Fimiston Open Pit Geochemistry Review and Fimiston South Geochemical Characterisation

Prepared for:

Kalgoorlie Consolidated Gold Mines

March 2022

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FIMISTON SOUTH PROJECT
FOP GEOCHEMISTRY REVIEW AND FS PROJECT MATERIALS CHARACTERISATION

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Document Control for Job Number: KCGMFWRC

Document Status	Prepared By	Authorised By	Date
Draft Report	Gert du Plessis & Tom Robson	Michael North Alan Wright	17 July 2020
Final Report	Michael North	Michael North	21 September 2020
Final Report Rev 1	Michael North	Michael North	22 January 2021
Final Report Rev 2	Jess Li	Michael North	9 March 2022

EXECUTIVE SUMMARY

Kalgoorlie Consolidated Gold Mines (KCGM) operates the Fimiston Operation, located approximately 600 km east of Perth and adjacent to the City of Kalgoorlie-Boulder. The project consists of the Fimiston Open Pit (FOP), Mt Charlotte underground mine, Fimiston and Gidji Processing plants and associated support infrastructure. KCGM plans to expand mining operations at the site via cutback of the FOP, referred to as the Fimiston South (FS) Project. The FS Project will be mined in the same manner as the current Golden Pike (GP) operation utilising a combination of existing and new mining plant.

The objective of this study was to geochemically characterise the waste rock to support environmental approvals and establish whether waste rock and ore generated during the FS Project will pose a significant increased risk to the surrounding environment. As such, the scope comprised:

- A review of all previous KCGM geochemical characterisation studies for the FOP,
- Geochemical characterisation assessment of additional samples for the FS Project.
- Review of current FOP mine waste management practices being implemented to assess risk in relation in relation to the above.

SUMMARY OF FINDINGS

Results of analysis indicates that waste rock and ore from the FS Project are geochemically very similar to materials previously mined at the FOP, with no indication based on properties of possible significant increased environmental risk. Overall trends were for lower concentrations of sulfur/sulfide and significant metals/metalloids than previously mined materials, with low solubilities of dissolved metals and metalloids.

Waste Rock

Results for the primary FS Project lithologies of Golden Mile Dolerite (GMD) (Major lithology 82% of FS waste), Paringa Basalt (PB) and Black Flag (BF) shale waste rock indicated the following:

- All samples of the major waste rock types GMD and PB (86% of waste) were classified non-acid forming (NAF), with most GMD and PB samples further classified acid consuming (AC) due to substantial available acid neutralisation capacity (ANC). Dolomite and/or ankerite were key carbonate minerals present contributing to the available ANC. Samples selected for comprehensive geochemical analysis were considered representative of expected mine waste based on consistency between total sulfur levels in selected samples and the expected sulfur content of most GMD waste (i.e. median value). Review of these drill hole sulfur content assays also indicated overall lower expected concentrations for all waste rock types in the FS database compared to previous mining areas for the FOP and hence lower potential for oxidative release from sulfides.
- BF shale (5% of waste rock from FS Project) total sulfur median concentrations were significantly lower in FS assays than median concentrations in previous FOP assays (0.79 % versus 1.98 %, respectively) – indicating a lower potential for acid formation. Samples selected for comprehensive geochemical analysis were considered representative of expected mine waste. All FS Project BF shale samples were classified NAF or NAF(AC). Overall, the majority of BF shale waste rock from FS Project is expected to be NAF and any seepage and/or runoff is expected to contain low levels of metals and metalloids. Portions of higher sulfur content material from the central bed area in particular may be classified as PAF however much of this is ore grade. No increased risk to the surrounding environment is anticipated for FS Project BF shale waste rock – particularly given continued assumption for management as PAF for this minor waste lithology.
- All waste rock lithologies were geochemically enriched in various elements (gold, silver, bismuth, cadmium, mercury, antimony, tellurium) typical of the Golden Mile deposit. Despite this enrichment of various elements, most were present in highly insoluble forms (e.g. tellurides). Antimony was marginally soluble in some 1:5 water leachates, however only 2 samples of 15 marginal exceeded the NPUG (DER 2014) value of 0.03

mg/L. This guideline was noted to be conservative based on the use of a 1:5 extract, there being no potential for human or stock groundwater use and antimony solubility in any seepage is expected to be limited to adsorption/precipitation reactions in the presence of hydrated iron oxides typically present in subsoils and laterites in Western Australia.

Overall, results indicate any seepage and/or runoff from fresh FS Project waste rock is predicted to be alkaline, non-saline and contain low to very low concentrations of environmentally significant elements. The BF shale material (5% of total waste) is all managed conservatively by KCGM as PAF waste material. Previous FOP studies indicated less than half of BF waste was possibly PAF, current FS Project samples indicate FS Project has a significantly lower potential for acid formation.

Ore

Results of geochemical characterisation and sulfur assay data review of FS Project ore indicated the following:

- Based on review of total sulfur assays, FS Project BF shale ore is expected to contain overall lower total sulfur content relative to FOP operations (medians of 2.5 % versus 4.1 %, respectively). Primary ore (mostly GMD hosted ore) for FS Project indicated lower total sulfur median of 1.34% compared to BF shale ore. Note that only GMD ore is currently processed, whilst BF shale ore is stockpiled for future processing.
- All five ore samples (2 BF shale and 3 GMD) were classified NAF with most (four of five) being sub-classified as acid consuming (PAF-AC).
- FS Project GMD ore contained overall similar or lower concentrations of environmentally significant metals and metalloids compared with previous FOP GMD ore.
- Despite geochemical enrichment of various elements in BF shale ore (gold, tellurium, arsenic and silver) and GMD ore (gold and tellurium), corresponding water-soluble concentrations were not significant. Antimony was marginally soluble in the BF shale ore leachate (0.23 mg/L) which exceeded the NPUG (DER 2014) value of 0.03 mg/L.

Overall, result of analysis of FS Project ore samples included in this study indicate FS ore is expected to be very similar in nature to FOP ore currently processed or stockpiled (BF shale). Although both current samples of BF shale ore indicate a NAF classification with high levels of ANC, sample size is limited for this minor lithology. Continuing management of BF shale as per previous FOP mining (i.e. as potentially PAF) would still be the conservative approach. As such, FS Project ore is not considered to pose any increased risk to the environment.

IMPLICATIONS FOR MANAGEMENT

Waste Rock

Results indicated similar geochemical properties are expected for FS Project waste rock versus FOP materials and no indication for increased environmental risk – overall trends were for lower sulfur content and enrichment than for previous mining. As such, waste rock management practices currently implemented at KCGM are considered to remain appropriate for FS Project waste rock. This includes:

- Management of PB and GMD as NAF materials suitable for coverage or co-mingling with BF shale waste rock.
- Conservative management of BF shale as potentially PAF with appropriate segregation and encapsulation strategies. Specific methods of KCGM's management strategy include:
  - Active co-mingling of BF shale waste rock during dumping with the acid consuming non-BF shale waste rock (i.e. GMD/PB).
  - Ongoing routine groundwater monitoring for signs of impact from waste rock seepage.

— No BF shale waste rock to be left exposed on any surface of WRLs and coverage of at least 5 m of benign waste rock over BF shale. Alternatively, a 2 m oxide waste cover may be used on flat upper surfaces - acting as a store and release layer due to higher fines content.

Ore

FS Project GMD ore for processing or stockpiling/blending is expected to remain geochemically similar to that previously assessed from FOP mining of GMD ore. Therefore, current management of GMD ore stockpiles (in particular low grade stockpiles which may remain for longer periods before processing), is expected to remain appropriate for FS Project GMD ore.

BF shale ore (from the central bed area of the BF seam), carries the greatest risk of AMD formation based on previous studies (GCA 2010 and MBS 2017) after prolonged exposure. Samples and review of drill assay data of BF ore (including high grade ore) assessed in the current assessment indicate lower sulfur contents and lower risk of acid formation in FS Project than previous FOP mining. It is recommended however, to continue management as per KCGM waste rock management procedures (KCGM 2020). As part of these procedures, high grade BF ore is stockpiled for future processing at end of mine life. If any such material is not processed, this would need to be managed as potentially PAF waste at mine closure by suitable means (e.g. burial/encapsulation within the waste rock dump, disposal into pit/underground beneath the water table).

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1. INTRODUCTION

1.1 BACKGROUND

Kalgoorlie Consolidated Gold Mines (KCGM) manages and operates the Fimiston Operation, located approximately 600 km east of Perth and adjacent to the city of Kalgoorlie-Boulder. The project consists of the Fimiston Open Pit (FOP), Mt Charlotte underground mine, Fimiston and Gidji processing plants and associated support infrastructure. KCGM intends to expand mining operations at the site via a cutback of the FOP, referred to as Fimiston South (FS) Project.

The objective of this study was to geochemically characterise the waste rock to support environmental approvals and establish whether waste rock and ore generated during the FS Project will pose a significant increased risk to the surrounding environment. The assessment included a combination of new laboratory testwork for the FS Project and review of results from previous FOP studies to assess the risk waste materials from the FS Project may pose to the surrounding environment.

1.2 SCOPE OF WORK

MBS Environmental (MBS) carried out the following scope of work for the FS Project waste rock characterisation study:

- Liaison with KCGM to obtain all available geochemical reports, documents and laboratory/drilling assay data. Information pertaining to FS Project expected breakdown volumes of waste rock lithologies and geological cross-sections for the FS Project were also provided by KCGM.
- Review previous geochemical waste rock characterisation studies for KCGM, namely:
  - Graeme Campbell and Associates (2010): Geochemical Characterisation of Mine-Waste Samples (Golden Pike Project) – Implications for Mine-Waste Management.
  - SoilWater Group (2013): Kinetics Investigation of Waste Material.
  - MBS Environmental (2017): Fresh Rock Waste Geochemical Characterisation for Fimiston Pit.
  - Current KCGM waste rock management procedure, including management of BF shale waste rock (V3, February 2020).
- Liaisons with KCGM site staff for collection and submission of suitable samples for analysis of FS Project geochemistry.
- Collate and interpret all geochemical data in supplied documentation for waste rock.
- Review current drill hole assay database for FS Project area, in particular sulfur assay results. Data was compared to equivalent data from previous FOP development.
- Comparison of drilling assay and results of geochemical testwork for FS Project samples to results from samples of rock previously mined from the FOP. The outcomes of these comparisons were used to form recommendations on whether existing waste rock management practices remain suitable for the FS Project.
- Preparation of this report, which forms an update to the previous waste rock characterisation report for FOP waste rock (MBS 2017).

1.3 PROJECT DESCRIPTION

Mining and mineral processing has occurred along an 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 (Figure 1).

Ore for gold production at KCGM is today sourced from two primary mining locations: the FOP (also referred to as the 'Super Pit'), located on the Golden Mile, and the Mt Charlotte Underground Mine located approximately 2 km north of the FOP.

All ore mined at KCGM is treated at the Fimiston Processing Plant using flotation and conventional carbon in leach (CIL) circuits which involve cyanide extraction and trapping onto activated carbon. A sulfide concentrate produced by flotation prior to the CIL process within the Fimiston Mill is transferred to the Gidji operation for further processing to improve extraction. Tailings from the Fimiston Processing Plant are currently pumped to the following Tailings Storage Facilities (TSFs); Fimiston I, Fimiston II and Kaltails (Figure 1). These TSFs are located to the north, east and south of the Fimiston Process Plant respectively. Fimiston I was initially constructed in 1988/89, with Fimiston II constructed in 1992.

The FS Project will be a continuation of mining of the greater Golden Mile orebody (mined by KCGM over the past 30 years) comprising the Morrison (MO) and Southern Extension (SE) resources at the southern end of the FOP. It will be mined in the same manner as Golden Pike (GP), the previous substantial open pit cutback (indicated as layback in Figure 1); however, will utilise a combination of existing and new mining fleet.

The majority of waste rock from the Fimiston Open Pit is placed in large waste rock dumps (WRDs) to the east, north and south of the open pit (Figure 1).

Figure 1: KCGM Fimiston Open Pit Site Layout

1.4 PROJECT GEOLOGY

1.4.1 General Description

The Golden Mile at the centre of the Kalgoorlie Goldfield is one of the richest gold deposits in the world. Composed of a series of mineralised faults known as lodes, the deposit mainly occurs in a host rock known as the Golden Mile Dolerite (GMD) (Figure 2).

1.4.2 Mineralisation Geology

Stratigraphy in the vicinity of the Fimiston deposit consists of a basal ultramafic unit called the Hannan Lake Serpentine (HLS), overlain successively by the Devon Consols Basalt (DCB), Kapai Slate (KS), Paringa Basalt (PB) and Black Flag (BF) shale.

Mineralisation at Fimiston occurs in a set of 842 gold-sulfide-telluride bearing lodes, which consist of veins characterised by breccias and open cavity-fill vein textures; sometimes overprinted by foliation. Mineralisation is greatest where the lodes converge and where their extensive alteration halos form a zone of pervasive mineralisation. Lodes can be up to two kilometres in strike length, many hundreds of metres long down-dip and tens of metres wide.

Fresh ore from FOP is refractory and therefore requires an ultra-fine grind to liberate the gold. Ore minerals typically include pyrite, chalcopyrite, other minor sulfides, tellurides of gold, silver, mercury, lead and native gold. Gold is approximately deported as 30 % native gold, 25 % telluride-gold, 35 % pyrite-gold and 10 % “invisible” inclusions in pyrite.

1.4.3 Fimiston South Project Geology

Fimiston South is primarily hosted within the GMD and is a continuation of the western and eastern lode systems. The FS deposits consist of an intensely mineralised shear zone system developed largely within the GMD, and to a lesser extent in the PB, between the Adelaide and Golden Pike faults. The deposits are within a syncline divided into eastern and western lodes arranged on either side of the Golden Mile Fault Zone, which contains the BF Beds.

The GMD, a layered gabbro, has been divided into ten units based on slight differences in mineral abundances and textures. These units have slightly varying chemistry and ductile characteristics, which control mineralisation. A small number of lodes are located within the BF beds that define the break between the western and eastern lodes.

Figure 2: Local Geology

1.4.4 Waste Rock Breakdown

A breakdown of waste rock composition by lithology and weathering zone is presented in Table 1 below. As for the previous FOP mining, the majority of fresh waste rock from the FS Project is GMD (greater than 80% (Table 1). The remaining fresh waste rock is composed primarily of BF shale (5%), and Porphyry and Paringa Basalt (PB) (approximately 3 %). Compared to previous FOP mining, the main difference in waste proportions of fresh waste is that PB will form a smaller proportion of the fresh waste rock volume (previously up to 14%). Portions of BF shale waste are potentially acid forming (PAF). All of this readily visually identified material is managed as PAF waste in accordance with the KCGM waste management plan Section 7).

Table 1: Fimiston South Waste Rock Breakdown

Weathering Zone	Lithology	Mt of waste	Percentage of Total Waste
Oxide	Combined Lithologies	37.9	5.8
Transition	Golden Mile Dolerite	20.3	3.1
	Paringa Basalt	0.002	<0.1
	Black Flag shale	1.25	0.2
	Other (primarily porphyry)	0.61	0.1
Fresh	Golden Mile Dolerite	541	82
	Paringa Basalt	1.95	0.3
	Black Flag shale	33	5.1
	Other (primarily porphyry)	17	2.6
Total Across Weathering Zones	**All**	**652**	**100**

2. GEOCHEMICAL CHARACTERISATION METHODS

There is no single method to reliably determine whether mine or process wastes containing small quantities of sulfur will produce net acidity upon field exposure to air and water. Sulfide minerals are variable in their behaviour under oxidising conditions and not all forms will produce sulfuric acid (H_2SO_4). The acid neutralising capacity of these materials is also variable, and the relative rates of acid-forming and acid-neutralising reactions is important when considering if the materials have potential to generate acidic and metalliferous drainage.

Instead, a combination of approaches is often applied to classify mine or process waste more accurately. These approaches are listed below in order of increasing data requirements (and therefore increased reliability):

- The method of "Sulfur Analysis", which only requires data for total sulfur content. Its adoption is based on long term experience of hard rock wastes from Western Australian mine sites under arid and semi-arid climatic 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 (Price 1997).
- The concept of "Ratio Analysis", 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 (Price 2009).
- Acid-Base Accounting (ABA), in which the Net Acid Producing Potential (NAPP) value, which is calculated by subtracting ANC from MPA, is used to classify the acid generating potential of mine waste. Positive NAPP values indicate that the waste has the potential to generate more acid than it can neutralise.
- Procedures recommended by AMIRA International (AMIRA 2002), which take into consideration measured values provided by the Net 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 stockpile or tailings storage facility.

Classification of wastes in this report uses procedures recommended by AMIRA (2002) based on NAPP and NAG pH 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.
- Analysis for ANC (quoted in kg H_2SO_4/t).
- Calculation of carbonate ANC (CC ANC), reported as kg H_2SO_4/t, from measured concentrations of total carbon (TC) or total inorganic carbon (TIC) (TIC avoids interference for some samples such as shales from organic carbon).
- Calculation of MPA = Tot_S * 30.6, reported as kg H_2SO_4/t.
- Calculation of Acid Production Potential (AP) = [(Tot_S – SO_4_S) * 30.6] kg H_2SO_4/t. 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. Using AP versus MPA corrects for non-oxidisable sulfur present in the sample (i.e. sulfate).
- Calculation of Effective NAPP = [AP – CC ANC] kg H_2SO_4/t. Effective NAPP values correspond more directly to ANC associated with readily reactive carbonates, providing non-neutralising carbonates such as siderite are absent.
- Analysis for NAG potential (reported as kg H_2SO_4/t) to both pH 4.5 and pH 7.
- Analysis for NAG pH (pH of the NAG liquors).

- 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 insoluble sulfur present as barite (barium sulfate), which is a non-acid producing mineral that can interfere with the results. The AMIRA approach of using NAG testing is particularly useful for materials classified as Potentially Acid Forming – Low Capacity (PAF-LC) or where there is very low ANC in the host rock. A combined acid generation classification scheme based on NAPP and NAG determinations which are based on AMIRA (2002); *Draft Guidance Materials Characterisation Baseline Data Requirements for Mining Proposals* (DMP 2016) and the equivalent federal guidelines (DIIS 2016), is presented in Table 2. This classification system, based on static ABA procedures and used in conjunction with geological, geochemical and mineralogical analysis can still leave materials classified as 'Uncertain' which may warrant further investigation by, for example, kinetic characterisation.

A sound knowledge of geological and geochemical processes must also be employed in the application of the above methods. These approaches and methods are described in greater detail in Appendix 1, which also describes potential biases/contribution from:

- Non-pyrite sulfides (e.g. pyrrhotite and base metal sulfides).
- Existing acidity (e.g. sulfate minerals such as jarosite) or exchangeable acidity.
- Reactive carbonates which do not contribute overall to neutralisation (e.g. siderite).

Table 2: Waste Classification Criteria

Primary Geochemical Waste Type Class	NAPP Value kg H_2SO_4/t	NAG pH
Potentially Acid Forming (PAF)	≥10	< 4.5
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	< 4.5
Uncertain (UC)	Positive	> 4.5
Uncertain (UC)	Negative	< 4.5
Non-Acid Forming (NAF)	Negative	> 4.5 or sulfur <0.2 %*
Acid Consuming (AC)	< -100	>4.5
Barren	≤2 and sulfur < 0.05 %	-

** Application of 0.2 % sulfur cut-off as a screening tool for the need for determination of NAG pH for classification may be applied on a site-specific basis in conjunction with assessment of ANC and NPR. This uses a ratio analysis approach for low risk samples based on Western Australian conditions where extensive experience has indicated no potential for samples with less than 0.2 % sulfur to generate net acidity in arid conditions for waste rock from hard rock mines. A negative NAPP and NPR of more than 4 (DIIS 2016) indicates no considered risk of acid generation in such instances.*

3. PREVIOUS GEOCHEMICAL STUDIES - FIMISTON OPEN PIT

Based on observations and recommendations from a review undertaken by HAL-Envirosciences Pty Ltd (HAL) in August 2006, there has been three significant previous reports and one field study of acid mine drainage (AMD) potential on FOP lithologies as summarised in Table 3.

Table 3: Summary of Previous Geochemical Studies

Company	Study Description
Graeme Campbell and Associates Pty Ltd (GCA 2010)	A study of 77 samples including 27 GMD, nine PB and 15 BF shale from the fresh rock 'primary' zone for static ABA testing, pH and EC. Selected samples were analysed for mineralogy by XRD (X-ray Diffraction).
Soilwater Group (SWG 2013)	A static and 52-week kinetic study of five waste rock samples including two BF shale and three GMD samples (refer Section 3.1).
MBS Environmental (MBS 2017)	Static characterisation of additional BF shale waste rock from FOP and 'field kinetic trials' plus leachate assessment of 'field kinetic trials': • KCGM staff collected 15 representative samples of BF shale along a transect of the exposed BF bed in the northern corner of FOP for static geochemical characterisation by MBS. Samples were collected every 1 metre extending out from the centre of the bed in easterly and westerly directions (sampling in a similar fashion as per GCA (2010)) in order to cover the entire width (14 m) of visible BF material. • Static geochemical characterisation of 15 waste rock samples collected at three nominal depths (surface, 0.5 m and 1 m) from 5 Intermediate Bulk Containers (IBCs) located at the Fimiston mine. These IBCs formed the basis of a KCGM 'field kinetic trial' and were filled with BF material either from what is believed to be a transect of the exposed BF shale. Records of the sample selection, initial or any subsequent analysis or exact date of the establishment of this trial are not available, although it is believed that they were established in either 2005 or 2006, possibly on the basis of preliminary recommendations from HAL-Envirosciences. • Assessment of three rainwater leachate samples from the above 'field kinetic trial' of BF bed samples in IBCs.

A brief summary of the combined results of GCA (2010), SWG (2013) and MBS (2017) studies is given in the following sub-sections.

3.1 SAMPLE BREAKDOWN

A summary of samples assessed in the three previous studies are presented in Table 4. In relation to sample selection for those previous studies:

- BF shale samples collected for GCA (2010) were hand sampled (15 samples) at intervals of approximately 1 m from within and adjacent to an available pit exposure within the fresh rock zone, as this lithology was not intersected during the drilling program.
- Soilwater Group (SWG 2013) collected two samples of BF shale from the main mineralised zone and three samples of 'Basalt' comprising one sample (marked "High Grade") from the eastern contact of the mineralised orebody and samples (marked "Low Grade") from either side of the mineralised orebody. Following review by MBS, these three samples are considered to represent GMD waste (rather than PB or ore) based on elemental analysis comparison.

- Sampling by horizontal transect (cross bed) of BF shale waste rock (MBS 2017) allowed comparison to previous data (GCA 2010) and assessment of the distribution of sulfur (and other elements) relative to position within the BF bed.
- Precise details of the origin and the start timing of the 'field kinetic trial' (IBCs) samples no longer exist, but field observations in September 2016 by MBS indicated that all samples comprised BF shale/metasediment and that two from the more central bed area showed evidence of oxidation and acid formation (IBC2 and IBC3). These samples (in particular IBC3 which was the most reactive), were indicated as being from the central bed area, much of which would normally be graded as ore rather than waste. The IBC contents were sampled by depth (as described in Table 3) to determine the degree of weathering (i.e. progression of oxidation front) over the previous 10 to 11 years and to indicate any differences in oxidation by depth.
- The three rainwater leachate samples from 'field kinetic trial' IBCs represented pooled water (effectively pore water) and from IBCs that had sufficient liquid in the base to sample.

