49	
0013 DCB4 UGHS140 66-69m	X	0.002	X	X	0.48	X
0014 DCB5 UGHS132 92-94m						
0015 KS1 UGHS012 356-358m	X	0.002	3.1	X	4.80	X
0016 KS2 UGHS092 151-154m	X	0.002	1.5	X	0.23	X
0017 KS3 UGHS010 90-92m						
0018 KS4 UGHS010 500-502m			4.5		4.60	
0019 KS5 UGHS144 70.5-72m			4.4		4.15	
0020 HLS1 UGHS038A 432-434m			X		0.15	
0021 HLS2 UGHS039 52-54m			X		0.63	
0022 HLS3 UGHS039 74-77m	X	0.003	0.3	X	0.53	X
0023 HLS4 CKD13 474-481m			X		0.14	
0024 NOB REG MC044273 12-13m			X		0.26	
0025 NOB GMD1 MC04272 40-45m			X		0.20	
0026 NOB GMD2 MC04273 201-206m			X		0.56	
0027 NOB GMD3 MC04273 225-230m	X	0.003	X	X	0.57	X

STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905			X		15.07	
0004 NAG Std 3						

BLANKS						
0001 Control Blank	X	0.002	X	X	X	X

ELEMENTS	TotAlk	U	U	V	V	Zn
UNITS	mgCaCO3/L	ppm	ug/l	ppm	mg/l	ppm
DETECTION LIMIT	2	0.01	0.005	1	0.01	1
DIGEST		4A/	Ws/	4A/	Ws/	4A/
ANALYTICAL FINISH	/CALC	MS	MS	OE	OE	OE
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	34	0.15	X	175	X	671
0002 WD2 UGHS012 280-282m		0.23		118		60
0003 WD3 UGHS154 87-89m	28	0.18	X	126	X	54
0004 WD4 UGHS007 325-327m		0.27		127		50
0005 WD5- UGHS012 371-373m						
0006 POR1 - UGHS012 330-333m	65	2.16	0.109	60	X	77
0007 POR2 UGHS140 55-57m		2.12		53		64
0008 POR3 UGHS132 56-58m		1.40		133		47
0009 POR4 UGHS010 395-398m		2.27		52		75
0010 DCB1 UGHS012 313-316m		0.16		193		304
0011 DCB2 UNGD010 329-330m	128	0.19	X	106	X	50
0012 DCB3 UGHS140 31-33m		0.11		159		55
0013 DCB4 UGHS140 66-69m	114	0.13	X	171	X	208
0014 DCB5 UGHS132 92-94m						
0015 KS1 UGHS012 356-358m	3	1.25	0.189	53	X	7256
0016 KS2 UGHS092 151-154m	30	0.07	0.006	6	X	221
0017 KS3 UGHS010 90-92m						
0018 KS4 UGHS010 500-502m		1.33		100		4789
0019 KS5 UGHS144 70.5-72m		1.17		69		994
0020 HLS1 UGHS038A 432-434m		0.05		107		141
0021 HLS2 UGHS039 52-54m		0.18		201		67
0022 HLS3 UGHS039 74-77m	62	0.15	X	189	X	90
0023 HLS4 CKD13 474-481m		0.03		117		68
0024 NOB REG MC044273 12-13m		0.04		247		63
0025 NOB GMD1 MC04272 40-45m		0.05		281		71
0026 NOB GMD2 MC04273 201-206m		0.11		326		95
0027 NOB GMD3 MC04273 225-230m	40	0.14	X	358	X	90