The greatest potential for generation of AMD exists within the fresh rock zone and in particular with BF shale, which typically contains more sulfide (e.g. pyrite) and possesses less ANC compared with other waste rock. All samples from weathered (transition and oxide) zones (GCA 2010) were found to be NAF and essentially inert and are not discussed further. Additional information on this weathered material can be found in GCA (2010) and MBS (2016).

Table 4: Fimiston Open Pit Waste Rock Sample Summary

Weathering Zone	Lithology	Number of Samples	Study
Oxide	Mottled zone	3	GCA 2010
	Upper saprolite	4	GCA 2010
	Lower saprolite	2	GCA 2010
	BF shale	3	GCA 2010
Transition	Upper saprolite	2	GCA 2010
	Lower saprolite	2	GCA 2010
	Not known/undifferentiated	7	GCA 2010
	GMD waste	1	GCA 2010
	PB waste	4	GCA 2010
Fresh	GMD waste (drill core)	27	GCA 2010
	GMD waste (grab samples)	3	SWG 2013
	PB waste (drill core)	9	GCA 2010
	BF shale waste (transects across exposed material)	15	GCA 2010
	BF shale waste	2	SWG 2013
	BF shale waste (transects across exposed material)	15	MBS 2017
	BF shale waste 'field kinetic trial' (five IBCs)	15	MBS 2017

3.2 FRESH BLACK FLAG SHALE GEOCHEMISTRY

3.2.1 BF Mineralogy (GCA 2010)

Only one previous study (GCA 2010) assessed the mineralogical composition of BF shale waste rock. Mineralogical analysis indicated BF shale samples contained pyrite in accessory amounts (2 to 10 %) within a matrix dominated by quartz, muscovite and accessory amounts of plagioclase (feldspar). The dominant carbonate mineral was ankerite (10 to 20 % by weight) with trace to accessory amounts (up to 10 % by weight) of siderite. Ankerite composition average was $(Mg_{0.39}Fe_{0.16}Ca_{0.48})CO_3$ and can therefore be expected to provide substantial ANC to neutralise any acid generated during oxidation. Note that BF shale containing higher proportions of siderite relative to ankerite will provide less ANC.

Sphalerite (ZnS), chalcopyrite ($CuFeS_2$) and graphite were also detected in trace amounts. It is worth noting that graphite presence will result in overestimation of CC ANC (carbonate ANC) for BF shale if total carbon is assumed to represent carbonate because graphite does not contribute to ANC.

3.2.2 BF Total Sulfur Distribution and Sulfur Forms

Sulfur assay data obtained using X-Ray Fluorescence (XRF) from drilling programmes for FOP were provided to MBS for review as part of the MBS (2017) study. Sulfur assay data for BF shale were segregated into ore and waste based on an ore-grade cutoff of 1.2 g/t Au and is summarised in Table 5.

Table 5: Sulfur (%) Summary for BF Shale Assay Data - FOP

Type	# Samples	Average	Median	90th Percentile	Maximum
BF ore	210	4.68	4.14	8.10	19.1
BF waste	2,687	2.58	1.98	5.49	17.4

As expected, total sulfur for ore-grade samples were higher on average than waste samples. Data indicated that 9 % of BF shale waste samples were below the 0.3% criterion adopted for potential acid generation in arid climates (refer Analysis Concept, Section 2). BF shale also contains organic sulfur forms which contribute to the total sulfur result but not to acid production potential (AP).

Table 6 shows summary statistics for sulfur forms measured for BF shale waste in previous geochemical characterisation studies, including sulfate sulfur (SO_4_S), chromium-reducible sulfur (CRS) and total sulfur (Total S). Overall, samples selected for these studies are considered representative of BF shale waste on the mining scale, given satisfactory spread of total sulfur concentrations versus drill assay data and similar average total sulfur content (2.58 % versus 3.07 %).

Results indicated reduced sulfur (sulfide) to be the main sulfur form for BF shale waste, specifically pyrite (Section 3.2.1). CRS (0.02 – 10.7%) provided a better indication of oxidisable sulfur content due to the biases of organic sulfur on total sulfur measurements for BF shale waste.

Table 6: Sulfur Forms Summary for BF Shale Waste (%)

Sample Type	Reference	# Samples	SO_4_S Range	SO_4_S Mean	CRS Range	CRS Mean	Total S Range	Total S Mean
BF Transect	GCA (2010)	15	<0.01 - 0.05	0.03	N/A	N/A	0.22 - 5.1	1.48
BF Kinetic	SWG (2013)	2	0.07 - 0.12	0.10	2.02 - 2.56	2.3	3.04 - 3.37	3.21
BF Transect	MBS (2017)	15	0.02 - 0.30	0.13	0.51 - 10.7	4.5	0.61 - 13	5.46
IBC Field Trial		15	0.06 - 1.8	0.41	0.02 - 7.2	1.6	0.08 - 8.2	2.11
Overall Total		**47**	**<0.01 - 1.8**	**0.17**	**0.02 - 10.7**	**2.8**	**0.08 - 13**	**3.07**

N/A = Not Analysed

3.2.3 BF Acid Formation Potential Classification

BF shale waste[1] was found to contain moderate to high levels of sulfide-sulfur (0.02 to 10.7 % CRS) but also moderate to high ANC (Table 7). Consistent results were obtained between GCA (2010) and MBS (2017) for BF shale transect samples, with higher inorganic carbon content observed along either side of the transect (lowest in central bed) with indications of vertical carbonate 'fingering' to the east of the transect. Generally, CC-ANC values were substantially higher than measured ANC values, consistent with the presence of siderite which does not contribute to ANC. Analysis of acid base buffering characteristic curves (ABCC) indicated very low levels of readily available acid buffering capacity, ranging from 0 to 35 kg H_2SO_4/t to pH 6 (reflects readily reactive carbonate ANC) and from 0.5 to 70 kg H_2SO_4/t to pH 4.5 (carbonate ANC consumed; less reactive silicate ANC starts to dominate) (GCA 2010; SWG 2013).

NAG pH and NAPP (from CRS), used for acid formation risk classifications according to criteria outlined in Table 2, are summarised as ranges across the three studies in Table 8, along with numbers of samples for each classification. Whilst acid formation risk classifications for BF shale waste varied among the three studies, results of positional transect samples across the BF shale exposure suggest the higher risk material is located in discrete locations within the BF shale 'lodes'. The following key points were noted from transect sampling of PB 'lodes' and assessment of samples from the 'field kinetic trials':

- Transect sampling of a BF shale 'lode' (MBS 2017) indicated all pit wall BF shale material from the central six metres of a BF bed (central bed), generally having higher CRS content and lower ANC relative to samples from the fringes of the transect, were classified as PAF high capacity (PAF-HC). Consistent with this, all three BF shale waste samples from IBC3 of the 'kinetic field trials' (MBS 2017), believed to be from the central bed zone, were also classified PAF-HC. In contrast, only one BF shale sample (8503 – noted to be central bed) assessed in GCA (2010) would be classified as PAF-HC (NAG pH 2.3, NAPP 107 kg H_2SO_4/t). It was noted that the GCA (2010) report did not provide sufficient details as to where the 'central bed' area extended to, which may explain the discrepancy between these two studies.
- The western most transect samples (MBS 2017) were all classified as NAF, while eastern samples were variable due to the apparent fingering of sulfidic lenses on this side of the central bed. Three of the four eastern samples were classified as NAF (and two AC), and one was PAF-HC. Consistent findings were reported for GCA (2010) for western and eastern BF shale transect waste, with all but one sample (8510) classified NAF (mostly AC).
- Despite classification as either PAF-low capacity (PAF-LC) or PAF-HC, three of the IBC samples (one surface and two at 1 m depths – MBS (2017)), remained circum-neutral (1:5 deionised water extract) after environmental exposure for the period of the trial, approximately 11 years. The depth of these materials in the profile versus oxidised and acidic PAF-HC samples other IBCs (IBC2 and IBC3) suggest that even a 1 m cover of benign waste rock was sufficient to prevent any significant oxidation on the decade timescale.
- Both BF shale samples from SWG (2013) were classified 'uncertain' in the original report on the basis of positive NAPP values (approximately 12 kg H_2SO_4/t for both samples) and NAG pH greater than pH 4.5 (pH 5.8 and 6.8). However, it is noted that NAPP was based on MPA calculated from total sulfur, while CRS provides a more accurate prediction of maximum acid production (no interference from organic sulfur in shales, refer Section 3.2.2). Based on the CRS data, both samples had negative NAPP and can be classified NAF.
- Two samples retain 'uncertain' classification; one sample from GCA (2010) (8510) was classified uncertain on the basis of a positive NAPP value and NAG pH > 4.5 (no CRS measurement) and one IBC sample (IBC5 – 0.5 m, MBS (2017)) was classified uncertain based on a NAG pH < 4.5 (4.3) and negative NAPP (-12 kg H_2SO_4/t).

The MBS (2017) study examined all data available at the time for total sulfur content versus NAG pH, which is considered the most reliable indicator of potential for net acid generation. Overall, based on estimations from total

[1] Gold content was not assayed on previous BF shale samples and as such it is assumed that all samples selected were waste material.

sulfur content and measured NAG pH, it was predicted that BF shale waste would require at least 2 % total sulfur to potentially generate AMD and be classified as PAF with a long 'lag period' prior to net acid production. Based on field conditions and column results (SWG 2013) this is likely in practice to be up to 4% total sulfur. Given the median total sulfur content of all assay samples was 1.98 %, this indicated the waste unit as a whole was near the tipping point of classification. Assay results from 2 to 4 % total sulfur related to a potential of 19 to 50 % of BF shale waste being PAF – long lag under worst case scenario conditions.

Table 7: ANC and CC ANC Summary for BF Shale Waste Samples (kg H_2SO_4/t)

Sample Type	Reference	# Samples	Sobek Modified ANC		ABCC		CC ANC	
			Range	Mean	ANC to pH 6	ANC to pH 4.5	Range	Mean
BF Transect	GCA 2010	15	20 - 210	112	0-35	0.5-70	29 - 343	207
BF Kinetic	SWG 2013	2	77 - 89	83	0.5	20-35	103 - 129	116
BF Transect	MBS 2017	15	9 – 180	79	N/A		7 – 235	91
IBC Field Trial	MBS 2017	15	-23 – 124	38	N/A		0 – 119	36

N/A = Not Analysed.

Table 8: Summary of NAG pH, NAPP and Acid Forming Classifications

Sample Type	Reference	# Samples	NAG pH Range	NAPP (CRS) Range (kg H_2SO_4/t)	Sample Numbers by Classification		
					NAF	PAF	UC
BF Transect	GCA 2010	15	2.3 – 9.0	-184 to 107	13	1	1
BF Kinetic	SWG 2013	2	5.8 – 6.8	12*	0	0	2
BF Transect	MBS 2017	15	2.2 – 8.7	-155 to 294	7	8	0
IBC Field Trial	MBS 2017	15	2.3 – 8.2	-77 to 164	6	8	1
Total		**47**	**2.2 – 9.0**	**-184 to 294**	**24**	**17**	**6**

* *MPA calculated from total sulfur.*

3.2.4 BF Elemental Composition

BF shale samples were geochemically enriched (having a global abundance index (GAI) value ≥ 3 – refer Section 5.3 for more detail) in a number of elements with significant spatial variation across intersections. Highest concentrations of metals and metalloids were found in the middle of intersections near the primary zone (Table 9).

Overall, BF shale was geochemically enriched in a number of elements which are associated with the mineralisation of the Golden Mile deposit.

Table 9: BF Shale Enriched Metals and Metalloids

Element	Reference Study	Average Crustal Abundance (mg/kg)	Concentration Range (mg/kg)	Maximum GAI
Gold	MBS (2017)	0.004	<0.001 to 0.74	6
Silver	GCA (2010), SWG (2013), MBS (2017)	0.07	<0.05 to 28	6
Antimony	GCA (2010), SWG (2013), MBS (2017)	0.2	5.3 to 374	6
Bismuth	GCA (2010), MBS (2017)	0.17	0.0.09 to 2.7	3
Boron	GCA (2010), MBS (2017)	10	<50 to 233	4
Copper	GCA (2010), MBS (2017)	55	27 to 1,897	5
Cadmium	GCA (2010), SWG (2013), MBS (2017)	0.2	0.1 to 15	6
Lead	GCA (2010), MBS (2017)	12.5	12 to 330	4
Mercury	GCA (2010), MBS (2017)	0.08	0.07 to 61	6
Molybdenum	SWG 2013, MBS 2017	1.5	0.8 to 103	6
Selenium	GCA (2010), SWG (2013), MBS (2017)	0.2	<0.5 to 7.1	6
Tellurium	MBS (2017)	0.001	<0.2 to 86	6
Tin	MBS (2017)	2	1.0 to 15	3
Zinc	GCA (2010), SWG (2013), MBS (2017)	70	151 to 8,021	6

3.2.5 Analysis of BF IBC Trial Liquids

It was possible to sample rainfall leachate water IBC2, IBC3 and IBC4 of the 'kinetic field trial' on site. No leachate sample was available from IBCs 1 and 2. It is important to note that concentrations of species in these leachates represented the net effect of up to 10 to 11 years of incident rainfall and evapoconcentration; therefore, care should be taken in drawing conclusions from them. The presence or absence of species (in particular metals and metalloids) however provides a reasonable indication of the potential for leaching of those species from BF materials under worst case exposure conditions.

The IBC Leachate analyses indicated the following:

- Leachate from IBC3 (believed to contain central bed BF shale) was strongly acid (pH 2.1), while IBC2 was marginally acidic (pH 4.1) and IBC4 was circum-neutral. These results were consistent with field observations suggesting extensive oxidation of PAF-HC material in IBC3, marginal oxidation in IBC2 and minimal overall oxidation of material in IBC4.
- The EC values of IBC3 and IBC4 were similar (64.8 and 69.4 mS/cm respectively), but sulfur content in IBC3 leachate was approximately double that of the circum-neutral IBC4. This result, plus a higher sodium concentration in IBC4 leachate, suggests a greater proportion of sodium chloride in IBC4 reflected evaporation versus IBC3, which received more sulfur from oxidising material close to the IBC surface. The EC value of IBC2 (2.8 mS/cm) and sulfur content (336 mg/L) was significantly lower and indicated only brackish water.
- Magnesium rather than calcium was the dominant cation associated with the sulfur (sulfate) in the liquids. Ankerite ($Ca(Fe,Mg,Mn)(CO_3)_2$) was the primary carbonate mineral determined by GCA (2010), but results indicate that the liquids in IBC3 and IBC4 are saturated with respect to gypsum and thus magnesium is the dominant cation.
- Strongly acidic and evapo-concentrated conditions of IBC3 indicated aluminium (2,007 mg/L), iron (528 mg/L), copper (622 mg/L), manganese (365 mg/L), nickel (7.6 mg/L), cobalt (76 mg/L) and zinc (7.8 mg/L) would be the dominant metals and metalloids released under these worst-case exposure conditions. Nickel and cobalt were released under these conditions, despite not being enriched in the bulk material.

- Mercury, tellurium, gold, silver and antimony were not found to be released in soluble forms regardless of pH and despite their geochemical enrichment, with most of these elements not detected or just above detection limits in the leachate samples. This confirms the environmentally insoluble nature of the forms of these elements (e.g. mercury and likely tellurium present in the telluride mineral, coloradoite).

3.2.6 BF Sulfide Oxidation and Solute Release Rates

3.2.6.1 Kinetic Column Study (SWG 2013)

The two BF shale samples assessed for SWG (2013) were not found to undergo any significant sulfide oxidation during the course of a 52-week kinetic leaching experiment. An initial flush of sulfate from previous oxidation was observed but diminished rapidly. These samples would be classified as NAF (using CRS) according the criteria in Table 2, given the negative NAPP (-19 to -13 kg H_2SO_4/t) and NAG pH values of 5.8 and 6.8 (discussed in Section 3.2.3). Leachate pH remained stable at approximately pH 7.4. Apart from initial flushing effects, significant solute release of metals and metalloids was found to be limited to molybdenum in one of the two samples studied. A solute release rate calculated for molybdenum was approximately 1 mg/kg/week, but less than 10 % of total molybdenum present in the sample was leached over 52 weeks.

3.2.6.2 Field IBC Kinetic Trial (MBS 2017)

Initial ABA results were not available for the IBC trial samples (MBS 2017), hence it was not possible to calculate the degree of oxidation in the samples during approximately 11 -years exposure. However, an approximation of sulfide oxidation rate was made based on the sulfate content of the IBC samples with the assumption that minimal net leaching of sulfate occurred – due to low rainfall and the limited solubility of gypsum. Sulfate concentrations were very low in unexposed fresh rock.

Sulfate sulfur results in the 0.5 m depth samples of the IBCs ranged from 0.24 to 0.97 %. Assuming the majority of sulfate remained *in-situ,* this corresponded to an AP of 7.3 to 30 kg H_2SO_4/t overall, or from 0.7 to 2.7 kg H_2SO_4/t per year on average over 11 years. The maximum sulfate content observed in any sample was due to the surface oxidation of PAF-HC material in IBC3 at 1.77 %. This corresponded to acid formation of 54 kg H_2SO_4/t or a generation rate of 4.9 kg H_2SO_4/t per annum. Given these acid production rates, and the typical available ANC content of BF shale samples tested (50 to 100 kg H_2SO_4/t), the material was classified as PAF with a 'long lag' sub classification indicating a delay period of several years before significant acid formation and leachate is likely, even for PAF-HC samples.

3.3 FRESH MAFIC ROCK (PB AND GMD)

3.3.1 Mineralogy (GCA 2010)

One previous study (GCA 2010) assessed the semi-quantitative mineralogical composition of PB and GMD. The only sulfide mineral detected by XRD in GMD (four samples) and PB (two samples) was pyrite in trace to accessory abundance. The dominant carbonate (ANC source) mineral was ankerite, along with some calcite and siderite. Ankerite composition was variable from $(Mg_{0.40}Fe_{0.15}Mn_{0.02}Ca_{0.51})CO_3$ (low iron) to $Mg_{0.27}Fe_{0.27}Mn_{0.01}Ca_{0.49})CO_3$ (high iron) however would still provide considerable available ANC.

Common rock forming minerals were quartz, plagioclase, chlorite, biotite/muscovite micas, all of which are consistent with mafic igneous lithologies.

3.3.2 Total Sulfur Distribution and Sulfur Forms

Sulfur assay data (XRF) for PB and GMD from the FOP, which may include some ore material as gold content was not indicated, were included in the geological drill hole database provided to MBS for review (MBS 2017) and are summarised in Table 10. The GMD data includes all the associated mafic units U1 to U9.

Data indicated that the majority (54 %) of GMD samples contained below the 0.3 % sulfur threshold of the Analysis Concept (Section 2), while for PB the proportion was approximately one third (28 %).

Table 10: Sulfur (%) Summary for GMD and PB Drillhole Assay Data

Type	# Samples	Mean	Median	90th Percentile	Maximum
GMD waste	101,751	0.69	0.26	1.81	22.4
PB waste	38,201	1.23	0.63	3.14	26.0

Table 11 shows summary statistics for sulfur forms measured for PB and GMD waste in previous geochemical characterisation studies, including parameters total sulfur (Total S) and sulfate-sulfur (SO_4_S) – note concentrations less than the laboratory limit of reporting (LOR) were assumed as equal to half the LOR for calculation purposes. In general, GMD had higher total sulfur content relative to PB among the samples selected for analysis. Sulfide-sulfur was the dominant sulfur form in both PB, and GMD given generally very low sulfate sulfur content.

Table 11: Sulfur Forms Summary for PB and GMD Waste Samples (%)

Waste Type	Reference	# Samples	Total S Range	Total S Mean	SO_4_S Range	SO_4_S Mean
PB waste	GCA (2010)	9	0.02 – 0.14	0.06	<0.01	<0.01
GMD waste	GCA (2010)	27	0.04 – 3.10	0.28	<0.01 – 0.03	0.01
	SWG (2013)	3	0.34 – 2.77	1.25	0.07 – 0.29	0.15

3.3.3 Acid Formation Potential Classification

Two previous studies (GCA 2010 and SWG 2013) geochemically characterised PB and GMD waste rock. Summary ABA data and acid forming classifications for mafic waste lithologies are provided in Table 12 and Table 13, respectively. Key points for static geochemical analysis of mafic lithologies were:

- All PB and GMD waste rock samples were classified NAF on the basis of generally low sulfide-sulfur content (most less than 0.2 %) and high ANC.
- GMD waste rock had higher ANC (means > 150 kg H_2SO_4/t) than PB (mean 98 kg H_2SO_4/t), sufficient to be classed acid-consuming (NAF-AC) (Table 2).
- The NAG pH of samples ranged from 8.3 to 10.4, also consistent with materials classified NAF or NAF (AC).
- ABCC analysis indicated high acid-buffering capacity for both GMD and PB waste rock. Data suggests GMD to have between 100 and 140 kg H_2SO_4/t readily available ANC (to pH 6) and between 120 to 165 kg H_2SO_4/t to pH 4.5 (Table 12). ANC buffering for PB ranged from 40 to 120 kg H_2SO_4/t (to pH 6) and from 70 to 140 kg H_2SO_4/t (to pH 4.5).
- Calculated maximum potential acidity (MPA) based on the 90th percentile sulfur contents (55 kg H_2SO_4/t for GMD and 96 kg H_2SO_4/t for PB) from drillhole assays. This is less than the mean ANC values for samples of GMD and PB tested: 171 kg H_2SO_4/t and 98 kg H_2SO_4/t, respectively. This indicates an extremely low risk of AMD generation from these lithologies. The data also suggest the much of this material (GMD) can be considered acid consuming for the purposes of mine closure. No further assessment of these lithologies was deemed necessary in terms of AMD potential.

Table 12: Summary ABA Data for Mafic Lithologies

Waste Type	Reference	N^O Samples	Total S (%)		Sulfate sulfur (SO_4-S, %)		ANC (kg H_2SO_4/t)			
			Range	Median	Range	Median	Range	Mean	To pH 6	To pH 4.5
PB waste	GCA (2010)	9	0.02 – 0.14	0.05	<0.01	<0.01	24 - 160	98	40-120	70-135
GMD waste	GCA (2010)	27	0.04 – 3.1	0.16	<0.01 – 0.03	0.01	97 - 230	171	100-140	120-165
	SWG (2013)	3	0.34 – 2.77	0.65	0.29 – 1.94	0.43	140 - 179	154	5-10	50-100

Table 13: Summary of Waste Classifications for Mafic Lithologies

Waste Type	Reference	N^O Samples	NAPP (kg H_2SO_4/t)		NAG pH	Classification
			Range	Mean	Range	
PB waste	GCA (2010)	9	-23 to -159	-96	8.3 – 8.4	NAF
GMD waste	GCA (2010)	27	-94 to -220	-158	8.3 – 9.4	NAF (AC)
	SWG (2013)	3	-64 to -171	-121	8.6 – 10.5	NAF (AC)

3.3.4 Elemental Composition

Examination of results indicates variable enrichment (GAI ≥ 3 – Section 5.3) in silver (<0.2 to 1.1 mg/kg) and antimony (1.4 to 9.1 mg/kg) for both lithologies, with some GMD waste samples also having elevated concentrations of mercury (maximum 0.44 mg/kg) and arsenic (10 to 260 mg/kg). One GMD waste sample (11-0216-002) for the SWG (2013) study also showed geochemical enrichment (GAI of 3) of cadmium (1.9 mg/kg) and selenium (3 mg/kg).

3.3.5 Sulfide Oxidation and Solute Release Rates

GMD waste samples used in 52-week kinetic leaching experiments (SWG 2013), did not exhibit any significant oxidation during the course of the experiment. Leachate pH remained stable at approximately pH 7.8. Apart from initial flushing effects, only arsenic in one of the three samples tested was found to be released at any significant level in comparison to relevant water quality criteria. A maximum arsenic concentration of 0.38 mg/L (release rate of 0.068 mg/kg/week) was recorded in week eight of the experiment, which is slightly below the livestock drinking water Default Guideline Value (DGV) of 0.5 mg/L (ANZECC 2000). The average arsenic release rate was approximately 0.03 mg/kg/week and less than 10 % of total arsenic present in the samples was leached over 52 weeks. This indicates that those elements highlighted as enriched (arsenic, antimony, mercury, selenium and silver) in GMD are not expected to be significantly soluble in fresh rock material, and only released extremely slowly with due to weathering.

4. DESCRIPTION OF SAMPLES FOR FIMISTON SOUTH

KCGM staff collected representative waste rock and ore samples (all fresh rock) from the FS Project according to a sampling and analysis plan (SAP) prepared by MBS. Sampling was undertaken over two stages:

- The first stage involved collection of 12 waste rock samples from drill core by KCGM staff, composited over 10 metre intervals. Drill rigs were positioned next to the existing FOP at the natural ground surface and collars were directed towards the FS Project area.
- The second stage (after review and advice by MBS), involved collection of 20 waste rock and three ore samples, mostly from drill core over two metre down-hole interval lengths. Of these, three GMD waste rock samples and one GMD ore sample were collected as grab samples from the FOP pit floor.

Plan view, cross-section and long-section geological figures for all samples are provided in Appendix 2. A summary of all FS Project waste rock and ore samples is presented in Table 14. Detailed sample descriptions are given in Table A3-1 of Appendix 3.

Table 14: Summary of FS Project Samples

Material	Lithology	Number of Samples		Total
		Stage 1	Stage 2	
Waste rock	BF shale	2	2	4
	GMD	8	13*	21
	PB	2	3	5
Total Waste Rock Samples		**12**	**18**	**30**
Ore	BF shale	0	2	2
	GMD	0	3**	3
Total Ore Samples		**0**	**5**	**5**
Total Samples		**12**	**23**	**35**

** Including three grab samples.*

*** Including one grab sample.*

5. LABORATORY METHODS – FS PROJECT MATERIALS

5.1 MINERALOGICAL ASSESSMENT

All Stage 1 samples (Table 14) were subjected to semi-quantitative X-Ray Diffraction (XRD) mineralogical assessment by ALS Metallurgy. Samples were pressed into a back-packed sample holder to minimize preferred orientation of particles. Powder XRD was used for analysis and a combination of matrix flushing and reference intensity ratio (RIR) derived constants was used to quantify mineralogical composition. Results from head assay analysis were also used to identify minerals.

5.2 ACID BASE ACCOUNTING

Sample analysis was performed by ALS Metallurgy and Intertek Genalysis. All samples (Stage 1 and 2) were screened using ABA parameters: total sulfur, total carbon and ANC. BF shale samples (waste and ore) were also assessed for acid insoluble carbon content to discern between graphite carbon and carbonate carbon (i.e. total inorganic carbon was calculated by difference between total and acid insoluble carbon). NAG testing was generally only conducted for samples containing at least 0.2 % total sulfur (refer 'Analysis Concept', Section 2). CRS was determined for all BF shale samples (including ore) and also on selected samples of GMD and PB waste and ore. Sulfate sulfur was measured only on selected samples excluding BF shale, which may contain organic sulfur that interferes with sulfate sulfur determination.

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 obtained either by direct measurement (CRS) or calculated as the difference between total sulfur and sulfate-sulfur, which is present in a fully oxidised form and is therefore not capable of generating additional acidity.

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 (NAG pH) 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 NAG pH 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.

5.3 ELEMENTAL COMPOSITION

Major and trace metals and metalloids were measured following digestion of a finely ground sample with a four-acid mixture of nitric, hydrochloric, perchloric and hydrofluoric acids, which is a total determination for the elements measured. Digest solutions were analysed using inductively coupled plasma mass spectrometry (ICP-MS) or optical emission spectrometry (ICP-OES) as required.

From this data, the global abundance index (GAI) for each element was calculated by comparison to the average earth crustal abundance (AusIMM 2001, Smith and Huyck 1999). Where concentrations of any given element fall below the laboratory limit of reporting (LOR), an indicative value equal to the respective LOR is used to calculate GAI or the GAI is assigned as zero. 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 0 to 6 (INAP 2009). A GAI of 0 indicates that the content of the element is less than or up to three times the average crustal abundance; a GAI of 1 corresponds to a three to six fold enrichment; a GAI of 2 corresponds to a 6 to 12 fold enrichment and so forth, up to a GAI of 6, which corresponds to a 96-fold, or greater, enrichment above average crustal abundances. A GAI of 3 or more is generally considered 'significant' and may warrant further investigation.

5.4 LEACHATE CHARACTERISATION

5.4.1 Water Leachate Characterisation

Samples of pulverised waste rock and ore were subject to a water leach similar to the Australian Standards Leaching Procedure (ASLP) 4439.3 Class 1 specification (Standards Australia 1997), except that the solid to liquid ratio used was 1:5. The use of a tumbled water extract of a finely ground sample allows the laboratory water extraction test to mimic weathering conditions that may be expected in a temperate, semi-arid environment over a period of several years. Extracting samples at a solid to liquid ratio of 1:5 in the present work was a compromise between the higher solid to liquid ratios that may be experienced in saturated waste rock storage conditions and the 1:20 ratio often used to simulate short-term leaching by rainwater and comparison to water quality criteria (ASLP extraction ratios are derived from a United States Environmental Protection Authority (USEPA) default attenuation factor of 20). Hence 1:5 extract ratio results are conservative for comparison to water quality criteria but also suitable for consideration of plant uptake. The filtered (0.45 µm) leachate solutions were analysed using ICP-OES, ICP-MS or other methods as necessary, for a range of elements including major ions (calcium, magnesium, potassium, sodium, sulfate and chloride) and a suite of environmentally significant metals and metalloids commensurate to total elemental composition. Leachates were simultaneously tested for electrical conductivity (EC), pH, fluoride and alkalinity (bicarbonate, carbonate and hydroxide forms) using electrochemical and volumetric (titration) methods.

5.4.2 NAG Liquor Analysis

Digestion solutions (i.e. 'liquor') generated during NAG testing (described in Section 5.2) were analysed (after filtration) on selected samples for a suite of environmentally significant metals and metalloids using ICP-MS/OES as required. This analysis provides an indication of elemental solubility under extreme oxidising conditions, and therefore useful information on potential release of metals and metalloids during sulfide oxidation.

5.4.3 Specialised Leaching Characterisation

Selected samples of waste rock and ore were subjected to four different extractions to further characterise the solubility behaviour of key metals and metalloids under a range of potential environmental conditions. These consisted of:

- A deionised water ASLP (1:20) extraction.
- A synthetic saline ASLP (1:20) extraction using 1 % and 5 % NaCl as the extraction fluid. This test predicts elemental solubility behaviour under saline conditions, which represents the local groundwater environment.
- Hydroxylamine ASLP (1:20) extraction. This test predicts element solubilities under acidic and reducing/anoxic conditions.

- Total environmentally available elements by aqua regia. Aqua regia refers to a mixture of hydrochloric and nitric acids in a ratio of 3:1 used to digest a finely crushed sample and represents total environmentally available elemental concentrations. Digest solutions were analysed by ICP-OES/MS as required.

Results from this specialised leachate testing, although not directly relevant to as-placed FS Project waste rock above-ground (which should remain oxic and non-saline), was mainly selected to inform the geochemical pit lake model as part of separate works.

6. RESULTS AND DISCUSSION – FIMISTON SOUTH GEOCHEMISTRY

6.1 MINERALOGICAL COMPOSITION

Results for semi-quantitative mineralogical analysis by XRD (ALS Metallurgy) for the 12 Stage 1 FS Project waste rock samples (Table 14) are presented in Table 15. Mineral phase concentrations are reported on a percentage by weight basis (% w/w). The original laboratory report is provided in Appendix 4.

Mineral compositions for FS Project waste rock samples were entirely consistent with previous FOP mineralogy results (GCA 2010) and reflective of their geological provenance. Key indications for FS Project samples were:

- Quartz and muscovite were dominant minerals for BF shale, collectively accounting for approximately 70% of the mineral matrix. Accessory carbonate minerals were present, dominated by dolomite/ankerite (around 8 %) followed by siderite/magnesite (between 4 and 7%) and calcite in trace amounts (<1%). Sulfide minerals were present as a mixture of pyrite and pyrrhotite, present in approximately equal proportions at between 2 and 4% each (4-7% total sulfide).
- Chlorite, quartz and plagioclase (feldspar) were dominant minerals for GMD waste rock, collectively accounting for between 50 and 75% of the mineral matrix. Calcic amphibole group minerals (e.g. tremolite) were detected in three of the eight GMD samples in moderate to high proportions (9 to 30%). The abundance of chlorite and amphiboles together with trace paragonite (metamorphic rock that transitions to chlorite) reflects the metamorphic geological nature of these materials. Carbonate minerals were relatively abundant, comprising calcite, dolomite/ankerite and siderite/magnesite (5 – 27% total carbonates), with dolomite/ankerite and calcite dominating over siderite/magnesite. These carbonate minerals, except siderite, are expected to provide most of the material ANC. Pyrite was the only sulfide mineral detected in low to trace amounts (up to 2%). Other trace minerals included ilmenite, rutile and magnetite present at low levels (between 2 and 4%).
- PB samples were dominated by quartz (41 to 47%) and dolomite/ankerite (20 to 29%), with accessory siderite/magnesite (11 to 13 %). Pyrite was the only sulfide mineral present at low levels between 1 and 2 %. Rutile (titanium dioxide) was also detected at low levels (2 to 4 %).

Table 15: Mineralogical Composition Summary of FS Project Waste Rock (% w/w)*

Group	Phase	Formula	BF Shale		GMD								PB	
Samples			#3	#4	#1	#2	#5	#6	#7	#8	#11	#12	#9	#10
Silicates	Calcic amphibole group	$Ca_2Si_8O_{22}(OH)_2$ (tremolite)	-	-	30	-	-	-	-	20	-	9	-	-
	Chlorite	$(Fe,Al,Mg)_6(Si,Al)_4O_{10}(OH)_8$	3	3	25	32	29	1	14	17	15	25	2	4
	Potassium feldspar	$KAlSi_3O_8$	1	1	1	1	-	-	-	2	1	-	-	-
	Quartz	SiO_2	54	54	18	31	29	36	34	13	31	22	41	47
	Plagioclase	$(Na,Ca)(Al,Si)_2Si_2O_8$	4	6	7	12	10	21	11	24	18	23	2	1
	Paragonite	$NaAl_2[(OH)_2AlSi_3O_{10}]$	-	-	-	-	1	-	1	-	1	-	6	6
	Clinopyroxene	$(X,Y)(Si,Al)_2O_6$ X = Ca,Na,Fe^{2+},Mg Y = $Al,Cr,Fe^{3+},Mg,Co,Mn,Sc,Ti,V$.	-	-	1	-	-	-	-	2	-	1	-	6
	Epidote	$Ca_2(Al_2,Fe)(SiO_4)(Si_2O_7)O(OH)$	-	-	8	-	-	-	-	8	-	5	-	-
	Mica	$KAl_2(Si_3AlO_{10})(OH)_2$ (muscovite)	17	13	<1	2	2	9	7	1	3	-	3	1
		$K(Mg,Fe)_3(AlSi_3O_{10})(F,OH)_2$ (biotite)	2	3	2	1	1	1	1	5	1	-	1	-
	Total Silicates		**81**	**80**	**92**	**79**	**72**	**68**	**68**	**92**	**70**	**85**	**55**	**65**
Carbonates	Calcite	$CaCO_3$	<1	-	4	13	15	-	-	3	-	7	-	-
	Dolomite – ankerite	$CaMg(CO_3)_2$ (dolomite) $Ca(Fe,Mg,Mn)(CO_3)_2$ (ankerite)	8	7	-	2	7	10	19	-	18	<1	29	20
	Siderite – magnesite	$FeCO_3$ (siderite) $MgCO_3$ (magnesite)	4	7	1	1	-	18	8	-	5	-	13	11
	Total Carbonates		**12**	**14**	**5**	**16**	**22**	**28**	**27**	**3**	**23**	**7**	**42**	**31**
Sulfides	Pyrite	FeS_2	3	2	-	-	-	1	2	-	1	1	1	2
	Pyrrhotite	$Fe_{(x-1)}S$	4	2	-	-	-	-	-	-	-	-	-	-
	Total Sulfides		**7**	**4**	**-**	**-**	**-**	**1**	**2**	**-**	**1**	**1**	**1**	**2**
Clays	Clay mineral	Undefined	<1	<1	2	2	3	<1	1	1	<1	1	<1	<1
	Kaolinite	$Al_2Si_2O_5(OH)_4$	<1	-	1	<1	1	-	<1	1	<1	1	-	-

Group	Phase	Formula	BF Shale		GMD								PB	
Samples			#3	#4	#1	#2	#5	#6	#7	#8	#11	#12	#9	#10
	Total Clays		<2	<1	3	2	4	<1	1	2	<2	2	<1	<1
Others	Ilmenite	$FeTiO_3$	-	-	-	-	-	2	2	-	2	1	-	-
	Rutile	TiO_2	-	-	-	-	2	-	2	-	-	2	4	2
	Magnetite	Fe_3O_4	-	-	-	3	-	-	-	3	4	2	-	-
	Total Other		-	-	-	3	2	2	4	3	6	5	4	2
Total			100	98	100	100	100	99	102	100	100	100	102	100

** Mineral phases not detected by XRD denoted with "-".*

6.2 SULFUR DISTRIBUTION

KCGM supplied MBS with the FS Project exploration drill hole database for interrogation, which included a total of 373,865 total sulfur assays across ore and waste rock within the proposed FS Project pit, typically composited over 1 m down-hole intervals totalling 530,639 linear metres (Table 16). The database was initially manipulated to approximately segregate in-pit from ex-pit materials (excluding assays below -1,000 m relative level (RL)) and ore from waste, with gold grades greater than 0.5 g/t qualifying as ore-grade for GMD (higher cut-off of 1.2 g/t for BF shale ore). Waste samples were then grouped according to their parent lithologies with particular focus on major waste rock lithologies (BF shale, PB and GMD). Minor lithologies were grouped together, being those present in insignificant proportions relative to the major lithologies or those that will not be encountered during mining of FS (e.g. Williamstown Dolerite and Devon Consols Basalt).

Total sulfur distribution and summary statistics are discussed for ore and waste in the following sub-sections. Comparison between FS Project drill assay data and previous historical FOP drill assay data (refer Section 3.2.2 and 3.3.2) is made below, noting the higher number of assays in current FS Project data (373, 865) versus previous FOP data (144,515).

Table 16: Breakdown of FS Project Assays

Material Type	Lithology	Number of Samples	Linear Metres Assayed (m)
Waste rock	BF shale	13,274	16,951
	GMD	232,579	333,171
	PB	27,044	36,777
	Minor/other	20,301	28,957
Ore	BF shale	575	613
	Other (i.e. GMD)	80,092	114,170
	Total	**373,865**	**530,639**

6.2.1 Fimiston South Ore

Total sulfur summary statistics for FS Project and FOP ore is presented for comparison in Table 17. The distribution of sulfur in BF shale ore (FS Project and FOP) and other ore types (e.g. notably GMD, data for FS Project only) are presented in Chart 1 and Chart 2 (note irregular x-axis), respectively. The following key points were drawn from the data:

- BF shale ore contains higher total sulfur concentrations than other ores (Table 17). Sulfur distribution curves were relatively similar for BF shale ore (Chart 1) and other ores (Chart 2) albeit offset to higher concentrations in BF ore. A proportion of total sulfur in BF shale is expected to be in non-acid generating organic form as also mentioned in Section 3.2.2.
- Total sulfur concentrations in BF shale ore from the current FS Project were overall lower in comparison to historical FOP assays, with a median of 2.53% versus 4.14 % (Table 17, Chart 1).

Overall, ore mined from the proposed FS Project is expected to contain similar or lower total sulfur concentrations compared to ore mined at the FOP. Based on mineralogical assessment, this sulfur is present as pyrite, pyrrhotite and also non-acid producing organic sulfur forms in BF shale.

Table 17: FOP and FS Project Total Sulfur Summary Statistics (% w/w) – Ore

Ore Type	Domain	Nº Samples	Average	Median	90th Percentile	Maximum
BF shale	FOP	210	4.68	4.14	8.10	19.1
	FS	575	3.01	2.53	5.67	14.2
Other ore (mostly GMD)	FS	80,092	1.9	1.34	4.31	21.9

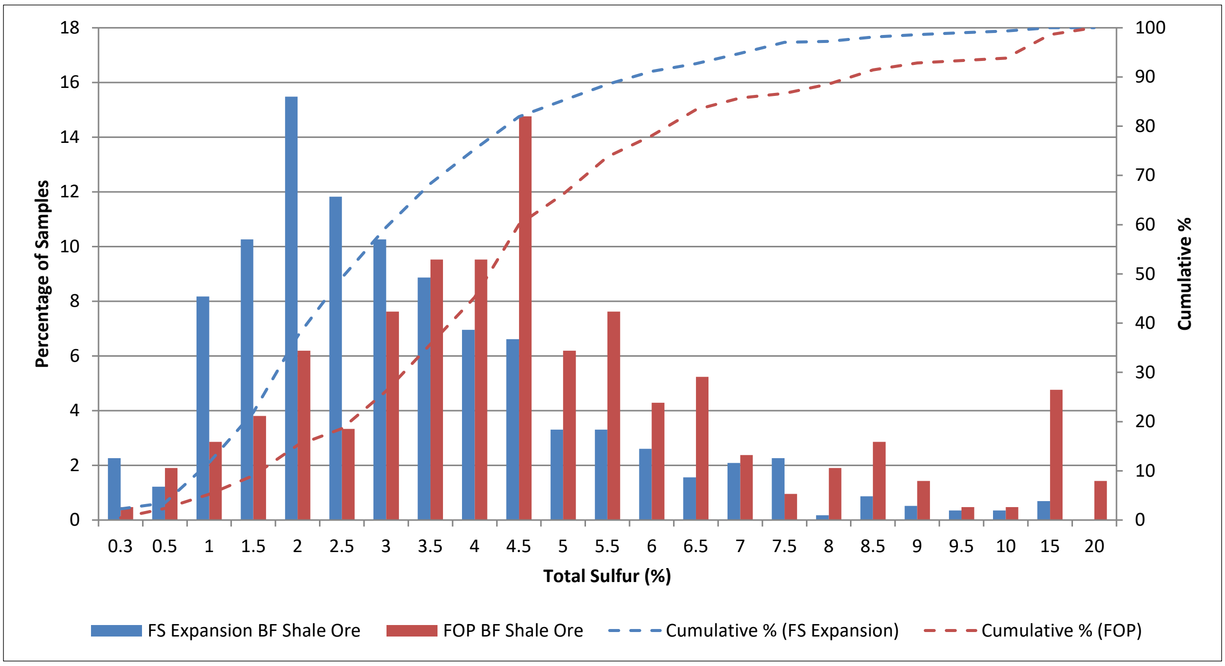

Chart 1: Total Sulfur Distribution for BF Shale Ore

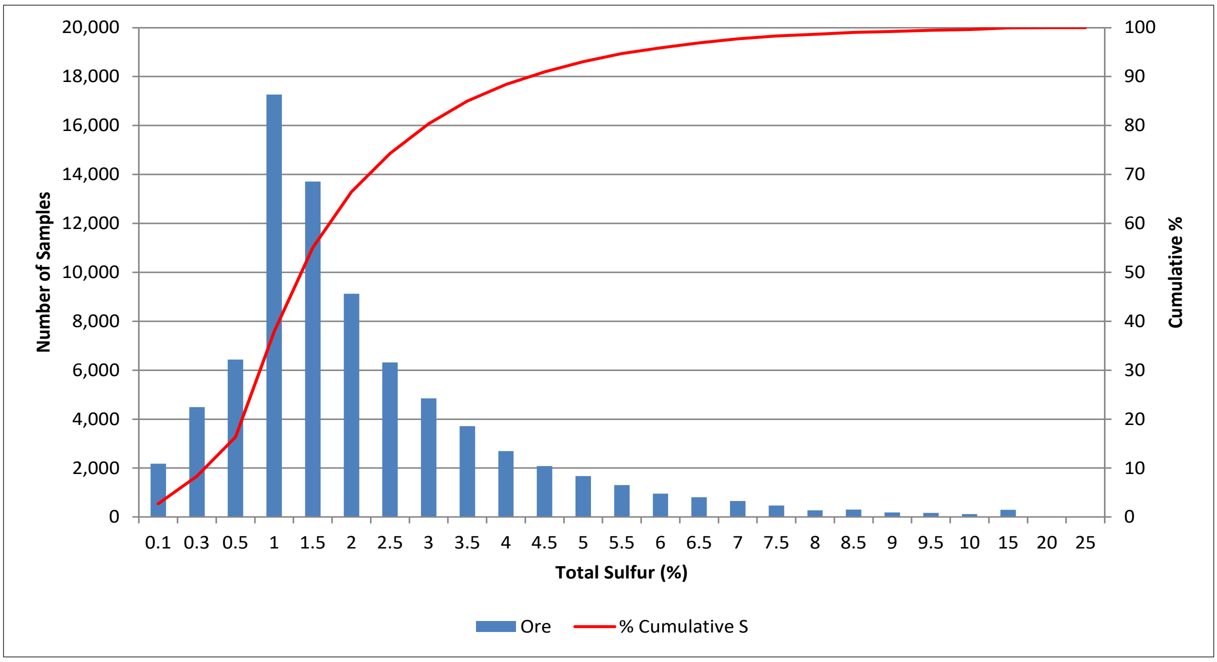

Chart 2: Total Sulfur Distribution for Non-BF Shale Ore (Other Ore)

6.2.2 Fimiston South Waste Rock

Total sulfur statistics across major and minor waste rock lithologies for both FS Project and FOP domains are summarised in Table 18. The distribution frequency of sulfur concentrations in BF shale, GMD, PB and other/minor lithologies for both domains are shown in Chart 3, Chart 4, Chart 5 and Chart 6, respectively. This data indicated the following:

- Despite recording higher maximum total sulfur, overall concentrations for BF shale, GMD and PB from FS Project were lower in comparison to FOP concentrations. The contrast between FS Project and FOP was highest for BF shale waste, which carries the highest risk of being classified PAF, whereby medial total sulfur concentrations were 0.79% (FS) and 1.98% (previous FOP). Median total sulfur concentrations recorded for FS Project GMD and PB waste were also approximately half of those recorded during from previous FOP drilling.
- The percentage of samples with less than 0.3 % total sulfur, and so considered unlikely to generate net acid seepage in arid to semi-arid environments, was much higher for FS Project waste versus FOP waste. Overall, this percentage was around 20 % higher for each waste rock lithology, with GMD (major waste rock unit by volume) having 77% of assayed samples (179,086 samples) with less than 0.3 % total sulfur. Approximately half of the PB samples assayed (11,899 samples), the next major waste type, contained less than 0.3 % total sulfur.
- Combined minor waste rock lithologies were not discussed in the MBS (2017) report. Results as above indicate overall lower total sulfur contents for FS Project assays versus FOP. Most of the samples (64 %) from the FS Project contained less than 0.3 % total sulfur with a median concentration of 0.18 %.

Overall, the FS Project is considered unlikely to encounter waste rock with greater acid forming potential than previous FOP mining. This was demonstrated by lower total sulfur assay concentrations reported across all major and minor waste rock lithology types for the FS Project versus the previously mined FOP material.