STANDARDS						
0001 DS-1						
0002 OREAS 502b						
0003 OREAS 905		5.14		10		139
0004 NAG Std 3						

BLANKS						
0001 Control Blank	4	X	X	X	X	X

ELEMENTS	Zn
UNITS	mg/l
DETECTION LIMIT	0.01
DIGEST	Ws/
ANALYTICAL FINISH	OE
SAMPLE NUMBERS	
0001 WD1 UGHS144 28-30m	X
0002 WD2 UGHS012 280-282m	
0003 WD3 UGHS154 87-89m	X
0004 WD4 UGHS007 325-327m	
0005 WD5- UGHS012 371-373m	
0006 POR1 - UGHS012 330-333m	X
0007 POR2 UGHS140 55-57m	
0008 POR3 UGHS132 56-58m	
0009 POR4 UGHS010 395-398m	
0010 DCB1 UGHS012 313-316m	
0011 DCB2 UNGD010 329-330m	X
0012 DCB3 UGHS140 31-33m	
0013 DCB4 UGHS140 66-69m	X
0014 DCB5 UGHS132 92-94m	
0015 KS1 UGHS012 356-358m	28.74
0016 KS2 UGHS092 151-154m	X
0017 KS3 UGHS010 90-92m	
0018 KS4 UGHS010 500-502m	
0019 KS5 UGHS144 70.5-72m	
0020 HLS1 UGHS038A 432-434m	
0021 HLS2 UGHS039 52-54m	
0022 HLS3 UGHS039 74-77m	X
0023 HLS4 CKD13 474-481m	
0024 NOB REG MC044273 12-13m	
0025 NOB GMD1 MC04272 40-45m	
0026 NOB GMD2 MC04273 201-206m	
0027 NOB GMD3 MC04273 225-230m	X

STANDARDS	
0001 DS-1	
0002 OREAS 502b	
0003 OREAS 905	
0004 NAG Std 3	

BLANKS	
0001 Control Blank	X

METHOD CODE DESCRIPTION

Method Code	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
/CALC	Intertek Genalysis Perth **3244 3237** No digestion or other pre-treatment undertaken. Results Determined by calculation from other reported data.	
/CSA	Intertek Genalysis Perth **3244 3237** Induction Furnace Analysed by Infrared Spectrometry	**MPL_W043, CSA : MPL_W043**
4A/MS	Intertek Genalysis Perth **3244 3237** Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Tubes. Analysed by Inductively Coupled Plasma Mass Spectrometry.	**4A/ : MPL_W002, MS : ICP_W003**
4A/OE	Intertek Genalysis Perth **3244 3237** Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Tubes. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	**4A/ : MPL_W002, OE : ICP_W004**
ANCx/MTR	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed with Electronic Meter Measurement	
ANCx/QUAL	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Qualitative Inspection	
ANCx/VOL	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Volumetric Technique.	
AR1/MS	Intertek Genalysis Perth **3244 3237** 1g Aqua-Regia digest. Analysed by Inductively Coupled Plasma Mass Spectrometry.	

METHOD CODE DESCRIPTION

Method Code	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
NAGx/MTR	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed with Electronic Meter Measurement	
NAGx/VOL	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed by Volumetric Technique.	
SCR/VOL	Intertek Genalysis Perth **3244 3237** Chromium Reducible Suplhur Analysed by Volumetric Technique.	
SHCl/OE	Intertek Genalysis Perth **3244 3237** Acid Soluble soil. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	
Ws/COL	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5 or to client request. Analysed by UV-Visible Spectrometry.	
Ws/MS	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5 or to client request. Analysed by Inductively Coupled Plasma Mass Spectrometry.	
Ws/MTR	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5 or to client request. Analysed with Electronic Meter Measurement	
Ws/OE	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5 or to client request. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	

METHOD CODE DESCRIPTION

Method Code	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
Ws/VOL	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5 or to client request. Analysed by Volumetric Technique.	

MINERALS
TEST REPORT

CLIENT

MARTINICK BOSCH SELL PTY LTD
4 Cook Street
WEST PERTH, W.A. 6005
AUSTRALIA

JOB INFORMATION

JOB CODE	:	282.0/1710554
NO. SAMPLES	:	8
NO. ELEMENTS	:	33
CLIENT ORDER NO.	:	[redacted] (Job 1 of 1)
SAMPLE SUBMISSION NO.	:	
PROJECT	:	KCGM MT CHARLOTTE KCGMMCG
DATE RECEIVED	:	13/07/2017
DATE REPORTED	:	27/09/2017
DATE PRINTED	:	27/09/2017

REPORT NOTES

1. Amended Report - This report replaces the previously issued results

TESTED BY

Intertek
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
[redacted]

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that figures beyond the least significant digit have significance.

For more information on the uncertainty on individual reported values, please contact the laboratory.

SAMPLE STORAGE

All solid samples (assay pulps, bulk pulps and residues will be stored for 60 days without charge. Following this samples will be stored at a daily rate until clients written advice regarding return, collection or disposal is received. If storage information is not supplied on the submission, or arranged with the laboratory in writing the default will be to store the samples with the applicable charges. Storage is charged at $4.00 per m3 per day, expenses related to the return or disposal of samples will be charged at cost. Current disposal cost is charged at $150.00 per m3.