Table 18: FOP and FS Project Total Sulfur Summary Statistics (% w/w) – Waste Rock

Waste Lithology	Domain	Number of Samples	Average	Median	90th Percentile	Maximum	% Samples < 0.3 % S
BF shale	FOP	2,687	2.58	1.98	5.49	17.4	9 %
	FS	13,274	1.48	0.79	3.71	23.2	28 %
GMD	FOP	101,751	0.69	0.26	1.81	22.4	53 %
	FS	232,579	0.24	0.15	0.49	38.0	77 %
PB	FOP	38,201	1.23	0.63	3.14	26.0	27 %
	FS	27,044	0.61	0.31	1.42	33.6	48 %
Other (minor units)	FOP	39,663	0.91	0.32	2.55	19.2	48 %
	FS	20,301	0.48	0.18	1.09	20.7	64 %

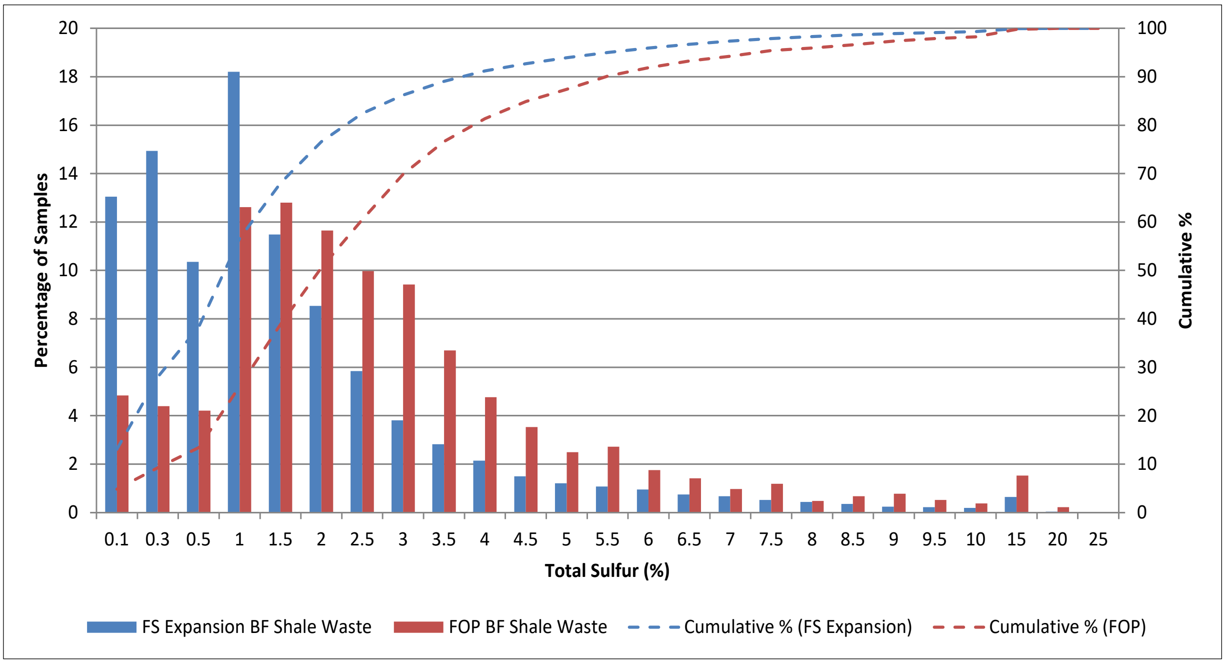

Chart 3: Total Sulfur Distribution for BF Shale Waste Rock

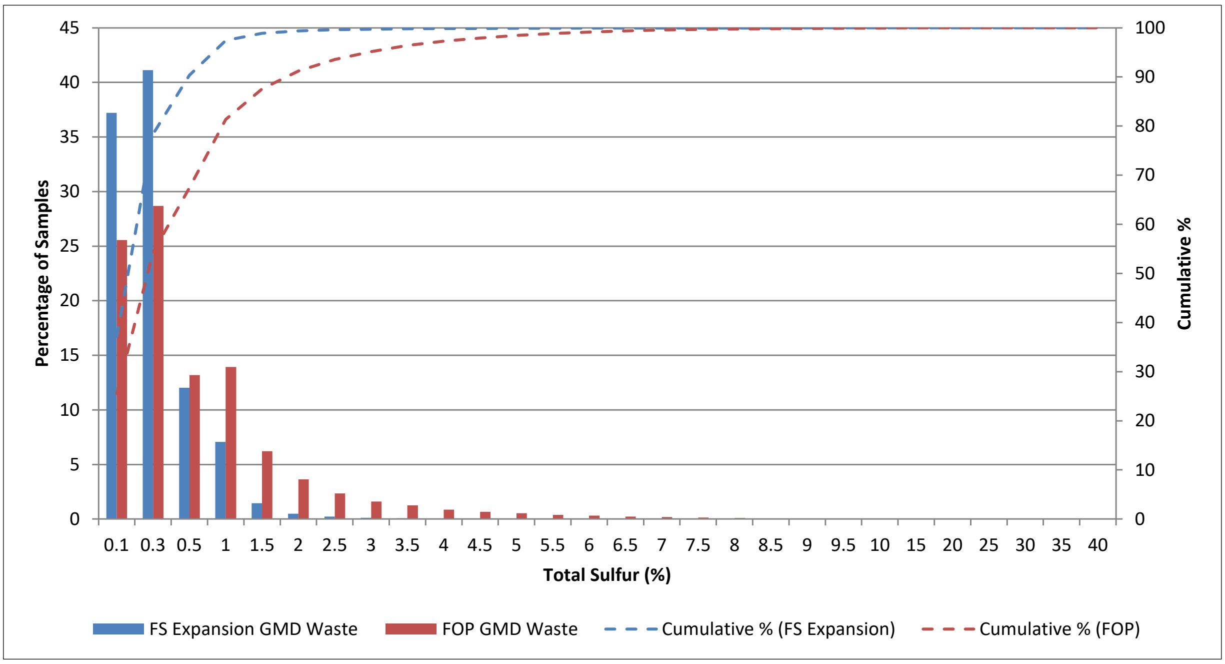

Chart 4: Total Sulfur Distribution for GMD Waste Rock

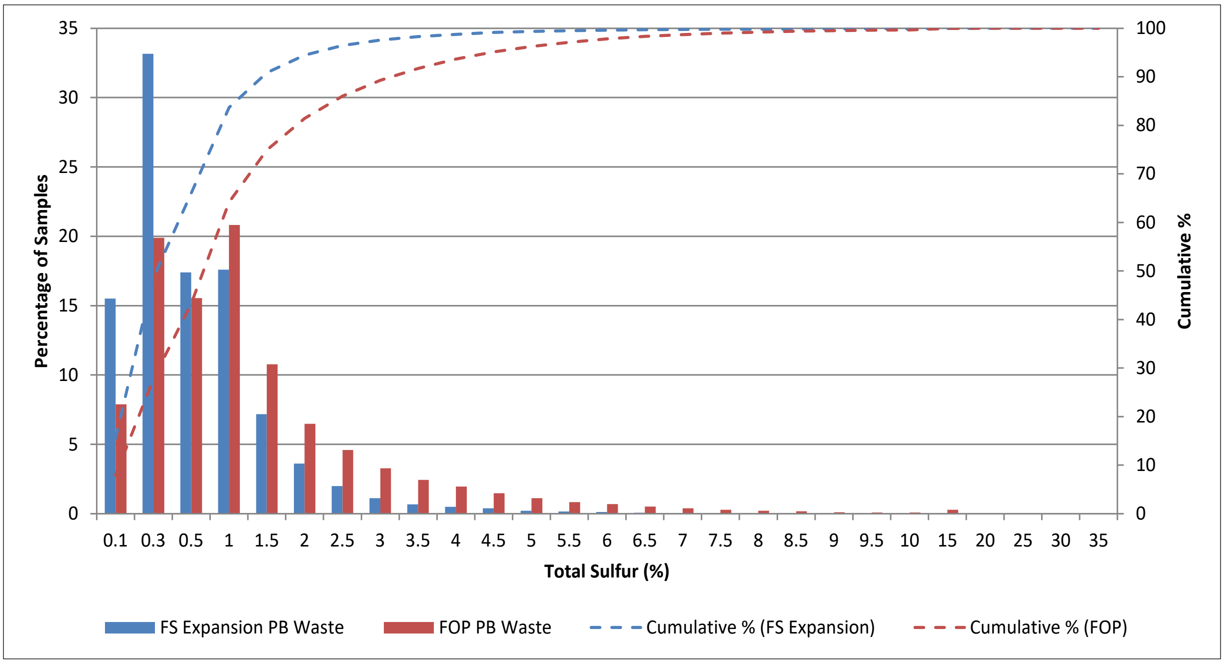

Chart 5: Total Sulfur Distribution for PB Waste Rock

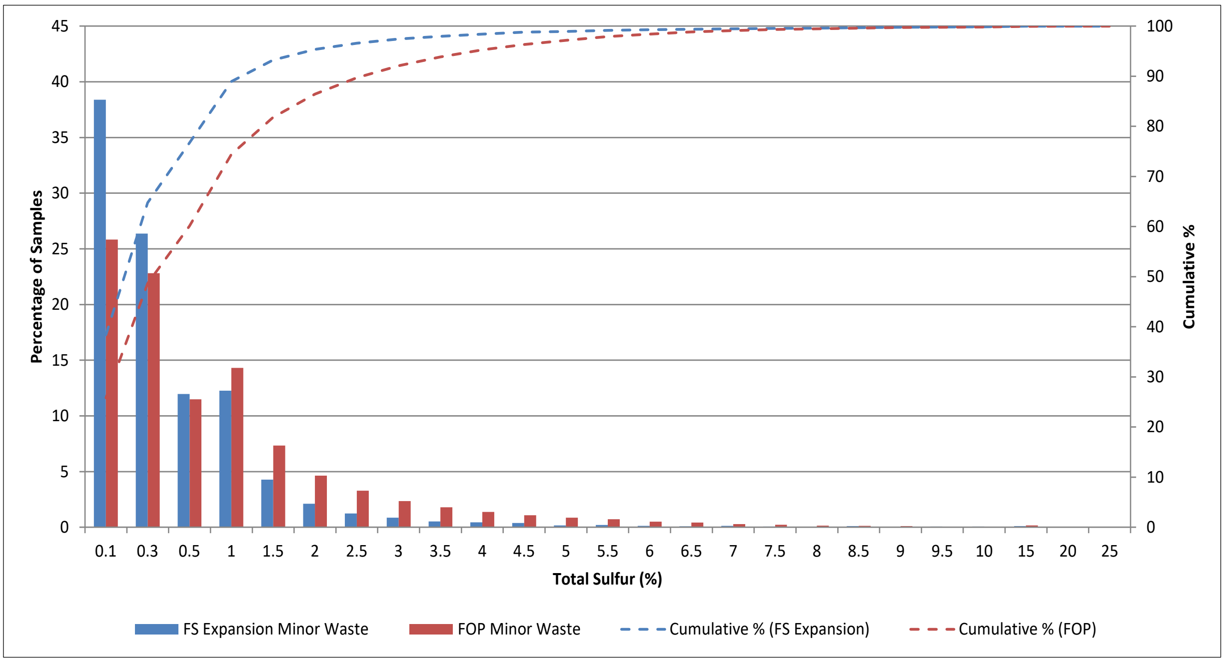

Chart 6: Total Sulfur Distribution for Other Waste Rock (Minor Lithologies)

6.3 FS STATIC ACID BASE ACCOUNTING

Laboratory results for static acid base accounting (ABA) parameters including total sulfur, total carbon, CRS, ANC, NAG testing and derived parameters of waste rock and ore are collated in Table A3-2 of Appendix 3. The original laboratory reports are included in Appendix 4

6.3.1 Sulfur Forms

A summary of results for total sulfur and CRS for waste rock and ore materials is provided in Table 19. Note that CRS was performed on all BF shale waste and ore samples, whereas only selected samples (at least two) of PB and GMD waste rock were tested for CRS.

The following are noted as key points based on results presented in Table 19 and previous FOP characterisation results for ABA (Section 2):

- BF shale waste rock, as expected, contained the highest total sulfur concentrations relative to GMD and PB waste rock. Sulfide sulfur was found to be the predominant sulfur form for BF shale based on results of CRS versus total sulfur concentrations and mineralogical analysis (Section 6.1). Pyrite and pyrrhotite were indicated to be the dominant sulfide minerals present which can contribute to acid production upon oxidation.
- GMD recorded the lowest total sulfur concentrations with a median concentration of 0.23 %. Total sulfur for PB was slightly higher with a median concentration of 0.45 % (however also significantly higher ANC – see 6.3.2 below). Both PB and GMD contained oxidisable sulfur concentrations (CRS) very close to total sulfur concentrations, confirming the presence of pyrite as indicated by XRD mineralogy (Section 6.1).
- Waste rock and ore samples selected for comprehensive geochemical testing were considered representative of expected FS Project material on the mining scale in terms of sulfur content, since total sulfur concentration ranges of selected samples (Table 19) fell within median[2] ranges established from the sulfur assay database (XRF) (Table 17 and Table 18).

Table 19: Sulfur (%) Forms Summary

Material Type	Lithology	Number of Samples	Total S Range	Total S Median	CRS Range	CRS Median
Waste	BF shale	4	0.18 - 3.3	1.07	0.14 - 2.96	0.89
	GMD	21	0.02 - 0.9	0.23	0.02 - 0.86	0.15
	PB	5	0.16 - 1.09	0.45	0.16 - 0.42	0.29
Ore	BF shale	2	2.97 - 3.94	3.45	2.5 - 2.8	2.65
	GMD	3	0.25 - 1.38	0.87	N/A	

N/A = Not Analysed.

6.3.2 Acid Neutralisation Capacity

A summary of results for ANC (direct measurement) and CC ANC (calculated from carbon content as surrogate for carbonate) is provided in Table 20. CC ANC is an estimate of the neutralising capacity provided by readily reactive carbonate minerals, whereas the measured ANC captures neutralisation by both readily reactive carbonate minerals but also less reactive silicate minerals (refer Appendix 1). Given the expectation that organic carbon may be present for BF shale, CC ANC was calculated from the measured total inorganic carbon concentration – total carbon was used for PB and GMD reasonably assuming carbon was present only as carbonate.

Based on the data in Table 20, XRD mineralogy (Section 6.1) and previous results for FOP, the following are noted as key points:

- Measured ANC values were high for all waste rock units and ore, with mean values greater than 100 kg H_2SO_4/t recorded for all material types. PB waste rock and GMD ore contained the highest ANC with mean values of 239 and 235 kg H_2SO_4/t, respectively, for FS.

[2] Median values adopted opposed to mean values to avoid potential biases from outliers with high total sulfur relative to the majority population.

- ANC for FS Project waste rock was overall higher in comparison to previous FOP (Table 20). This could be attributed to lower proportions of non-neutralising carbonate minerals (e.g. siderite) in FS rock, but this was not confirmed because semi-quantitative XRD cannot differentiate between magnesite and siderite.
- Consistent with previous findings, there was correlation between ANC and CC ANC values, indicating that readily reactive carbonate minerals provide a substantial proportion of the measured ANC (Chart 7). Dolomite/ankerite were indicated to be the predominant carbonate minerals for all materials (semi-quantitative mineralogy could not differentiate between these), although ankerite is expected to dominate as per mineralogical assessment discussed in GCA (2010) (Section 3.2.1 and 3.3.1). CC ANC was also observed to be overall higher than the measured ANC for most samples (biased right – Chart 7), which suggests the presence of some carbonate minerals that don't contribute to ANC such as siderite. Siderite was detected during mineralogical assessment (Section 6.1) as well as in ANC digest solutions (colour test). This is consistent with previous findings from MBS (2017) and GCA (2010). Measured ANC is considered the most reliable means of predicting the neutralisation capacity for waste rock and ore.

Table 20: ANC (kg H_2SO_4/t) and CC ANC (kg H_2SO_4/t) Summary

<table>
<tr><th>Material Type</th><th>Lithology</th><th>Domain</th><th>Number of Samples</th><th>ANC Range</th><th>ANC Mean</th><th>CC ANC Range</th><th>CC ANC Mean</th></tr>
<tr><td rowspan="6">Waste</td><td rowspan="2">BF shale</td><td>FS</td><td>4</td><td>57 - 166</td><td>126</td><td>82 – 222</td><td>161</td></tr>
<tr><td>FOP</td><td>32</td><td>9 - 210</td><td>95*</td><td>7 - 343</td><td>147</td></tr>
<tr><td rowspan="2">GMD</td><td>FS</td><td>21</td><td>43 - 281</td><td>193</td><td>24 – 377</td><td>209</td></tr>
<tr><td>FOP</td><td>30</td><td>97 - 230</td><td>169</td><td colspan="2">N/D</td></tr>
<tr><td rowspan="2">PB</td><td>FS</td><td>5</td><td>183 - 281</td><td>239</td><td>252 – 412</td><td>345</td></tr>
<tr><td>FOP</td><td>9</td><td>24 - 160</td><td>98</td><td colspan="2">N/D</td></tr>
<tr><td rowspan="2">Ore</td><td>BF shale</td><td>FS</td><td>2</td><td>184 - 249</td><td>217</td><td>209 – 361</td><td>285</td></tr>
<tr><td>GMD</td><td>FS</td><td>3</td><td>183 - 316</td><td>235</td><td>178 - 482</td><td>324</td></tr>
</table>

N/D = Not Determined (total carbon not measured).

* *Excluding IBC samples (MBS 2017) which have undergone some degree of oxidation in the field.*

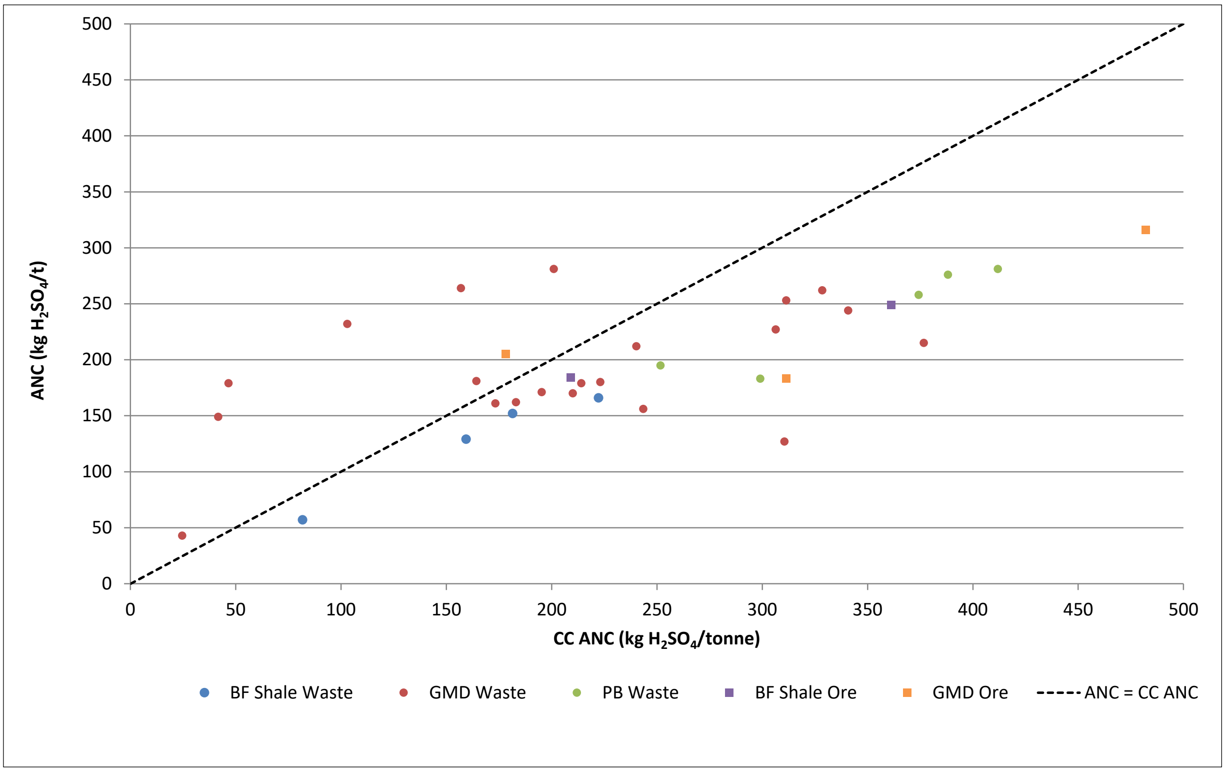

Chart 7: Correlation Between ANC and CC ANC (FS and FOP)

6.3.3 Acid Formation Potential Classification

Acid forming potential classifications based on criteria in Table 2 are outlined in Table A3-2 of Appendix 3. Summary data for NAG pH and NAPP for FS Project waste rock and ore is shown in Table 21 along with acid formation potential classifications. These classifications are represented as a plot of NAPP versus NAG pH in Chart 8 for all samples. The four quadrants are labelled as NAF, PAF and two UC (uncertain) according to the classification criteria in Table 2.

Note that NAPP was calculated from CRS for BF shale and from total S for PB and GMD. As above, CRS was used for BF shale as it provides a better estimation of sulfide sulfur due to the presence of organic sulfur. Based on examination of these results, the following was noted:

- All FS Project waste rock and ore samples tested were classified NAF based on negative NAPP values paired with NAG pH values greater than pH 4.5.
- Most waste rock and ore samples were further classified acid consuming (AC) based on substantial ANC, giving NAPP values of less than -100 kg H_2SO_4/t.

Overall, FS Project waste rock and GMD ore is not considered at risk of producing any acidic drainage. Results for FS Project PB and GMD waste rock were very similar to previous FOP mining in that these materials are recognised as largely acid consuming materials.

Although both current samples of BF shale ore (as well as four samples of waste BF shale) indicate a NAF classification with high levels of ANC, sample size is limited for this minor lithology. Continuing management of BF shale as per previous FOP mining (i.e. as potentially PAF) based on previous transect/IBC testing would still be the conservative approach. Variation in BF results are still attributed to the 'interfingering' of carbonates within the BF bed (discussed in Section 3.2.3).

Table 21: Summary of Acid Forming Classifications

Material Type	Lithology	Number of Samples	NAG pH Range	NAPP Range	NAPP Mean	Classification
				kg H_2SO_4/t		
Waste	BF shale	4	8 - 8.9	-38 to -150	-89	NAF
	GMD	21	8.4 - 11.3	-40 to -279	-185	NAF (AC)
	PB	5	7.9 - 9.7	-169 to -276	-220	NAF (AC)
Ore	BF shale	2	7.3 - 7.6	-98 to -172	-135	NAF (AC)
	GMD	3	8.3 - 10.3	-157 to -309	-210	NAF (AC)

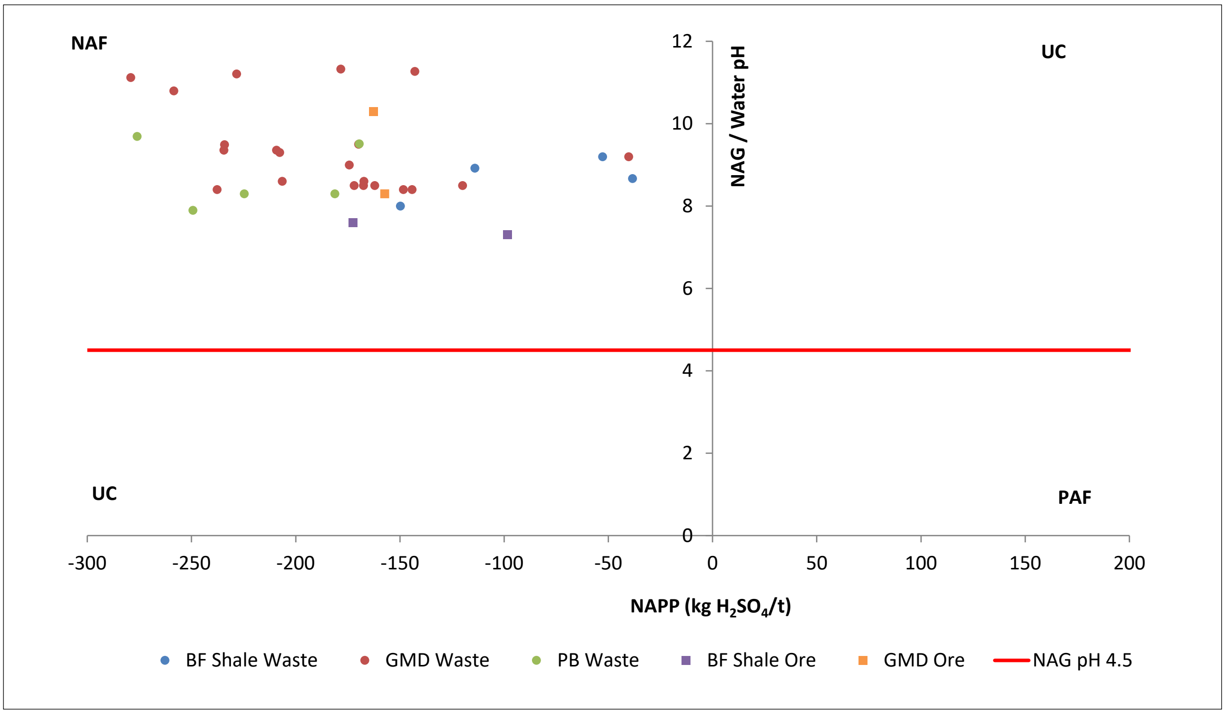

Chart 8: AMD Plot Classifications of FS Project Waste Rock and Ore

6.4 FIMISTON SOUTH ELEMENTAL COMPOSITION

6.4.1 Fimiston South Waste Rock

Tables A3-3 and A3-4 of Appendix 3 present total metal and metalloid compositions and calculated GAI values for FS Project waste rock and ore samples, respectively. Original laboratory reports are provided in Appendix 4.

A comparison of elemental concentrations of geochemically enriched species (GAI of 3 or more) previously identified for FOP waste rock versus FS Project is given in Table 22, Table 23 and Table 24 for BF shale, GMD and PB, respectively. A value equal to half the laboratory limit of reporting (LOR) was used for GAI calculation purposes where elemental concentrations fell below the LOR. Highlighted cells denote elements that were geochemically enriched for FOP waste rock but not in FS Project waste rock. Note that unenriched elements are not listed in the tables below.

Key points noted are as follows:

- FS Project BF shale was variably geochemically enriched in most of the same elements as for previous BF shale testwork including gold, silver, mercury, antimony, tellurium and zinc, although these were typically present at lower concentrations in FS Project (Table 22). Enrichment of these elements is typical of BF shale at the Golden Mile deposit. Elements including copper, lead, molybdenum, selenium and tin were geochemically enriched for FOP BF shale waste, but present in much lower concentrations for FS Project BF shale (GAI < 3). Comparison of bismuth and cadmium concentrations was limited as a consequence of the high laboratory LORs, although they seem to fall within the same ranges for FS Project versus previous BF shale assessment.
- Antimony remained geochemically enriched in GMD waste rock, with similar concentrations noted for FS Project and FOP materials. Whilst a single sample was enriched in mercury (sample 1, 0.7 mg/kg, GAI of 3), overall enrichment is absent and mercury is expected to be present as the highly insoluble mineral, coloradoite. No FS Project GMD samples were enriched in arsenic, silver or selenium (single samples noted to be geochemically enriched in previous FOP GMD samples).
- Antimony remained geochemically enriched for essentially all PB waste rock although noting that PB is a minor waste rock for FS (Table 1, 0.3% fresh rock waste). One sample (sample 19) was geochemically enriched in gold (0.19 mg/kg, GAI of 5) and tellurium (1 mg/kg, GAI of 6) which are two elements typically associated with mineralisation of the Golden Mile deposit (gold tellurides). No samples were geochemically enriched in silver (versus one previous FOP PB sample (GCA8495)).

Overall, FS Project waste rock were geochemically enriched in broadly the same elements identified for FOP materials, although typically present at lower concentrations than previously found.

Table 22: Comparison of BF Shale Enriched Elements for FOP and FS Project*

Element	FS Project (3 Samples)		FOP (39 Samples)	
	Concentration Range (mg/kg)	Maximum GAI	Concentration Range (mg/kg)	Maximum GAI
Ag	0.25 to 0.6	3	<0.05 to 28	6
Bi	0.19 to <10	4	0.09 to 2.7	3
B	N/A	-	<50 to 233	4
Cu	72 to 410	2	27 to 1,897	5
Cd	0.15 to <5	3	0.1 to 15	6
Pb	<5 to 35	1	12 to 330	4
Hg	0.25 - 1.8	4	0.07 to 61	6
Mo	1 to <5	0	0.8 to 103	6
Sb	6.5 to 18	6	5.3 to 374	6
Se	0.9	2	<0.5 to 7.1	6
Te	<0.2 to 1.6	6	<0.2 to 86	6
Sn	0.9	2	1.0 to 15	3
Zinc	106 to 306	3	151 to 8,021	6

** Highlighted cells denote elements not geochemically enriched in FS Project BF shale waste samples.*

N/A = Not Analysed

Table 23: Comparison of GMD Enriched Elements for FOP and FS Project*

Element	FS Project (13 Samples)		FOP (7 Samples)	
	Concentration Range (mg/kg)	Maximum GAI	Concentration Range (mg/kg)	Maximum GAI
Au	<0.02 to 1.67	6	N/A	-
Ag	<0.05 to 0.3	2	<0.1 to 0.9	3
As	13.5 to 200	2	10 to 260	3
Hg	0.01 to 0.7	3	<0.01 to 0.44	2
Sb	0.9 to 7.4	5	3 to 17	6
Se	<0.5	0	<1 to 3	3

** Highlighted cells denote elements not geochemically enriched in FS Project GMD waste rock samples.*

N/A = Not Analysed.

Table 24: Comparison of PB Enriched Elements for FOP and FS Project*

Element	FS Project (3 Samples)		FOP (3 Samples)	
	Concentration Range (mg/kg)	Maximum GAI	Concentration Range (mg/kg)	Maximum GAI
Au	<0.02 to 0.19	5	N/A	-
Ag	0.08 to <0.3	1	<0.2 to 1.1	3
Sb	3.0 to 3.5	4	1.8 to 2.4	3
Te	<0.2 to 0.5	6	N/A	-

** Highlighted cells denote elements not geochemically enriched in FS Project PB waste rock.*

N/A = Not Analysed.

6.4.2 FS Ore

Total elemental concentrations and calculated GAI values for the three ore grade samples (one BF shale and two GMD) are given in Tables A3-3 and A3-4 of Appendix 3, respectively. Sample 32 (GMD) in these tables was a grab sample collected from the current pit floor of FOP mining, whilst sample 30 (GMD) and sample 15 (BF) represent FS Project ore.

Results indicate the following:

- Gold, antimony and tellurium were geochemically enriched across both GMD and BF shale ore types as expected, which is consistent with the geological nature of the deposit.
- Silver and arsenic were two additional elements geochemically enriched in BF shale ore.
- Molybdenum was geochemically enriched in the FOP GMD ore sample (56 mg/kg, GAI of 5), but not in the FS Project GMD ore sample (0.2 mg/kg, GAI of 0).
- Other environmentally significant elements including beryllium, cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, selenium, thorium, tin, uranium, vanadium and zinc were present at very low concentrations in both FS Project ore types.

MBS Environmental also reviewed KCGM's monthly head assay data for Fimiston Flotation Feed materials (GMD ore feed) to identify whether concentrations of key elements (potentially enriched across these samples or otherwise of significance for assessment) for FS Project GMD ore are significantly different in comparison to previous FOP mining. This comparison is shown in Table 25, noting that average (or otherwise indicated) concentrations were used for Fimiston Flotation Feed.

Overall, concentrations of key elements in GMD ore from the FS Project were similar to (manganese, thorium and uranium) or lower than concentrations in FOP GMD ore. Note that levels of manganese, thorium and uranium in FS Project GMD ore are not considered to reflect significant geochemical enrichment or risk. The generally lower concentrations in sample 30 (FS Project), are likely to mostly be associated with lower levels of gold mineralisation in this low grade ore sample. The result of 21 mg/kg gold in sample 32 (high grade ore) is also considered an abnormally high result.

Table 25: Comparison of Key Elements in FS Project and FOP GMD Ore (mg/kg)

Element	Sample 30 (low grade)	Sample 32 (high grade)	Fimiston Flotation Feed (Average)
	FS Project	In Pit Grab FOP	Current FOP
Au	0.47	21	1.79
Ag	0.07	0.52	1.11
As	48	122	107
Mn	1,998	1,594	1,652
Sb	4.86	18	12
Te	<0.2	4.10	2.69
Th	0.96	0.45	0.84
U	0.26	0.13	0.23
Hg	0.18	0.20	0.99

6.5 PRESENCE OF NATURALLY OCCURRING RADIONUCLIDES

Naturally occurring radioactive materials (NORM) arise due to the presence of one or more radioactive isotopes naturally present in a material. Thorium (Th-232) and uranium (U-238) are naturally radioactive (ϒ emitters) elements present in very low concentrations in all ore and waste rock samples (Table A3-3 of Appendix 3).

The total activity concentration of FS Project materials can be calculated based on the total elemental concentrations and specific activities for naturally occurring uranium and thorium series radionuclides (U-238, Th-232). Calculated U/Th activity concentrations, based on average total concentrations for waste rock lithologies and ore, are presented in Table 26. The specific activities applied for naturally occurring proportions of the isotopes were: U (U-238) 12,445 Bq/g U and Th (Th-232) 4,059 Bq/g Th (IAEA 2006).

Table 26: Calculated Naturally Occurring Radionuclide Activity Concentrations*

Lithology	Domain	Uranium		Thorium		Total U + Th
		mg/kg	Bq/g	mg/kg	Bq/g	Bq/g
Exclusion/Exemption Limit		N/A	1	N/A	1	1
BF shale waste	FOP	1.46 (39)	0.0172	1.46 (7)	0.0196	0.0368
	FS	1.14 (1)	0.0141	1.14 (1)	0.0174	0.0315
GMD waste	FOP	0.13 (10)	0.0015	0.45 (7)	0.0016	0.0030
	FS	0.21 (2)	0.0025	0.75 (2)	0.0030	0.0056
PB waste	FOP	1.1 (3)	0.0132	3.8 (3)	0.0156	0.0287
	FS	0.1 (1)	0.0012	0.4 (1)	0.0016	0.0029
GMD ore	FOP	0.13 (1)	0.0016	0.45 (1)	0.0018	0.0034
	FS	0.26 (1)	0.0032	0.96 (1)	0.0039	0.0071
BF shale ore	FS	1.51 (1)	0.0186	5.87 (1)	0.0238	0.0425

N/A = Not Applicable.

* *Values in parenthesis indicate number of samples analysed.*

A level of 1 Bq/g head of chain activity concentration is considered 'inherently safe' to humans for uranium and thorium series radionuclides (IAEA 2004, IAEA 2006) and this value is set as the 'exclusion limit' as the resulting effective dose to workers or members of the public is very unlikely to be more than 1 mSv/year which is considered background level. The level of 1 Bq/g for these applies individually to each radionuclide (U/Th), however the sum is often compared to this value as a conservative screening tool (Table 26). Levels of Th/U head of chain activity above 10 Bq/g are considered a dangerous good (ten times the exclusion limit) for transport purposes (ARPANSA 2014).

Overall, levels of naturally occurring radionuclides uranium and thorium were very low for all samples of waste rock and ore, which was consistent with lack of geochemical enrichment of uranium and thorium. They do not classify under any relevant criteria described above, being well below the levels of activity (exemption limits) which would trigger possible further assessment.

6.6 LEACHATE CHARACTERISATION

6.6.1 Water Leachate Analysis

Leachate composition from 1:5 deionised water extracts of FS Project materials are discussed in the following sub-sections with reference to applicable environmental comparison guidelines including ANZECC (2000) livestock drinking water Default Guideline Values (DGVs) for cattle and DER (2014) Non-Potable Groundwater Use Guidelines (NPUG). No static water leachate characterisation was previously conducted for FOP materials, only one kinetic study by SWG (2013) for waste rock. Note as discussed in Section 5.4.1, static water leaching is not suitable for predicting long term release rates, especially in the case of fresh rock samples containing significant amounts of sulfide minerals that are likely to undergo a very long and gradual period of reaction and release. Kinetic studies are generally more appropriate in such cases.

Results are collated in Tables A3-5 and A3-6 of Appendix 3. All original laboratory reports in Appendix 4.

6.6.1.1 Soluble Salts, Alkalinity and pH

Results for major ions (Ca, Mg, Na, K), alkalinity, salinity and pH are provided in Table A3-5 of Appendix 3. Key points from this data were:

- Leachate pH was consistent between waste rock and ore lithologies, being basic with a range of pH 8.5 to 9.3. Leachate salinity was low to very low, with a total dissolved solids (TDS, calculated from EC) range of 79 to 1,072 mg/L. This represents fresh water quality within (for example) livestock consumption guidelines.
- Dominant major cations were variable across waste rock lithologies, with potassium dominant for BF shale, calcium dominant for GMD and sodium dominant for PB. Calcium was the dominant major cation for both ore lithologies. Sulfate and chloride concentrations were generally consistent with one another and low across all waste rock lithologies (highest for BF shale with a range of 10 to 15 mg/L). Fluoride concentrations were very low (maximum 0.13 mg/L for BF shale ore sample 15) and did not exceed the ANZECC (2000) livestock drinking water DGV of 2 mg/L.
- Alkalinity was variable across waste rock lithologies and ore, with moderate levels noted for GMD waste (average 20 mg $CaCO_3$/L), PB waste (average 29 mg $CaCO_3$/L) and ore (41 and 62 mg $CaCO_3$/L for BF shale and GMD ore, respectively). Ignoring one outlier, alkalinity for BF shale samples was very low with both samples containing 9 mg $CaCO_3$/L bicarbonate. Alkalinity was predominantly provided by bicarbonate forms, with some samples (GMD/PB waste and ore) with pH values close to pH 9 containing carbonate alkalinity.

Overall, any seepage and/or runoff from FS Project waste rock or ore is expected to be basic and non-saline, with moderate (GMD/PB waste and ore) to low (BF shale waste) levels of soluble alkalinity.

6.6.1.2 Soluble Metals and Metalloids

Results for water soluble metals and metalloids in 1:5 ratio extracts are provided in Table A3-6 of Appendix 3. In the absence of livestock or NPUG comparison guidelines for thallium and lithium, the US EPA (2020) maximum contaminant limit (MCL) has been applied for thallium and the ANZECC (2000) irrigation water (short/long-term) trigger value has been applied for lithium. Reference values are intended to provide a means of comparison against soluble metal and metalloid concentrations of water leachates, noting that grinding of the samples will significantly increase surface exposure relative to 'as mined' whole rock.

The following key observations were noted from these results:

- Despite variable geochemical enrichment of elements in BF shale waste (gold, silver, mercury, tellurium and zinc), GMD waste (gold, mercury and titanium) and PB waste (gold and tellurium), the corresponding water-soluble concentrations of these elements were very low, typically below reporting limits. Likewise, observed water soluble concentrations of geochemically enriched elements for BF shale ore (gold, tellurium, arsenic and silver) and GMD ore (gold and tellurium) were insignificant. This demonstrates the insoluble nature of minerals present under aerated leaching conditions.
- Antimony was geochemically enriched in all waste rock lithologies and ore and showed marginal solubility in all samples under circum-neutral conditions of the water leach. No livestock drinking water DGV (ANZECC 2000) has been set for antimony and the NPUG (DER 2014) guideline is 0.03 mg/L. Four samples recorded concentrations exceeding this comparison value: two of BF shale waste (maximum 0.15 mg/L), one of GMD waste (sample 6, 0.035 mg/L) and one of BF shale ore (0.23 mg/L). The NPUG guideline is based on a ten-fold factor to the human health drinking water guideline of 0.003 mg/L and its application is considered conservative, given that there is no potential for human or livestock groundwater use (hypersaline environment) and that BF is a minor waste disposed internally within the waste dump. Like arsenic, which is chemically similar, antimony adsorption/precipitation of antimony in the presence of hydrated iron oxides that typically exist in the iron rich clays and subsoils of most parts of WA is expected to limit mobility depending on site conditions.
- Soluble aluminium was detected at low concentrations in all samples, with no exceedances to the ANZECC (2000) livestock drinking water DGV of 5 mg/L. All 1:5 water leachates exceeded the NPUG (DER 2014) of

0.2 mg/L, although it is noted that this guideline corresponds to an aesthetic guideline based on post-flocculation of aluminium sulfate in water treatment and is not related to environmental risk.

- Arsenic, although not geochemically enriched for PB waste, was present at a slightly elevated concentration in leachate from sample 9 (0.189 mg/L), which exceeded the NPUG guideline of 0.1 mg/L. It is noted however that this concentration would fall below this guideline value if considered on a 1:20 extraction ratio basis. Given this and comments above relating to adsorption/precipitation reactions typically noted for arsenic, arsenic solubility in PB waste (and other waste rock and ore) is not considered to be of any risk to the surrounding environment.
- Other environmentally significant elements including barium, beryllium, cadmium, cobalt, chromium, copper, manganese, molybdenum, nickel, lead, selenium, thorium, uranium, vanadium and zinc, were typically present at or below the laboratory LOR values. These elements are considered essentially insoluble under the natural pH range of materials and present no significant environmental risk.

Leachate results from crushed and finely ground samples are considered to represent a worst-case scenario, given the surface area and water exposure of actual mined materials will be much lower. Despite these conditions, results of ground samples still indicate overall very low levels of soluble metals and metalloids. Furthermore, adsorption/precipitation and dilution effects are expected to control soluble metal/metalloid concentrations.

6.6.2 NAG Liquor Analysis

Results for analysis of soluble metals and metalloids in NAG liquors of selected FS Project waste rock samples are presented in Table A3-7 of Appendix 3.

As discussed in Section 5.4.2, analysis of the NAG liquor provides an indication of metals and metalloids that may be leachable from waste rock over an extended period if extreme oxidising conditions were to prevail for an extended period (several years to decades). It is important to reiterate that elemental concentrations in NAG liquors are not a prediction of expected concentrations of actual seepage. Instead, they provide an indication of chemical species that may be of environmental concern (depending on consideration of toxicity, potential for bioaccumulation, available receptors etc.) if appropriate waste management practices are not effectively implemented, resulting in exposure of reactive sulfidic waste rock to oxidising conditions.

Elements unaffected by extreme oxidising conditions, as observed by similar or lower concentrations in comparison to water soluble concentrations (on true mg/kg soluble basis), were gold, silver, mercury and tellurium. Those environmentally significant elements noted as more soluble under extreme oxidising conditions with reference to environmental comparison criteria are given in Table 27.

Although indicated in NAG liquor, none of the elements shown in Table 27 were observed to be released in significant concentrations during the 52-week kinetic experiment by SWG (2013). Materials in the 52 week kinetic tested were noted to have undergone no significant oxidation, and as such are not expected to pose any adverse risks to the surrounding environment under normal site conditions. The NAG liquor is much stronger/forced oxidation. BF shale is considered the key lithology at possible risk of oxidative release (arsenic, copper, nickel) however this mostly relates to the central bed area, much of which is ore grade (> 1.2 g/t gold) for processing with a long lag time (IBC trial, MBS2017) for acid formation.

Table 27: Notable Elements Released Under Extreme Oxidising Conditions for FS Project Waste Rock

Waste Type	Element	Concentration Range (mg/L)	Reference Value (mg/L)	Reference Type
GMD waste	Al	51 to 99	5	Livestock drinking water DGV
	As	0.20 to 0.48	0.1	NPUG
	Mn	3.4 to 5.8	5	NPUG
PB waste	Al	16 to 48	5	Livestock drinking water DGV
	As	0.20 to 0.59	0.5	Livestock drinking water DGV
	Ni	0.15 to 0.69	0.2	NPUG
BF shale waste	Al	30 to 42	5	Livestock drinking water DGV
	As	1.16 to 1.23	0.5	Livestock drinking water DGV
	Cu	4.0 to 4.4	1	Livestock drinking water DGV
	Pb	0.13 to 0.18	0.1	Livestock drinking water DGV
	Ni	0.48 to 0.71	0.2	NPUG
	Sb	0.02 to 0.08	0.03	NPUG
	Zn	4.1 to 7.3	3	NPUG

6.6.3 Specialised Leaching

Results for analysis of soluble metals and metalloids in NAG liquors of selected FS Project waste rock samples are presented in Table A3-8 of Appendix 3.

As discussed in Section 5.4.3, the purpose of this specialised leaching testwork was to assess elemental solubility under differing conditions other than de-ionised (which is aerobic and non-saline as suitable for rainfall effects). While this is considered suitable for most situations of free draining rock above ground (waste rock dumps), other situations such as TSFs (hypersaline) and post-closure FOP pit lake formation (hypersaline, possibly anaerobic/reducing) represented a knowledge gap from previous works regards potential changes to solubility. On-going closure studies for pit-lake modelling in particular required an assessment and data for modelling purposes.

A series of 1:20 extracts of waste and ore samples were assessed for relative differences as per the following:

- A deionised water ASLP (1:20) extraction 'base' conditions of solubility
- A synthetic saline ASLP (1:20) extraction using 1 % and 5 % NaCl as the extraction fluid. Saline conditions where potential for chloro complex formations (e.g. silver, mercury, cobalt, nickel) or common ion effects may enhance or limit solubility, respectively.
- Hydroxylamine ASLP (1:20) extraction. This test predicts element solubilities under acidic and reducing/anoxic conditions. Reducing conditions can enhance solubility (depending on form) of elements such as arsenic, mercury, manganese, antimony and others.
- Total environmentally available elements by aqua regia. For cross- comparison by sample of the total amount which is potentially environmentally available over very prolonged periods.

A summary of the behaviour of the elements under the above conditions relative to concentrations found in a standard 1:20 ASLP de-ionised water leachate are summarised in in Table 28. A summary of key point is as follows:

- Changes in solubility relating to increased sodium chloride based salinity were minimal. Increased solubility of major elements Ba, Ca, Mg, S, and K is considered a result of increased ionic strength as seen soil extractants such potassium chloride and calcium chloride. Arsenic was notable however maximum concentration was still only 0.072 mg/L (sample 15, BF shale ore) which was less than 0.5% of the arsenic content by aqua regia. This indicates saline leaching risk of waste rock and ore where applicable is of minimal risk to the environment for all metals and metalloids.

- Many elements relating to acid neutralisation/reaction with hydroxy species had increased solubility in the hydroxylamine hydrochloride leachate. Of those listed in Table 28 however only manganese, iron and vanadium are also considered redox active (i.e. known to be more soluble under reducing conditions). Likewise marginal increased solubility for various elements is also considered to be related to the acidic rather than reducing nature of the extract. Further work to separate these affects by sequential leaching was not warranted based on the low concentrations observed.
- Mercury in general was also largely insoluble across all material types (ore and waste) under both conditions. The exception was one sample of GMD ore (a grab sample from current FOP mining) which was found to be very high grade ore (21 g/t). Consistent with gold content, this sample had 3.79 mg/kg of total mercury versus the average feed for Fimiston mill ore of 0.99 mg/kg. This sample did indicate some soluble mercury in the reducing and acidic conditions of the hydroxylamine leach (0.068 mg/L), which may indicate some presence of (for example) mercury oxide or elemental mercury (e.g. gold amalgam). However this ore material:
  - Is an outlier at the very upper end of high grade ore content
  - Would be processed as ore where soluble mercury would be captured by scrubbing without release
  - Strongly acidic/reducing conditions are not indicated under any expected site conditions.