Samples received as liquids, waters or solutions will be held for 60 days free of charge then disposed of, unless written advice fo return or collection is received.

LEGEND

X = Less than Detection Limit
SNR = Sample Not Received
* = Result Checked
DTF = Result still to come
IS = Insufficient Sample for Analysis

NA = Not Analysed
UA = Unable to Assay
> = Value beyond Limit of Method
+ = Extra Sample Received Not Listed

ELEMENTS	Ag	Al	As	B	Ba	Be
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l
DETECTION LIMIT	0.01	0.01	0.1	0.01	0.05	0.1
DIGEST	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	MS	OE	MS	OE	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	X	2.78	1.7	0.02	112.14	1.1
0002 WD3 UGHS154 87-89m	0.28	0.79	10.6	0.03	1528.30	4.0
0003 POR1 - UGHS012 330-333m	0.03	1.95	2.3	0.02	209.89	1.3
0004 DCB2 UNGD010 329-330m	0.05	1.05	2.2	0.02	847.16	2.4
0005 DCB4 UGHS140 66-69m	0.12	1.95	2.1	0.01	383.31	3.0
0006 KS2 UGHS092 151-154m	0.04	0.29	7.5	0.02	17.99	1.8
0007 HLS3 UGHS039 74-77m	0.31	2.72	1.0	0.03	37.01	0.7
0008 NOB GMD3 MC04273 225-230m	0.03	0.73	0.3	0.02	14.90	1.1
CHECKS						
0001 WD1 UGHS144 28-30m	0.02	2.85	2.1	X	125.16	1.0
STANDARDS						
0001 TMDW	1.94		79.8		52.18	20.5
BLANKS						
0001 Control Blank	X	X	X	0.01	X	X

ELEMENTS	Ca	Cd	Co	Cr	Cu	Fe
UNITS	mg/l	ug/l	ug/l	mg/l	mg/l	mg/l
DETECTION LIMIT	0.01	0.02	0.1	0.01	0.01	0.01
DIGEST	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	OE	MS	MS	OE	OE	OE
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	372.41	3.49	31.5	0.07	X	144.11
0002 WD3 UGHS154 87-89m	283.99	1.23	16.8	0.14	0.02	48.59
0003 POR1 - UGHS012 330-333m	234.19	0.42	9.3	0.01	0.01	89.92
0004 DCB2 UNGD010 329-330m	279.94	0.58	24.6	0.11	X	47.97
0005 DCB4 UGHS140 66-69m	411.68	1.04	61.8	0.03	X	136.34
0006 KS2 UGHS092 151-154m	238.75	1.02	2.4	0.05	0.06	107.87
0007 HLS3 UGHS039 74-77m	401.19	0.68	36.6	0.04	X	157.13
0008 NOB GMD3 MC04273 225-230m	1440.61	1.66	8.1	X	X	57.67
CHECKS						
0001 WD1 UGHS144 28-30m	370.62	3.48	34.4	0.07	X	145.31
STANDARDS						
0001 TMDW		10.17	25.4			
BLANKS						
0001 Control Blank	X	X	X	X	X	X

ELEMENTS	Hg	K	Li	Mg	Mn	Mo
UNITS	ug/l	mg/l	ug/l	mg/l	mg/l	ug/l
DETECTION LIMIT	0.1	0.1	0.05	0.01	0.001	0.05
DIGEST	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	MS	OE	MS	OE	OE	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	X	0.2	8.74	140.87	15.670	X
0002 WD3 UGHS154 87-89m	X	1.1	4.24	179.59	5.993	0.12
0003 POR1 - UGHS012 330-333m	X	2.3	3.62	96.35	3.601	0.58
0004 DCB2 UNGD010 329-330m	X	1.5	3.17	182.19	4.215	0.14
0005 DCB4 UGHS140 66-69m	X	3.8	8.00	185.05	8.781	X
0006 KS2 UGHS092 151-154m	X	0.2	3.33	98.41	2.393	0.60
0007 HLS3 UGHS039 74-77m	X	2.2	10.11	158.54	12.355	X
0008 NOB GMD3 MC04273 225-230m	X	0.2	3.40	18.52	23.639	X
CHECKS						
0001 WD1 UGHS144 28-30m	X	0.3	9.14	144.90	16.578	X
STANDARDS						
0001 TMDW	X		20.08			101.08
BLANKS						
0001 Control Blank	X	X	X	X	0.002	X