Table 28: Elemental Behaviour Versus Water Leachate for Special Leaches

Leach Type	Increased Solubility	Possible Marginal Increase	No Effect Observed or Reduced Solubility
Saline Leaching	Ba	As, Ca, K, Mg, Mn, Rb, S,	Ag, Al, B, Bi, Cd, Co, Cr, Cu, Fe, Hg, Li, Mo, Nb, Ni, P, Pb, Sb, Sc, Se, Si, Sn, Te, Th, Ti, Tl, U, V, Zn
Hydroxylamine HCl (Reducing and Acidic)	Al, Ba, Ca, Co, Cr, Cu, Fe, Mg, Mn, Na, Ni, P, Sc, Si, V, Zn	Ag, As, Be, Cd, Hg*, Li, Pb, Rb, Te, Th, Ti, Tl, U,	B, Bi, K, Mo, Nb, S, Se, Sn, Sb

** Only seen in very High Grade GMD sample (sample 32)*

7. REVIEW OF KCGM WASTE ROCK MANAGEMENT PROCEDURES

MBS reviewed KCGM's current waste rock management procedures (KCGM 2020) to identify whether any changes need to be implemented for FS Project. To clarify, changes to current management practices would only be required if there was significant variation in geochemical properties between FS Project and FOP waste rock (e.g. increase in AMD risk).

Geochemical characterisation of FOP waste rock has identified BF shale to be the only material with potential to generate AMD although kinetic testing showed that BF shale also had a long-lag period for acid production as negligible sulfide oxidation occurred within experiment timeframe of one year. As such, only BF shale requires management by segregation and prevention of net seepage.

7.1 OPERATIONAL CONTROL, MONITORING AND MEASUREMENT

BF shale beds accounts for approximately 4 to 5 % of total mine waste, but despite this minor proportion, it is managed according to KCGM's operational guidelines (MIN_PLN013_WI_Design Guidelines) to ensure correct placement and encapsulation within the waste rock landforms (WRLs). Specific management protocols for BF shale include:

- BF shale is fully encapsulated by other mine waste and not placed at surface anywhere on the WRLs.
- A buffer of 5 m non-BF shale waste rock is placed above any BF shale.
- BF shale is dumped in designated areas and "clean" material (non-sulfidic waste rock, e.g. PB and/or GMD) from at least one other shovel co-mingled with BF shale when dumped.
- BF shale dumping locations are recorded to enable auditing and review to ensure criteria above is met (i.e. fully encapsulated, not exposed, buffer zones).
- Groundwater quality is routinely monitored from bores surrounding the northern and eastern WRLs to track if waste rock seepage is impacting on the groundwater environment.
- High-grade BF ore (≥ 1.2 g/t Au) is stockpiled for future processing at end of mine.

7.2 NON-CONFORMANCES AND CORRECTIVE/PREVENTATIVE ACTION

WRL construction plans, and schedules are documented in the monthly waste dump schedule and results of monthly surveys along with any applicable corrective actions are presented during the monthly reconciliation presentations, with accountabilities and action plans developed and tracked.

Non-conformances for BF shale placement are reported and investigated through KCGM's Accident Incident Reporting System (INX). They are individually assessed by the Short Term Planning Engineer – Waste Dumps and Mining Department using several criteria (dumping location, volume of material, dilution with non-BF shale waste rock) to determine the appropriate course of action.

KCGM reviews the waste rock management plan on an annual basis to evaluate its ongoing effectiveness.

7.3 FIMISTON SOUTH PROJECT WASTE ROCK MANAGEMENT

Based on geochemical characterisation results for FS Project materials, there is no particular requirement to change waste rock management procedures currently implemented for FOP materials. This is based on:

- The geochemistry of waste rock for FS Project were not found to be significantly different to previous FOP mined materials (consistent with it being an extension of the same geology) and as such do not pose an increased risk of adversely impacting on the surrounding environment.
- The estimated volume of BF shale waste rock still represents a minor proportion of total mine waste (5 %).
- The mined BF in FS Project mining is indicated based on sulfur assays to have a lower net risk of acid formation than previous FOP mined BF shale waste rock.

The use of a 5 m cover of NAF fresh waste rock above portions of BF shale may however be substituted by use of available stockpiles of oxide waste which has been assessed in other works (MBS 2021) which indicated this material as suitably benign. The depth of cover where oxide is used (on flat upper surfaces to prevent erosion) need not be 5 m (as specified currently for fresh rock). Given the arid climate and higher fines content (lower permeability), a 2 m cover of oxide waste layer would be sufficient to prevent net percolation and hence any potential for AMD .

8. CONCLUSIONS AND IMPLICATIONS FOR MANAGEMENT

8.1 SUMMARY OF FINDINGS – FIMISTON SOUTH PROJECT

8.1.1 GMD Waste Rock

Results of geochemical characterisation and sulfur assay data review of GMD waste rock, the major waste rock type for the FS Project (82 % of fresh rock waste), indicated the following:

- Total sulfur distribution in FS Project GMD waste was shown to be lower in comparison to previously mined FOP assays, with 77% of samples (179,086 samples) containing less than 0.3 % total sulfur. Samples selected for comprehensive geochemical analysis were considered representative of expected mine waste based on consistency between total sulfur levels in selected samples and the expected sulfur content of most GMD waste (i.e. median value).
- Consistent with previous GMD analysis, all FS Project GMD waste rock samples were classified NAF and the majority of samples were further classified as acid consuming (NAF-AC) as they contained substantial carbonate ANC. Under normal site conditions, any seepage and/or runoff is expected to be alkaline and non-saline with moderate levels of soluble alkalinity.
- As per previous assessments, antimony remained geochemically enriched in all FS Project GMD waste samples at similar concentrations to previous FOP. This is typical of Golden Mile mineralisation. Mercury was geochemically enriched in only a single sample, although highly insoluble in corresponding water extracts (1:5 ratio). Further to this, concentrations of other environmentally significant elements (except antimony discussed below) in 1:5 water leachates were very low, which demonstrates the insoluble nature of minerals present (e.g. tellurides).
- Antimony was marginally soluble in 1:5 water leachates, with a marginal exceedance to the NPUG (DER 2014) value of 0.03 mg/L noted for one sample (0.035 mg/L). This guideline was noted to be conservative based on there being no potential for human or stock groundwater use, plus antimony solubility in any seepage is expected to be limited to adsorption/precipitation reactions in the presence of hydrated iron oxides typically present in subsoils and laterites in Western Australia.

Overall, GMD waste rock from FS Project was consistent with previous FOP GMD and is not considered to pose any increased risk to the surrounding environment.

8.1.2 PB Waste Rock

Results of geochemical characterisation and sulfur assay data review of FS Project PB waste rock (the second major waste rock type by volume) indicated the following:

- Total sulfur concentrations for FS Project PB waste rock were overall lower in comparison to FOP assays, with approximately half of assayed samples (11,899 samples) containing than 0.3 % total sulfur. Samples selected for comprehensive geochemical analysis were considered representative of expected mine waste.
- All FS Project PB waste rock samples were classified NAF (AC) due to substantial ANC, which was consistent with FOP results. Under normal site conditions, any seepage and/or runoff is expected to be alkaline and non-saline with moderate levels of soluble alkalinity.
- Antimony was geochemically enriched in all FS Project PB waste rock samples, as for FOP PB, but present at slightly higher concentrations. Gold and tellurium were also noted as geochemically enriched in single FS Project PB samples (not measured for FOP PB). As above, these elements (including antimony) are associated with the geological nature of the Golden Mile deposit. Despite this enrichment, corresponding water-soluble concentrations of these and other environmentally significant elements were very low (insoluble) in 1:5 water leachates and again demonstrates the recalcitrant nature of minerals present (e.g. tellurides).

Overall, PB waste rock from FS Project was consistent with previous FOP PB and not considered to pose any increased risk to the surrounding environment.

8.1.3 BF Shale Waste Rock

Results of geochemical characterisation and sulfur assay data review of FS Project BF shale waste rock (minor waste rock type of approximately 5%) indicated the following:

- Total sulfur median concentrations in FS Project BF were significantly lower than median concentrations in FOP assays (0.79 % versus 1.98 %, respectively) with a corresponding decrease in considered for acid formation. FS Project BF shale samples assay indicated 28 % of contained less than 0.3 % total sulfur (considered incapable of acid generation for any hard rock). Samples selected for comprehensive geochemical analysis were considered representative of expected mine waste.
- Acid formation potential classifications of BF shale samples were variable for FOP, based on past transect sampling of BF beds on the FOP walls. Samples from the western side of transects were classified PAF whilst those from the eastern side of the central BF bed were classified NAF. This finding was previously attributed to carbonate 'interfingering' of the BF bed. Results for samples of BF shale drill core assessed in the current study (no transect) suggests that the carbonate ‘interfingering’ extends into the FS Project zone based on generally high ANC in those shales. All FS Project BF shale samples assessed were classified NAF or NAF(AC).
- FS Project BF shale was geochemically enriched in most of the same elements as for FOP BF shale including gold, silver, mercury, antimony, tellurium and zinc - although present at generally lower concentrations in FS Project samples. Enrichment in these elements is typical of BF shale at the Golden Mile deposit. Of these and other environmentally significant elements, only antimony showed marginal water-solubility with two samples (maximum 0.15 mg/L) exceeding the NPUG (DER 2014) guideline of 0.03 mg/L. As discussed above, this comparison is considered to be very conservative and antimony solubility is expected to be limited to adsorption/precipitation reactions under environmental conditions.

Overall, the significant majority of BF shale waste rock from FS Project is expected to be NAF and any seepage and/or runoff is expected to contain low levels of metals and metalloids. Portions of higher sulfur content material from the central bed area in particular may be classified as PAF, however much of this is ore grade. No increased risk to the surrounding environment is anticipated for FS Project BF shale waste rock – particularly given continued assumption for management as PAF for this minor waste lithology.

8.1.4 Ore

Results of geochemical characterisation and sulfur assay data review of FS Project ore indicated the following:

- Based on review of total sulfur assays, FS Project BF shale ore is expected to contain overall lower total sulfur content relative to FOP operations (medians of 2.5 % versus 4.1 %, respectively). Primary ore (mostly GMD hosted ore) for FS Project indicated lower total sulfur median of 1.34% compared to BF shale ore. Note that only GMD ore is currently processed, whilst BF shale ore is stockpiled for future processing.
- All five ore samples (2 BF shale and 3 GMD) were classified NAF with most (four of five) being sub-classified as acid consuming (PAF-AC).
- FS Project GMD ore contained overall similar or lower concentrations of environmentally significant metals and metalloids compared with previous FOP GMD ore.
- Despite geochemical enrichment of various elements in BF shale ore (gold, tellurium, arsenic and silver) and GMD ore (gold and tellurium), corresponding water-soluble concentrations were insignificant. Antimony was marginally soluble in the BF shale ore leachate (0.23 mg/L) which exceeded the NPUG (DER 2014) value of 0.03 mg/L.

Overall, FS Project ore samples assessed in this study indicate FS ore is expected to be very similar in nature to FOP ore currently processed or stockpiled (BF shale). Although both current samples of BF shale ore indicate a NAF classification with high levels of ANC, the sample size was limited for this minor lithology. Continuing management of BF shale ore as per previous FOP mining (i.e. as potentially PAF) would still be the conservative approach. As such, FS Project ore (and resulting tailings) is not considered to pose any increased risk to the surrounding environment.

8.2 IMPLICATIONS FOR WASTE ROCK AND ORE MANAGEMENT

8.2.1 Waste Rock

Results indicated similar geochemical properties are expected for FS Project waste rock versus FOP materials and no indication for increased environmental risk – overall trends were for lower sulfur content and enrichment than for previous mining. As such, waste rock management practices currently implemented at KCGM are considered to remain appropriate for FS Project waste rock. This includes:

- Management of PB and GMD as NAF materials suitable for coverage or co-mingling with BF shale waste rock.
- Conservative management of BF shale as potentially PAF with appropriate segregation and encapsulation strategies. Specific methods of KCGM's management strategy include:
  - Active co-mingling of BF shale waste rock during dumping with non-BF shale waste rock (i.e. GMD/PB).
  - Ongoing routine groundwater monitoring for signs of impact from waste rock seepage.
  - No BF shale waste rock to be exposed on any surface of WRLs and coverage of at least 5 m of benign waste rock over BF shale. Alternatively, oxide waste may be used as suitable cover on flat upper surfaces by acting as a store and release layer. Given the arid climate and higher fines content (lower permeability), a nominal thickness of 2 m of oxide waste is considered sufficient for this to prevent potential for AMD formation.

8.2.2 Ore

FS Project GMD ore for processing or stockpiling/blending is expected to remain geochemically similar to that previously assessed from FOP mining of GMD ore. Therefore, current management of GMD ore stockpiles (in particular low grade stockpiles which may remain for longer periods before processing), is expected to remain appropriate for FS Project GMD ore.

BF shale ore (from the central bed area of the BF seam), carries the greatest risk of AMD formation based on previous studies (GCA 2010 and MBS 2017) after prolonged exposure. Samples and review of drill assay data of BF ore (including high grade ore) assessed in the current assessment indicate lower sulfur contents and lower risk of acid formation in FS Project than previous FOP mining. It is recommended however, to continue management as per KCGM waste rock management procedures (KCGM 2020). As part of these procedures, high grade BF ore is stockpiled for future processing at end of mine life. If any such material is not processed, this would need to be managed as potentially PAF waste at mine closure by suitable means (e.g. burial/encapsulation within the waste rock dump, disposal into pit/underground beneath the water table).

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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) 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.
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
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.

Term	Explanation
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.
PAF short lag PAF long log	Sub classifications of PAF which reflects the relative time required for acid formation being generally taken as short (< 2 years) or long (> 2 years) under field exposed conditions. The lag period before acid formation is controlled by the amount and reactivity of available ANC to neutralise acid as it is formed by oxidation.
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: ACID FORMING WASTE CLASSIFICATION METHODOLOGY

1. OXIDATION OF SULFIDES

There is no simple method of defining whether mine waste containing small quantities of sulfur will produce net acid release upon field exposure to air and water. Sulfide minerals containing ferrous iron such as pyrite (FeS_2), marcasite (FeS_2) and pyrrhotite ($Fe_{(1-x)}S$) normally oxidise to produce sulfuric acid and ferric oxy-hydroxide. Whilst sulfur in pyrite will always form sulfuric acid, a portion of the sulfur in marcasite and pyrrhotite forms highly soluble sulfite, thiosulfate, more complex polythionate ions and elemental sulfur, some or all of which may never form acid (discussed in more details in Section 4). Similarly, sulfur in chalcopyrite and arsenopyrite rarely forms sulfuric acid due to simultaneous oxidation of copper and/or arsenic resulting in formation of non-acid forming copper sulfides and soluble sulfates (Section 5). Sulfur in galena (PbS), sphalerite (ZnS), molybdenite (MoS_2), stibnite (Sb_2S_3) and other iron-free sulfides is non-acid producing. Sulfur present as sulfate in minerals such as barite ($BaSO_4$), anhydrite ($CaSO_4$), gypsum ($CaSO_4.2H_2O$), epsomite ($MgSO_4.7H_2O$) and alkali sulfates is also non-acid producing.

There is also a group of iron and aluminium sulfate minerals that fall into a special category as acid releasing sulfates. An example is the mineral jarosite ($KFe_3(OH)_6(SO_4)_2$) or natrojarosite ($NaFe_3(OH)_6(SO_4)_2$), an oxidation product of pyrite formed under certain environmental conditions. Substitution of aluminium for iron results in the common aluminium sulfate mineral, alunite ($KAl_3(OH)_6(SO_4)_2$). Although sulfur in jarosite/natrojarosite (and alunite) is fully oxidised and therefore cannot produce further acidity under oxidising conditions, it can release acidity by hydrolysis as indicated by the chemical Equation 1:

Equation 1

$$KFe_3(OH)_6(SO_4)_2 + 3H_2O \rightarrow 3Fe(OH)_3 + K^+ + 3H^+ + 2SO_4^{2-}$$

This form of acidity is commonly referred to as “stored acidity” or “residual acidity” and does not fit in within traditional acid base accounting (ABA) which are designed to consider acid generation capacity from sulfides. This aspect of acidity in discussed further in Section 6 of this Appendix.

Potential for acid production relies on determination of total sulfur content (Tot_S), and non-sulfide sulfur content (commonly described as sulfate sulfur (SO_4_S)). Where necessary, determination of sulfur in the acid insoluble minerals barite (barium sulfate) and celestite (strontium sulfate), may be undertaken.

2. ACID NEUTRALISATION

Acid Neutralising Capacity (ANC) is a measure of the natural ability of the sample to neutralise acid. It is normally determined in the laboratory by measuring the amount of residual acidity following reaction of a finely ground sample of mine waste with an excess of dilute hydrochloric acid. The concentration of acid used for the ANC method is first determined by testing the vigour of the reaction of the sample with hydrochloric acid, as assessed by the rate evolution of carbon dioxide gas and any colour change (a 'fizz rating'). This method captures all minerals, including carbonates, oxides, hydroxides, phosphates and some silicate minerals that are capable of neutralising hydrochloric acid. Iron carbonates such as siderite ($FeCO_3$) and ferroan ankerite ($CaFe[CO_3]_2$) do not overall contribute to neutralisation of acid due to oxidation of the ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}) which in turn releases acid due to hydrolysis of the ferric ion. To correct for presence of these iron carbonate minerals, ANC is generally determined by a modified method (Sobek *et al.* 1978). This uses an indicator (phenanthroline) to show presence ferrous ions following reaction with hydrochloric acid (reported as a colour change in laboratory reports), followed by forced oxidation of the ferrous ions (hydrogen peroxide) prior to back titration with sodium hydroxide.

The standard ANC results are based on the assumption that all acid-neutralising materials are rapid-acting – which is generally only true for reactive carbonates such as calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$). In practice, some neutralising capacity is supplied by silicate and alumino-silicate minerals which can have slow to very slow reaction kinetics which is also only capable of buffering to a pH of approximately 3 to 4 which may be insufficient to prevent metalliferous drainage. Measurement of total carbon content (or total inorganic carbon) provides a simple method of estimating the contribution of the former, more reactive, carbonate minerals to the ANC although iron carbonates (if present) will interfere with this calculation (bias high). The reactivity of common silicate and carbonate neutralising minerals (at pH 5) are shown in Table A1-1 (Sverdrup 1990). Minerals in the dissolving, fast and intermediate weathering mineral groups (relative reactivity between 0.4 and 1, Table A1-1) are considered to have practical neutralising capacity in the field (Kwong 1993).

The Acid Buffering Characteristic Curve (ABCC) test can be employed in cases where the proportion of readily available ANC needs to be assessed. The ABCC test involves slow titration of a sample with acid while continuously monitoring the solution pH. While silicate based ANC will continue to react for a long period, the neutralising capacity to pH 4.5 from the ABCC is a useful indicator of the readily available ANC.

Table A1-1: Common Acid Consuming Silicate and Carbonate Minerals

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	anorthite, nepheline, olivine, garnet, jadeite, leucite, spodumene, diopside, wollastonite, forsterite	0.6
Intermediate weathering	epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, serpentine, amphibole, chlorite, biotite	0.4
Slow weathering	albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	quartz, rutile, zircon	0.004

3. WASTE CLASSIFICATION

3.1 BACKGROUND

The Department of Mines, Industry Regulation and Safety (DMIRS) has issued draft procedures for geochemical characterisation of mine waste materials *Draft Guidance Materials Characterisation Baseline Data Requirements for Mining Proposals* (DMP 2016). These guidelines have not yet been finalised following feedback from industry (including MBS) and other departments. The 2016 DMIRS recommends that characterisations of subsurface materials and processing waste include the following information:

- A description of the host geology and mineralisation of the project area.
- The indicative volume of ore and waste materials that will be mined.
- The indicative tonnages and proportion of each waste lithology.
- Adequate characterisation of the subsurface materials (including overburden) and processing waste to ensure that the risk(s) posed by adverse components can be determined.
- Diagram(s) and map(s) of the sampling locations sufficient to indicate, the location of key mine activities and the 3D spatial distribution of samples.
- A description of the methodology used to characterise the materials.
- Interpretation of baseline data and broad implications for risk assessment and treatments.

Whilst these guidelines remain as draft, this report has been prepared in accordance with the draft guidelines and equivalent federal guidelines (DIIS 2016) where possible. The main deviation from DMP 2016 guidelines in MBS assessment is that only selected samples below 0.2 % total sulfur are analysed for Net Acid Generation (NAG) testing based on alternative assessment and previous experience in WA (DMP 2016 proposed all samples above 0.05 % sulfur should be tested).

3.2 ACID FORMING CLASSIFICATION

There is no single method to reliably determine whether mine or process wastes containing small quantities of sulfur will produce net acidity upon field exposure to air and water. Sulfide minerals are variable in their behaviour under oxidising conditions and not all forms will produce sulfuric acid (H_2SO_4). The acid neutralising capacity of these materials is also variable, and the relative rates of acid-forming and acid-neutralising reactions is important when considering if the materials have potential to generate acidic and metalliferous drainage.

Instead, a combination of approaches is often applied to more accurately classify mine or process waste. These approaches are listed below in order of increasing data requirements (and therefore increased reliability):

- The method of “Sulfur Analysis”, which only requires data for total sulfur content. Its adoption is based on long term experience of hard rock wastes from Western Australian mine sites under arid and semi-arid climatic 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 (Price 1997).
- The concept of “Ratio Analysis”, 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 Ration – NPR) is above a value of two and considered non-existent above a value of four (Price 2009, DIIS 2016).
- Acid-Base Accounting (ABA), in which the Net Acid Producing Potential (NAPP) value, which is calculated by subtracting ANC from MPA, is used to classify the acid generating potential of mine waste. Positive NAPP values indicate that the waste has the potential to generate more acid than it can neutralise.

- Procedures recommended by AMIRA International (AMIRA 2002), which take into consideration measured values provided by the Net 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 stockpile or tailings storage facility.

The "analysis concept" methodology is suitable to characterise mine waste during the early stages of feasibility drilling to ensure potentially acid forming materials are not missed - total sulfur should always be included as an element within assay data collection for resource drilling and insufficient sulfur assays of waste rock may hinder later approvals (DMP 2016). Ratio concept classification can be incorrect due to SO_4_S and barium sulfate content, particularly in manganese ores and most zinc-copper stratiform sulfide horizons where barite is often a substantial rock forming mineral. The ratio concept often gives incorrect results when used with acid sulfate soils and in conditions of very high salinity. It will also give incorrect results if applied to waste dumps that have not been rehabilitated and where the dominant residual sulfides in the wastes are base metal sulfides. This includes the iron-bearing sulfides chalcopyrite, bornite and arsenopyrite which all have high sulfur content but generate little or no acid.