ELEMENTS	Na	Nb	Ni	Pb	pH	S
UNITS	mg/l	ug/l	mg/l	ug/l	NONE	mg/l
DETECTION LIMIT	0.1	0.005	0.01	0.5	0.1	0.05
DIGEST	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	OE	MS	OE	MS	MTR	OE
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	1.6	X	0.04	86.9	4.4	0.55
0002 WD3 UGHS154 87-89m	0.7	X	0.11	12.5	4.3	1.80
0003 POR1 - UGHS012 330-333m	2.3	X	0.01	49.1	4.1	0.99
0004 DCB2 UNGD010 329-330m	5.4	X	0.11	10.9	4.3	1.47
0005 DCB4 UGHS140 66-69m	1.2	X	0.15	19.0	4.5	0.75
0006 KS2 UGHS092 151-154m	0.8	X	X	147.5	4.2	2.22
0007 HLS3 UGHS039 74-77m	3.8	X	0.04	3.4	4.5	0.62
0008 NOB GMD3 MC04273 225-230m	1.9	X	X	1.9	5.2	0.36
CHECKS						
0001 WD1 UGHS144 28-30m	1.7	X	0.04	89.6	4.4	0.60
STANDARDS						
0001 TMDW		0.013		38.9		
BLANKS						
0001 Control Blank	X	X	X	X	2.9	X

ELEMENTS	Sb	Se	Sn	Ta	Te	Th
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DETECTION LIMIT	0.01	0.5	0.1	0.001	0.1	0.005
DIGEST	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 WD1 UGHS144 28-30m	0.73	X	X	X	X	0.098
0002 WD3 UGHS154 87-89m	1.34	0.7	X	0.001	2.6	0.182
0003 POR1 - UGHS012 330-333m	2.28	0.7	X	X	0.3	0.330
0004 DCB2 UNGD010 329-330m	1.44	X	X	X	0.8	0.104
0005 DCB4 UGHS140 66-69m	1.17	0.6	X	X	X	0.060
0006 KS2 UGHS092 151-154m	13.89	0.7	X	X	0.8	0.180
0007 HLS3 UGHS039 74-77m	0.53	0.8	X	X	X	0.072
0008 NOB GMD3 MC04273 225-230m	0.19	3.8	X	X	X	X
CHECKS						
0001 WD1 UGHS144 28-30m	0.90	0.5	X	X	X	0.089
STANDARDS						
0001 TMDW	9.99	9.9	X	0.041	3.3	0.015
BLANKS						
0001 Control Blank	X	X	X	X	X	X

ELEMENTS	U	V	Zn
UNITS	ug/l	mg/l	mg/l
DETECTION LIMIT	0.005	0.01	0.01
DIGEST	ASLP/	ASLP/	ASLP/
ANALYTICAL FINISH	MS	OE	OE
SAMPLE NUMBERS			
0001 WD1 UGHS144 28-30m	0.187	X	0.37
0002 WD3 UGHS154 87-89m	0.113	X	0.04
0003 POR1 - UGHS012 330-333m	0.549	0.02	0.32
0004 DCB2 UNGD010 329-330m	0.115	X	0.14
0005 DCB4 UGHS140 66-69m	0.048	X	0.30
0006 KS2 UGHS092 151-154m	0.057	X	0.60
0007 HLS3 UGHS039 74-77m	0.077	X	0.23
0008 NOB GMD3 MC04273 225-230m	0.014	X	0.03

CHECKS			
0001 WD1 UGHS144 28-30m	0.195	X	0.39

STANDARDS			
0001 TMDW	9.958		

BLANKS			
0001 Control Blank	X	X	X

METHOD CODE DESCRIPTION

Method Code	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
ASLP/MS	Intertek Genalysis Perth **3244 3237** AS4439.3-1997: Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Inductively Coupled Plasma Mass Spectrometry.	**ASLP/ : ENV_W037, MS : ICP_W003**
ASLP/MTR	Intertek Genalysis Perth **3244 3237** AS4439.3-1997: Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed with Electronic Meter Measurement	
ASLP/OE	Intertek Genalysis Perth **3244 3237** AS4439.3-1997: Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	**ASLP/ : ENV_W037, OE : ICP_W004**