Classification of wastes in this report uses procedures recommended by AMIRA (2002) based on NAPP and NAG pH results as well as total sulfur analysis/ratio analysis concepts above where this is appropriate. The following is a definition of terms as used in ABA reporting by MBS:

- Analysis for total sulfur (Tot_S) and sulfate-sulfur (SO_4_S), both reported as sulfur. Sulfate sulfur is conventionally determined by a heated 4 molar hydrochloric acid digestion followed by ICP-OES finish. In some circumstances, however, an alkaline extraction method using sodium carbonate may be appropriate to resolve interferences with high barium/strontium sulfate minerals as these are substantially more soluble under alkaline conditions. Chromium Reducible Sulfur (CRS) may also be used in conjunction with total sulfur and sulfate sulfur, which provides a direct analysis for sulfide sulfur. However, it should be noted that CRS was developed for finely divided acid sulfate soils specific to framboidal pyrite and without careful controls by the laboratory may not yield reliable results for waste rock, particularly when crystalline sulfide minerals are not micro-crystalline.
- Analysis for ANC (reported as kg H_2SO_4/t).
- Calculation of carbonate ANC (CC ANC), reported as kg H_2SO_4/t, from measured concentrations of total carbon (TC) or total inorganic carbon (TIC) (TIC avoids interferences for some samples such as shales from organic carbon).
- Calculation of Maximum Potential Acidity (MPA) = Tot_S * 30.6, reported as kg H_2SO_4/t.
- Calculation of Acid Production Potential (AP) = [(Tot_S – SO_4_S) * 30.6] kg H_2SO_4/t.
- Calculation of NAPP = [AP – ANC] kg H_2SO_4/t. Using AP versus MPA corrects for non-oxidisable sulfur present in the sample (i.e. sulfate).
- Calculation of Effective NAPP = [AP – CC ANC] kg H_2SO_4/t. Effective NAPP values correspond more directly to ANC associated with readily reactive carbonates, providing non-neutralising carbonates such as siderite are absent.
- Analysis for NAG potential (reported as kg H_2SO_4/t) to both pH 4.5 and pH 7.
- Analysis for NAG pH (the pH of the NAG test liquors).
- Calculation of NPR = ANC/AP (reported as kg H_2SO_4/t).
- Calculation of Effective NPR (Eff NPR) = CC ANC/AP (reported as kg H_2SO_4/t). As above, this corresponds more directly with reactive carbonates.

This AMIRA approach is more conservative than either the Analysis Concept or the Ratio Concept alone, although it assumes the absence of insoluble sulfur such as barite (barium sulfate), which is a non-acid producing mineral that can interfere with the results. The AMIRA approach of using NAG testing is particularly useful for PAF-LC (Potentially Acid Forming – Low Capacity) materials or where there is very low ANC in the host rock. A combined acid generation classification scheme based on NAPP and NAG determinations which is based on AMIRA 2002 and the 2016 DMIRS *Draft Guidance Materials Characterisation Baseline Data Requirements for Mining Proposals* (DMP 2016) and the equivalent federal; guidelines (DIIS 2016), is presented in Table A1-2.

Table A1-2: Acid Formation Risk Classification Criteria

Primary Geochemical Waste Type Class	NAPP Value kg H2SO4/t	NAG pH
Potentially Acid Forming (PAF)	≥10	< 4.5
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	< 4.5
Uncertain (UC)	Positive	> 4.5
Uncertain (UC)	Negative	< 4.5
Non-Acid Forming (NAF)	Negative	> 4.5 or sulfur < 0.2 %*
Acid Consuming (AC)	< -100	> 4.5
Barren	≤2 and sulfur < 0.05 %	-

** Application of 0.2% sulfur cut-off as a screening tool for the need for determination of NAG pH for classification may be applied on a site specific basis in conjunction with assessment of ANC and NPR). This uses a ratio analysis approach for low risk samples based on WA conditions where extensive experience has indicated no potential for samples with less than 0.2% sulfur to generate net acidity in arid conditions for waste rock from hard rock mines. A negative NAPP and NPR of more than 4 (DIIS 2016) indicates no considered risk of acid generation in such instances.*

This classification system, based on static ABA procedures and used in conjunction with geological, geochemical and mineralogical analysis can still leave materials classified as 'Uncertain' which may warrant further investigation by, for example, kinetic characterisation. An optional NAF subclassification of 'Barren' is included to account for materials which have neither acid forming nor acid generating potential. Samples which are 'Uncertain' due to conflicting NAPP versus NAG pH values may be tentatively assigned as NAF or PAF based on a NAG pH value above or below pH 4.5 respectively, however further examination/justification may be warranted. A sound knowledge of geological and geochemical processes must also be employed in the application of the above methods.

4. PYRRHOTITE OXIDATION REACTIONS

As indicated in Section 1, the oxidation chemistry of pyrrhotite is more complicated than that of pyrite, which forms the basis of standardised acid base accounting procedures. The nature of the oxidation products of pyrrhotite and the associated amount of acid produced will depend on several factors, the most important being the availability of oxygen (or redox potential), pH and the presence of specialised bacteria (sulfide oxidising and/or sulfate reducing).

There are many possible reaction products that can be formed by the oxidation of pyrrhotite, depending on the oxidation state of both iron and sulfur in the reaction products. In the case of iron, the reaction products contain either ferrous iron (Fe^{2+}) or ferric iron (Fe^{3+}). Ferrous iron is readily oxidised and so it can only be formed as a major reaction product under conditions of very low redox potential (*i.e.*, extremely low available oxygen). Ferric ion is soluble only at low pH values, typically < 1.5. At pH values > 4.5, it is rapidly precipitated as hydroxide/oxide minerals such as ferrihydrite ($Fe(OH)_3$) or goethite (FeOOH). At pH values between 1.5 and 4.5, it can form various sulfate minerals such as jarosite ($KFe_3(SO_4)_2(OH)_6$), copiapite ($(Fe,Mg)Fe_4(SO_4)_6(OH)_2.20H_2O$) or schwertmannite ($Fe_8O_8(OH)_6SO_4$).

The situation with the sulfur reaction products from pyrrhotite is much more complex. Table A1-3 lists some, but not all, of the various sulfur reaction products produced by oxidation of pyrrhotite under varying conditions, the most important of which is the degree of oxygen availability. Other important factors that influence the reactivity of pyrrhotite in tailings are the size and morphology of the pyrrhotite minerals. The crystal structure of pyrrhotite changes with different values of 'x' in the chemical formula for pyrrhotite, $Fe_{(1-x)}S$. When the value of 'x' is close to zero, the crystal structure is hexagonal. At higher values of 'x', pyrrhotite adopts a monoclinic structure.

Table A1-3: Sulfur Species Produced by Reaction of Pyrrhotite with Oxygen and Water

Sulfur Species	Chemical Formula	Oxidation Number of S	Increasing Oxidation Potential
Sulfide	S^{2-}, e.g. FeS	-2	↓
Hydrogen sulfide	H_2S	-2	
Disulfide	S_2^{2-}, e.g. FeS_2	-1	
Elemental sulfur	S, S_8	0	
Thiosulfate	$S_2O_3^{2-}$	+2	
Tetrathionate	$S_4O_6^{2-}$	+2.5	
Trithionate	$S_3O_6^{2-}$	+3.33	
Sulfite	SO_3^{2-}	+4	
Dithionate	$S_2O_6^{2-}$	+5	
Sulfate	SO_4^{2-}	+6	

The dithionate, trithionate and tetrathionate are the first three members of a group of sulfur oxy-anions referred to as 'polythionates'. In acid mine drainage context, the combination of the polythionate ions with thiosulfate and the sulfite ion is referred to as the 'sulfite' group.

The following discussion can be considered as an understanding of the following generalised (unbalanced) reaction equation (Equation 2) for the oxidation of iron sulfides with oxygen and water:

Equation 2

$$Fe_{(1-x)}S + H_2O + O_2 \rightarrow Fe^{2+}/Fe^{3+} + S_aO_b^{c-} + H^+$$

Note: 'x' = 0.5 corresponds to pyrite.

'x' = 0.0 corresponds to 'pyrrhotite' for this discussion.

a = 1, b = 0, c = 0 corresponds to elemental sulfur.

a = 1, b = 4, c = 2 corresponds to sulfate.

From this knowledge, it is possible to determine the theoretical amounts of acid that can be produced by oxidation of the iron sulfides. Table A1-4 lists the maximum amounts of acidity that can be generated by the oxidation of the sulfide in pyrrhotite. The final oxidation state of the sulfur-containing reaction product is determined by the availability of oxygen, as indicated by the O_2:FeS ratio in increasing value listed in Table A1-3. Three scenarios for acid generation for each sulfur species are considered, depending on the oxidation state of the iron-containing reaction product. If only the sulfur in FeS is oxidised, the oxidation state of iron remains at +2 and so the acid generated is only sourced by the oxidation reaction of the sulfide component. If the Fe^{2+} is oxidised and precipitated as $Fe(OH)_3$, then two moles of acid will be produced from every mole of oxidised Fe^{2+}. However, if the ferric hydroxide subsequently reacts with sulfuric acid to form jarosite according to Equation 3, then the net result is that only one mole of free acid is generated for every mole of Fe^{2+} oxidised. Minerals such as jarosite are said to represent 'stored' acidity, *i.e.* their formation consumes some of the acidity generated by the oxidation of the iron sulfides, but addition of alkali is required to increase the pH to neutral or higher.

Equation 3

$$K^+ + 3Fe(OH)_3 + 3H^+ + 2SO_4^{2-} \rightarrow [KFe_3(SO_4)_2(OH)_6] + 3H_2O$$

Although the discussion provided above may prove difficult to understand by people with a limited understanding of chemistry, the information provided below in Table A1-4 is extremely important in the understanding of the implications for acid generation by the oxidation of iron sulfides. Table A1-4 lists the theoretical amounts of acid that can be produced, depending on the end-products of the reactions with both iron and sulfur.

Thus, depending on the reaction conditions, the reaction of pyrrhotite with oxygen and water may be either acid-consuming or acid-generating. The maximum amount of acid consumption occurs under conditions of limited oxygen supply when elemental sulfur (plus pyrite) is formed. Note that the reaction described by Equation 4 usually occurs at very low pH values (pH < 2) which are rarely achieved in the field. Maximum acid generation occurs when sulfate and Fe^{3+} hydrolysis products including ferrihydrite are the reaction products. In these situations, associated with high oxygen availability, up to 2 moles of H^+ (1 mole of sulfuric acid H_2SO_4) can be produced from every mole of pyrrhotite. Overall however, the oxidation of pyrrhotite only becomes net acid producing if the hydrolysis of released Fe^{3+} is a major reaction and this is often in practice prevented by precipitation reactions from fully occurring.

Table A1-4: Amount of Acid Produced by the Oxidation of Pyrrhotite as Determined by the Nature of the Iron and Sulfur Reaction Products

Sulfur oxidation product(s)	Number of moles of acidity (H^{+}) produced per mole of sulfur				Increasing Oxygen Availability
	O_2:FeS ratio	Fe^{2+} product	Jarosite product	Ferric hydroxide product	↓
H_2S	Nil	2 moles consumed (Equation 4)	1 mole consumed	None	
Pyrite + S	0.25	1 mole consumed (Equation 5)	None	1 mole produced	
Elemental S	0.5	2 moles consumed (Equation 6)	1 mole consumed	None	
Sulfite	1.5	Nil (Equation 7)	1 mole produced	2 moles produced	
Dithionate	1.75	1 mole consumed (Equation 8)	None	1 mole produced	
Sulfate	2.0	None (Equation 9)	1 mole produced	2 moles produced	
	Acidic — pH Stability Range → Neutral				

Equation 4

$$FeS + 2H^{+} \rightarrow Fe^{2+} + H_2S$$

Equation 5

$$3FeS + 4H^{+} + O_2 \rightarrow FeS_2 + S + 2Fe^{2+} + 2H_2O$$

Equation 6

$$2FeS + 4H^{+} + 3O_2 \rightarrow 2Fe^{2+} + 2S + 2H_2O$$

Equation 7

$$2FeS + 3O_2 \rightarrow 2Fe^{2+} + 2SO_3^{2-}$$

Equation 8

$$4FeS + 7O_2 + 4H^{+} \rightarrow 4Fe^{2+} + 2S_2O_6^{2-} + 2H_2O$$

Equation 9

$$FeS + 2O_2 \rightarrow Fe^{2+} + SO_4^{2-}$$

5. ACID GENERATION FROM OTHER SULFIDE MINERALS

The principle of Acid Base Accounting procedures described above is based on the acid generating properties of the iron sulfide mineral pyrite (FeS_2). Pyrite reacts with oxygen and water to produce acidity (H^+) according to Equation 10:

Equation 10

$$4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 16H^+ + 8SO_4^{2-}$$

The stoichiometry of this reaction indicates that oxidation of one mole of pyrite will produce two moles of sulfuric acid or alternatively, 30.6 kg of sulfuric acid will be produced by oxidation of one tonne of mine waste containing 1% by weight of sulfur.

Other iron sulfides, such as pyrrhotite ($Fe_{(1-x)}S$), marcasite (FeS_2) and mackinawite ($Fe_{(1+x)}S$) react by different mechanisms, but all have a maximum potential production capacity of one mole of sulfuric acid per mole of sulfur. This gives a factor of 30.6 kg of sulfuric acidic potentially produced by oxidation of one tonne of mine waste containing 1% by weight of sulfur.

Copper sulfide minerals also react with oxygen, however the amount of acid produced depends on the composition of the mineral, and in particular the iron content. Chemical equations for the oxidation of copper sulfide minerals such as chalcocite (Cu_2S), covellite (CuS), chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) are presented in Equation 11 to Equation 14 (inclusive):

Equation 11

$$2Cu_2S + 2H_2O + 5O_2 \rightarrow 2Cu(OH)_2 + 2Cu^{2+} + 2SO_4^{2-}$$

Equation 12

$$CuS + 2O_2 \rightarrow Cu^{2+} + SO_4^{2-}$$

Equation 13

$$4CuFeS_2 + 17O_2 + 10H_2O \rightarrow 4Cu^{2+} + 4Fe(OH)_3 + 8SO_4^{2-} + 8H^+$$

Equation 14

$$4Cu_5FeS_4 + 18H_2O + 37O_2 \rightarrow 12Cu^{2+} + 8(Cu(OH)_2 + 4Fe(OH)_3 + 16SO_4^{2-} + 8H^+$$

Other base metal sulfides containing metals including cobalt, nickel, lead and zinc indicate similar behaviour to those of copper sulfides. Chemical equations for the oxidation of common nickel sulfide minerals such as millerite (NiS), pentlandite ($Fe_xNi_{(9-x)}S_8$), and violarite ($FeNi_2S_4$) are presented in Equation 15 to Equation 17 (inclusive):

Equation 15

$$NiS + 2O_2 \rightarrow Ni^{2+} + SO_4^{2-}$$

Equation 16

$$Fe_xNi_{(9-x)}S_8 + {}^{(5x-2)}/_2H_2O + {}^{(36-7x)}/_2O_2 \rightarrow (9-x)Ni^{2+} + xFe(OH)_3 + 8SO_4^{2-} + (2x-2)H^+$$

Equation 17

$$4FeNi_2S_4 + 14H_2O + 31O_2 \rightarrow 8Ni^{2+} + 4Fe(OH)_3 + 16SO_4^{2-} + 16H^+$$

The predicted maximum amounts of sulfuric acid that can be produced by complete oxidation of various iron, copper and nickel sulfide minerals are listed in Table A1-5. These values indicate that acid generation is only possible if the sulfide mineral contains iron. Chalcopyrite, a common iron-copper sulfide mineral, has potential to generate acidity upon complete oxidation, but the maximum amount of potential acidity per percentage unit of sulfur in the mine waste is only half that of pyrite (or marcasite or pyrrhotite).

Table A1-5: Predicted Sulfur Acid Generation Potential from Oxidation of Iron, Copper and Nickel Sulfide Minerals

Mineral Name	Formula	Acid Generation Potential (kg H_2SO_4/t)	
		Per tonne of Mineral	Per 1% Sulfur
Pyrite	FeS_2	1,633	30.6
Marcasite	FeS_2	1,633	30.6
Pyrrhotite	$Fe_{(1-x)}S$	1,115	30.6
Chalcocite	Cu_2S	Nil	Nil
Covellite	CuS	Nil	Nil
Chalcopyrite	$CuFeS_2$	267	15.3
Bornite	Cu_5FeS_4	49	7.6
Millerite	NiS	Nil	Nil
Pentlandite	$Fe_xNi_{(9-x)}S_8$	Variable, depending on the value of x.	
Violarite	$FeNi_2S_4$	650	15.3

It should also be noted that oxidation of copper and nickel sulfide minerals can form soluble copper (Cu^{2+}) and nickel (Ni^{2+}) ions. Both metals form slightly soluble hydroxides (($Cu(OH)_2$) and $Ni(OH)_2$)), which significantly reduces the concentration of free metal ions in solution if the pH remains above 6.5. However, oxidation of copper and nickel sulfide minerals containing iron (e.g. chalcopyrite and violarite) can result in very low pH values, typically below 4.5 if there are insufficient carbonate minerals present to consume the generated acidity. For this reason, it is recommended that NAG measurements for mine waste containing copper and/or nickel sulfides be conducted to endpoint pH values of 4.5 and 7.0:

- NAG acidity to pH 4.5 includes hydrogen (H^+), ferric (Fe^{3+}), manganese (Mn^{2+}) and aluminium (Al^{3+}) ion acidity, but not copper ions (Cu^{2+}) or nickel (Ni^{2+}) ions.
- NAG acidity to pH 7.0 also includes the amount of alkalinity required to precipitate all of the soluble copper ions as $Cu(OH)_2$ and nickel ions as $Ni(OH)_2$. The difference between NAG acidity to pH 4.5 and NAG acidity to pH 7.0 is a measure of the amount of oxidisable copper and nickel sulfides in the sample.

The potential for mixed element iron sulfides to generate variable amounts of acidity is further complicated by the presence of arsenic. Arsenopyrite (FeAsS) is a common sulfide mineral often associated with gold mineralisation in the Western Australian goldfields.

Oxidation of arsenopyrite may be described by Equation 18 and Equation 19:

Equation 18

$$4FeAsS + 21O_2 + 16H_2O \rightarrow 4Fe(OH)_3 + 4SO_4^{2-} + 4AsO_4^{3-} + 20H^+$$

Equation 19

$$2FeAsS + 7O_2 + 2H_2O \rightarrow 2\text{"}FeAsO_4\text{"} + 2SO_4^{2-} + 4H^+$$

"$FeAsO_4$" may vary from crystalline ferric arsenate minerals such as scorodite ($FeAsO_4.2H_2O$) to arsenate anions adsorbed onto hydrous iron oxide surfaces. Regardless of the actual form of "FeAsO4", oxidation of arsenopyrite results in formation of 30.6 kg of sulfuric acid from one tonne of mine waste containing 1% by weight of sulfur, as for pyrite, marcasite and pyrrhotite (Table A1-5). If, however, the iron end product is $Fe(OH)_3$, then the resulting amount of acid (in the form of both sulfuric acid, H_2SO_4, and arsenic acid, H_3AsO_4) will be 2.5 times higher. Oxidation of arsenopyrite by this reaction results in formation of 76.5 kg of sulfuric acid equivalents from one tonne of mine waste containing 1% by weight of sulfur.

In conclusion, using a factor of 30.6 to calculate the amount of acidity as kg H_2SO_4/t is only valid if all of the sulfur is present as iron sulfide minerals. If mixed copper, nickel and other base metals are present, use of the 30.6 conversion factor will over-estimate the amount of acidity produced. If arsenopyrite is present, use of the 30.6 conversion factor may under-estimate the amount of acidity produced.

6. RESIDUAL ACIDITY

It is important to note that material classified as NAF by acid-base accounting methodology described above may not have circum-neutral or alkaline pH values. For reasons outlined in this section, it is possible for NAF waste to be moderately to highly acidic as a result of existing "residual" or "natural" acidity. Conversely, it is common for PAF waste to be slightly to moderately alkaline. Laterite waste rock is an example of material that usually classifies as NAF by acid-base accounting procedures described above, but often records moderate to highly acidic pH values.

As discussed in Section 1 of this Appendix, most of the "residual" or "natural" acidity of these materials is explained by the presence of iron and aluminium sulfate minerals including jarosite and alunite. Additional acidity may be associated with cation exchange properties of highly weathered clay minerals. The sum of the concentrations of "acidic" cations including H^+, Al^{3+} and Mn^{2+} (present in acidic clays and expressed in units of centimoles of positive charge per kilogram) is referred to as "exchangeable acidity". The contribution of "exchangeable acidity" in acidic, clay-rich lateritic waste rock may be as high as 5 kg H_2SO_4/t (depending on clay mineralogy).

It is important to note that leachate from materials containing only "exchangeable acidity" usually contain low levels of soluble acidity, which presents a low risk to the receiving environment. However, elevated levels of "exchangeable acidity" are toxic to plants (phytotoxic), meaning that such materials are unsuitable as a growth medium or as a subsoil water storage for plants.

A summary of typical pH conditions associated with different waste types is presented in Table A1-6. It should be noted that standard ABA classification of clay rich laterites and saprock may result in 'PAF' classification if the NAG pH is < 4.5, however this ignores the initial 1:5 pH (which may be as low as pH 4 for these materials). Such naturally acidic laterites/subsoils have no further potential for acid generation (no sulfides) and are perhaps better termed 'Actual Acid Sulfate Soils' when considering management.

Table A1-6: pH Control of Various Waste Rock Types by Significant Minerals

Typical pH Values	Significant Minerals	Typical Waste Rock Types
Greater than 9.0	Sodium and potassium carbonate, reactive silicates such as forsterite (Mg_2SiO_4), wollastonite ($CaSiO_3$) and cordierite ($(Mg,Fe)_2Al3(Si_5AlO_{18})$).	Mafic and ultramafic volcanics.
8.0 to 9.0	Calcium and magnesium carbonates such as calcite ($CaCO_3$), magnesite ($MgCO_3$), dolomite ($CaMg(CO_3)_2$) and ankerite ($Ca(Fe,Mg,Mn)(CO_3)_2$).	Mafic and ultramafic volcanics, calcareous sedimentary rocks.
5.0 to 9.0	Many common silicate and aluminosilicate minerals such as feldspars, micas and pyroxenes.	Many igneous, non-calcareous sedimentary and metamorphic rock types.
4.0 to 5.0	Highly weathered clay minerals including kaolinite ($Al_2Si_2O_5(OH)_4$), goethite ($FeOOH$) and gibbsite ($Al(OH)_3$).	Laterite and saprock developed over acidic igneous rock types.
Less than 4.0	Alunite, jarosite and related minerals.	Gossans, acid sulfate soils, oxidised sulfidic wastes.

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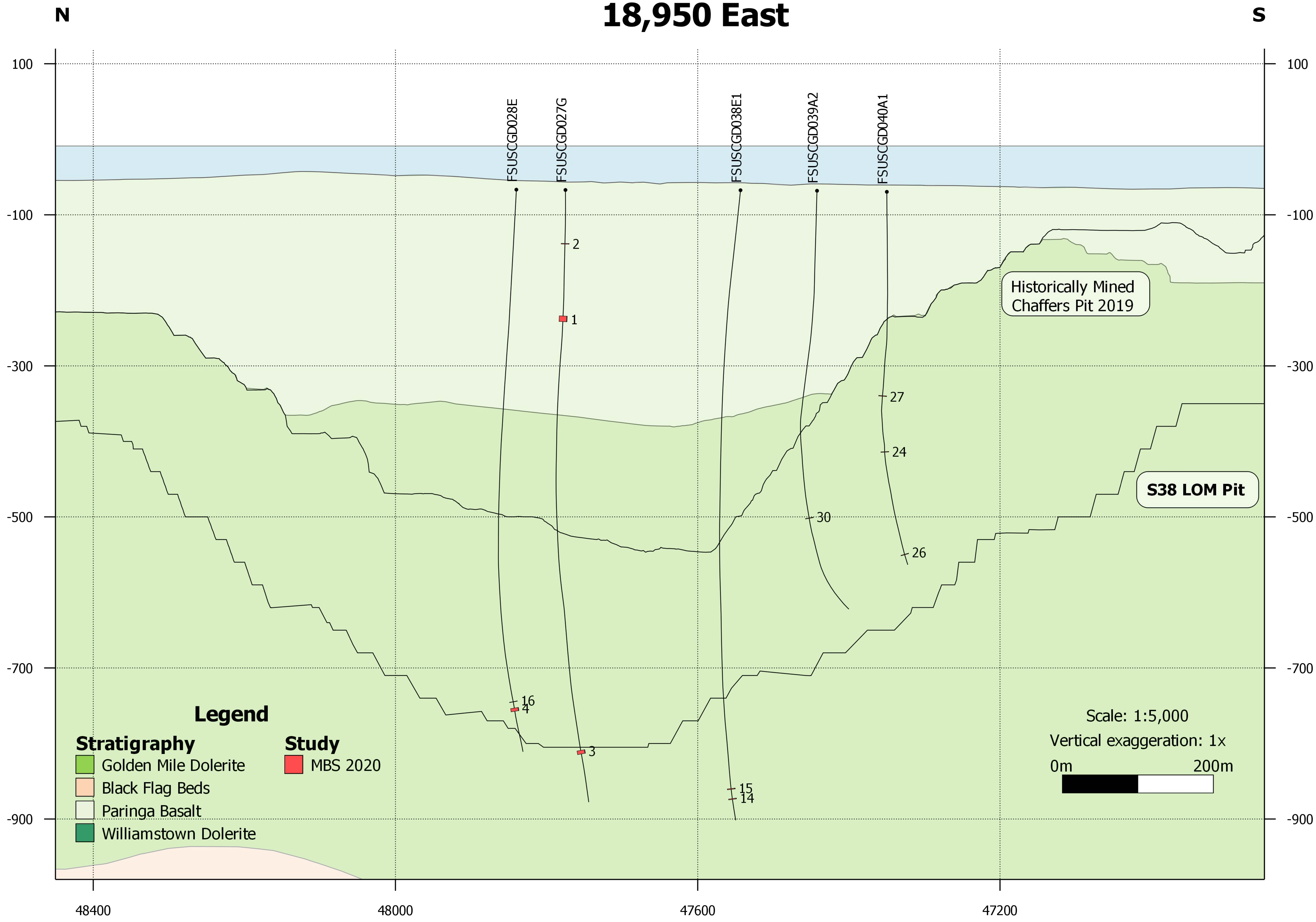
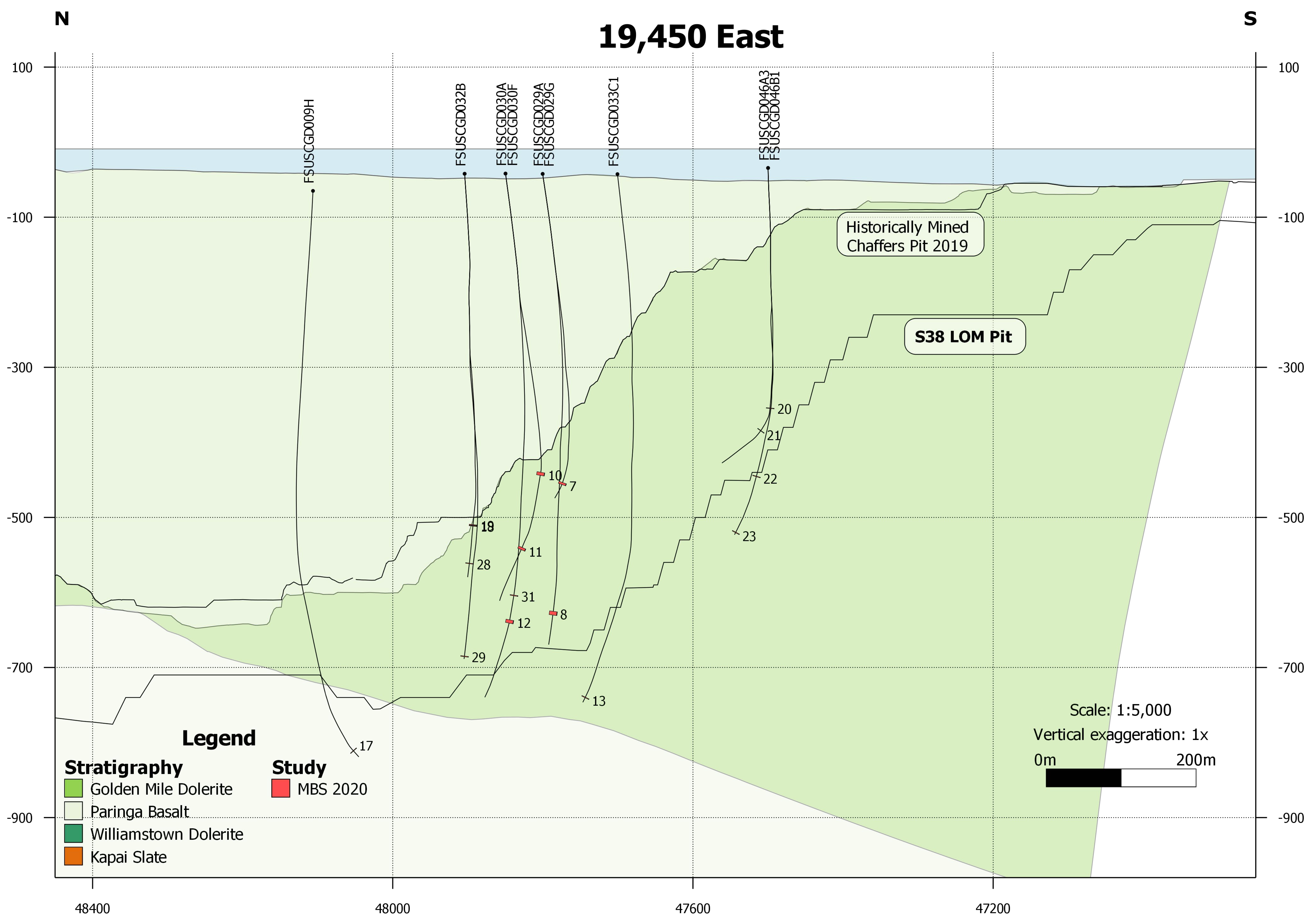
APPENDIX 2: PLAN AND CROSS-SECTIONAL DIAGRAMS FOR FS PROJECT CHARACTERISATION SAMPLES

+48800 N
+48600 N
+48400 N
+48200 N
+48000 N
+47800 N
+47600 N
+47400 N
+47200 N
+47000 N
+18600 E
+18800 E
+19000 E
+19200 E
+19400 E
+19600 E
+20000 E
+20200 E
FSUSCGD009H
FSUSCGD027G
FSUSCGD038E1
FSUSCGD032B
FSUSCGD033CL
17
30
25
27
24
Looking down
0 50 100 150 200

18,950 East



N
S
100
-100
-300
-500
-700
-900
48400
48000
47600
47200
FSUSCGD028E
FSUSCGD027G
FSUSCGD038E1
FSUSCGD039A2
FSUSCGD040A1
2
1
27
24
30
26
16
4
3
15
14
Historically Mined Chaffers Pit 2019
S38 LOM Pit
Legend
Stratigraphy
Golden Mile Dolerite
Black Flag Beds
Paringa Basalt
Williamstown Dolerite
Study
MBS 2020
Scale: 1:5,000
Vertical exaggeration: 1x
0m
200m



N
S
19,450 East
100
-100
-300
-500
-700
-900
FSUSCGD009H
FSUSCGD032B
FSUSCGD030A
FSUSCGD030F
FSUSCGD029A
FSUSCGD029G
FSUSCGD033C1
FSUSCGD046A3
FSUSCGD046B1
Historically Mined Chaffers Pit 2019
S38 LOM Pit
10
7
11
31
12
8
28
29
13
17
18
20
21
22
23
Scale: 1:5,000
Vertical exaggeration: 1x
0m
200m
Legend
Stratigraphy
Golden Mile Dolerite
Paringa Basalt
Williamstown Dolerite
Kapai Slate
Study
MBS 2020
48400
48000
47600
47200

47,100 North


W
E
100
-100
-300
-500
-700
-900
18400
18800
19200
19600
20000
Historically Mined
Chaffers Pit 2019
S38 LOM Pit
17
FSUSCGD009H
Legend
Mineralisation
Mineralisation
Stratigraphy
Golden Mile Dolerite
Black Flag Beds
Paringa Basalt
Williamstown Dolerite
Kapai Slate
Devon Console Basalt
Hannan's Lake Serpentenite
Study
MBS 2020
Scale: 1:5,000
Vertical exaggeration: 1x
0m
200m

W
47,450 North
Historically Mined Chaffers Pit 2019
S38 LOM Pit
-100
-300
-500
-700
-900
18400
18800
19200
19600
20000
FSUSCGD046A3
FSUSCGD046B1
FSUSCGD040A1
FSUSCGD039A2
FSUSCGD039D1
FSUSCGD038E1
27
24
30
23
26
25
20
21
22
15
14
Legend
Mineralisation
Mineralisation
Stratigraphy
Golden Mile Dolerite
Black Flag Beds
Paringa Basalt
Kapai Slate
Hannan's Lake Serpentenite
Study
MBS 2020
Scale: 1:5,000
Vertical exaggeration: 1x
0m
200m

47,800 North

W
E
100
-100
-300
-500
-700
-900
18400
18800
19200
19600
20000
Historically Mined
Chaffers Pit 2019
S38 LOM Pit
FSUSCGD029J
FSUSCGD029A
FSUSCGD032
FSUSCGD030A
FSUSCGD032B
FSUSCGD029G
FSUSCGD033C1
FSUSCGD030F
FSUSCGD028E
FSUSCGD028G
FSUSCGD027G
Legend
Mineralisation
Mineralisation
Stratigraphy
Golden Mile Dolerite
Black Flag Beds
Paringa Basalt
Williamstown Dolerite
Kapai Slate
Devon Console Basalt
Hannan's Lake Serpentenite
Study
MBS 2020
Scale: 1:5,000
Vertical exaggeration: 1x
0m
200m

APPENDIX 3: COLLATED RESULTS

LIST OF APPENDIX 3 TABLES

Table A3-1: Detailed Sample Descriptions – FS Project

Source	Site ID	MBS ID	Hole ID	Depth Interval (m)	Domain	Lithology
Waste Rock						
Drill core/chips	Sample #4	4	SCGD028E	1031-1040	Black Flag	BF Shale
Drill core/chips	Sample #3	3	SCGD027G	1064-1073	Black Flag	BF Shale
Drill core/chips	SXT_MET_022	14	SCGD038E1	1130-1132	BFB	BF Shale
Drill core/chips	SXT_MET_021	13	SCGD033C1	1311-1313	BFB	BF Shale
Drill core/chips	Sample #1	1	SCGD027G	195-204	GMD U2	GMD
Drill core/chips	Sample #5	5	SCGD028G	351-360	GMD U3	GMD
Drill core/chips	SXT_MET_036	27	SCGD040A1	450-452	U5	GMD
Drill core/chips	SXT_MET_029	20	SCGD046A3	650-652	U9	GMD
Drill core/chips	SXT_MET_033	24	SCGD040A1	650-652	U8	GMD
Drill core/chips	Sample #6	6	SCGD028G	721-730	GMD U8	GMD
Drill core/chips	SXT_MET_030	21	SCGD046A3	750-752	U9	GMD
Drill core/chips	Sample #7	7	SCGD029A	768-777	GMD U8	GMD
Drill core/chips	SXT_MET_031	22	SCGD046B1	798-800	U9	GMD
Drill core/chips	Sample #2	2	SCGD027G	821-83	GMD U9	GMD
Drill core/chips	Sample #11	11	SCGD030A	917-926	GMD U8	GMD
Drill core/chips	Sample #8	8	SCGD029G	920-930	GMD U4	GMD
Drill core/chips	SXT_MET_037	28	SCGD032	926-928	U6	GMD
Drill core/chips	SXT_MET_034	25	SCGD039D1	940-942	U9	GMD
Drill core/chips	Sample #12	12	SCGD030F	970-980	GMD U5	GMD
Drill core/chips	SXT_MET_032	23	SCGD046B1	1000-1002	GMD	GMD
Drill core/chips	SXT_MET_035	26	SCGD040A1	1060-1062	U8	GMD
Drill core/chips	SXT_MET_038	29	SCGD032B	1116-1118	U7	GMD
Grab sample	Grab 2 (SXT_MET_042)	33	-	-	GMD	GMD
Grab sample	Grab 3 (SXT_MET_043)	34	-	-	GMD	GMD
Grab sample*	Grab 4 (SXT_MET_044)	35	-	-	GMD	GMD
Drill core/chips	Sample #9	9	SCGD029J	231-240	Paringa Basalt	PB
Drill core/chips	Sample #10	10	SCGD030A	660-670	Paringa Basalt	PB
Drill core/chips	SXT_MET_027	18	SCGD032	797-799	Paringa Basalt	PB
Drill core/chips	SXT_MET_028	19	SCGD032	800.4-802	Paringa Basalt	PB
Drill core/chips	SXT_MET_026	17	SCGD009H	1223-1225	Paringa Basalt	PB
Ore						
Drill core/chips	SXT_MET_023	15	SCGD038E1	1106-1108	BFB	BF shale
Drill core/chips	SXT_MET_024	16	SCGD028E	1013-1014	LO	BF shale
Drill core/chips	SXT_MET_039	30	SCGD039A2	726.25-728	LO	GMD
Drill core/chips	SXT_MET_040	31	SCGD030F	898-900	U3	GMD
Grab sample**	Grab 1 (SXT_MET_041)	32	-	-	GMD	GMD

* *Originally logged as low-grade ore, but considered waste based on Au content.*

** *Originally logged as waste, but considered ore (high grade) based on Au content.*

Table A3-2: Acid Base Accounting and Acid Formation Risk

Sample ID	Type	Lithology	pH	Total S	CRS	SO4_S	TotC	TIC	ANC	CC-ANC	NAPP	CRS MPA	MPA	NAG pH	CRS NPR	Carb. NPR	Tot_S NPR	Eff. NPR	Classification*
			pH Units	%	%				kg H_2SO_4/t					pH Units	Ratio				
4	Waste	BFS	7.5	1.36	1.24	NA	2.6	2.2	152	181	-114	38	42	8.9	NA	-143	4	5	NAF(AC)
3	Waste	BFS	8.0	3.3	2.96	NA	4.2	2.0	129	159	-38	91	101	8.7	NA	-69	1	2	NAF(AC)
14	Waste	BFS	9.2	0.18	0.14	NA	1.0	1.0	57	82	-53	4.3	5.5	NA	13	-77	10	19	NAF(AC)
13	Waste	BFS	9.3	0.78	0.53	NA	2.7	2.7	166	222	-150	16	24	8	10	-206	7	14	NAF(AC)
35	Waste	GMD	9.3	0.25	NA	0.02	5.9	NA	316	482	-309	NA	7.7	8.4	NA	-474	45	63	NAF(AC)
33	Waste	GMD	9.2	0.04	NA	<0.01	2.4	NA	171	195	-170	NA	1.2	9.5	NA	-194	160	160	NAF(AC)
34	Waste	GMD	9.2	0.09	NA	<0.01	2.6	NA	170	210	-167	NA	2.8	8.6	NA	-207	65	76	NAF
1	Waste	GMD	7.4	0.02	<0.04	NA	0.6	0.6	179	47	-178	NA	0.6	11.3	NA	-46	292	76	NAF(AC)
5	Waste	GMD	7.4	0.06	<0.04	NA	2.5	2.5	281	201	-279	NA	1.8	11.1	NA	-199	153	109	NAF(AC)
27	Waste	GMD	9.2	0.09	NA	NA	0.3	NA	43	25	-40	NA	2.8	NA	NA	-22	16	9	NAF(AC)
20	Waste	GMD	9.3	0.14	NA	NA	2.9	NA	212	240	-208	NA	4.3	NA	NA	-236	49	56	NAF(AC)
24	Waste	GMD	8.9	0.5	NA	NA	3.8	NA	253	311	-238	NA	15	8.4	NA	-296	17	20	NAF(AC)
6	Waste	GMD	8.0	0.58	0.5	NA	3.8	3.8	227	306	-209	15	18	9.4	15	-289	13	17	NAF(AC)
21	Waste	GMD	9.1	0.28	NA	NA	4.6	NA	215	377	-206	NA	8.6	8.6	NA	-368	25	44	NAF(AC)
7	Waste	GMD	7.5	0.9	0.86	NA	4.1	4.0	262	328	-234	26	28	9.4	NA	-301	10	12	NAF(AC)
22	Waste	GMD	8.9	0.23	NA	NA	3.8	NA	127	310	-120	NA	7.0	8.5	NA	-303	18	44	NAF(AC)
2	Waste	GMD	7.6	0.18	0.12	NA	2.0	1.9	264	157	-258	3.7	5.5	10.8	72	-151	48	28	NAF(AC)
11	Waste	GMD	8.5	0.32	0.32	NA	4.2	4.2	244	341	-234	9.8	9.8	9.5	NA	-331	25	35	NAF(AC)
28	Waste	GMD	9	0.22	NA	NA	2.0	NA	181	164	-174	NA	6.7	NA	NA	-157	27	24	NAF(AC)
8	Waste	GMD	9.3	0.2	0.18	NA	0.5	0.5	149	42	-143	5.5	6.1	11.3	NA	-36	24	7	NAF(AC)
25	Waste	GMD	8.6	0.23	NA	NA	2.6	NA	179	214	-172	NA	7.0	8.5	NA	-207	25	30	NAF(AC)

Sample ID	Type	Lithology	pH	Total S	CRS	SO4_S	TotC	TIC	ANC	CC-ANC	NAPP	CRS MPA	MPA	NAG pH	CRS NPR	Carb. NPR	Tot_S NPR	Eff. NPR	Classification*
			pH Units	%	%				kg H_2SO_4/t					pH Units	Ratio				
12	Waste	GMD	7.5	0.12	0.08	NA	1.3	1.3	232	103	-228	2.4	3.7	11.2	NA	-99	63	28	NAF(AC)
23	Waste	GMD	8.5	0.41	NA	NA	2.7	NA	180	223	-167	NA	13	8.5	NA	-210	14	18	NAF(AC)
26	Waste	GMD	8.9	0.25	NA	NA	3.0	NA	156	243	-148	NA	7.7	8.4	NA	-236	20	32	NAF(AC)
29	Waste	GMD	9	0.55	NA	NA	2.1	NA	161	173	-144	NA	17	8.4	NA	-156	10	10	NAF(AC)
9	Waste	PB	7.2	0.16	0.16	NA	5.1	5.0	281	412	-276	4.9	4.9	9.7	NA	-407	57	84	NAF
10	Waste	PB	8.0	0.44	0.42	NA	3.7	3.7	183	299	-170	13	13	9.5	14	-286	14	22	NAF(AC)
18	Waste	PB	9.3	0.87	NA	NA	4.8	NA	276	388	-249	NA	27	7.9	NA	-361	10	15	NAF
19	Waste	PB	9.3	1.09	NA	NA	4.6	NA	258	374	-225	NA	33	8.3	NA	-341	8	11	NAF(AC)
17	Waste	PB	9.2	0.45	NA	NA	3.1	NA	195	252	-181	NA	14	8.3	NA	-238	14	18	NAF(AC)
15	ore	BFS	9.3	3.94	2.8	NA	2.7	2.6	184	209	-98	86	121	7.3	NA	-123	2	2	NAF(AC)
16	ore	BFS	9.1	2.97	2.5	NA	4.4	4.4	249	361	-173	77	91	7.6	3.3	-285	3	5	NAF(AC)
30	ore	GMD	8.7	0.87	NA	0.03	3.8	NA	183	311	-157	NA	27	8.3	NA	-285	7	12	NAF(AC)
31	ore	GMD	8.2	1.38	NA	NA	2.2	NA	205	178	-163	NA	42	10.3	NA	-136	5	4	NAF(AC)
32	ore	GMD	9	0.57	NA	0.02	2.2	NA	162	183	-162	NA	17	8.5	NA	-166	10	10	NAF

NA = Not Analysed/Assessed.

** BF shale waste was classified using CRS and TIC and derived calculated parameters, whereas GMD/PB were classified using total S/C and derived calculated parameters (refer Section 7.3 of report).*

Denotes PAF classification

Denotes Uncertain classification

Denotes NAF/AC classification

Table A3-3: Total Metal and Metalloid Concentrations

Sample ID	Type	Lithology	Au	Ag	Al	As	B**	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg**	K	Li	Mg	Mn
			mg/kg		%	mg/kg					%	mg/kg				%	mg/kg	%	mg/kg	%	mg/kg
4	Waste	BFS	0.02	<0.3	7.3	140	NA	640	< 5	< 10	2.1	< 5	25	60	346	5.0	0.4	3.01	15	2.44	500
3	Waste	BFS	0.33	0.6	6.3	130	NA	490	< 5	< 10	1.9	< 5	55	50	410	6.2	1.8	2.62	15	1.88	400
13	Waste	BFS	0.02	0.25	7.1	139	<5	490	1.23	0.19	4.0	0.15	30	107	72	4.0	0.25	2.73	10	2.02	648
33	Waste	GMD	0.04	<0.05	6.6	14	<5	61	0.39	<0.01	4.7	0.05	35	12	29	9.1	0.07	0.37	146	2.43	1,317
34	Waste	GMD	0.05	0.12	5.6	24	<5	93	0.54	<0.01	4.9	0.06	41	21	28	11	0.12	0.43	59	1.89	1,806
35	Waste	GMD	0.26	<0.05	3.8	48	<5	95	0.65	<0.01	6.4	0.08	32	14	35	16	0.21	0.65	40	2.91	5,989
1	Waste	GMD	0.02	< 0.3	7.6	50	NA	70	< 5	< 10	7.2	< 5	55	110	168	9.5	0.7	0.16	35	5.08	1,500
5	Waste	GMD	< 0.02	< 0.3	7.3	20	NA	45	< 5	< 10	6.7	< 5	40	50	122	8.5	0.2	0.56	55	3.12	1,400
6	Waste	GMD	0.27	0.3	5.2	170	NA	110	< 5	< 10	2.9	< 5	40	10	< 2	11	0.3	1.71	15	1.32	1,800
21	Waste	GMD	0.01	<0.05	5.1	39	<5	105	0.55	<0.01	5.0	0.07	47	12	95	11	0.02	0.53	33	1.89	1,702
7	Waste	GMD	1.7	0.3	5.6	200	NA	115	< 5	< 10	4.7	< 5	80	< 10	34	13	<0.1	1.06	55	1.96	2,000
2	Waste	GMD	< 0.02	0.3	6.5	30	NA	85	< 5	< 10	5.8	< 5	45	20	64	11	<0.1	0.33	70	2.76	1,700
11	Waste	GMD	< 0.02	< 0.3	5.2	40	NA	140	< 5	< 10	5.3	< 5	70	< 10	22	14	<0.1	0.56	70	2.28	2,100
8	Waste	GMD	< 0.02	< 0.3	7.8	70	NA	70	< 5	< 10	5.9	< 5	55	20	106	9.4	<0.1	0.27	30	3.4	1,500
12	Waste	GMD	< 0.02	< 0.3	7.2	30	NA	20	< 5	< 10	6.1	< 5	50	30	120	9.4	<0.1	0.05	50	3.44	1,500
26	Waste	GMD	0.001	<0.05	5.2	26	<5	93	0.72	<0.01	3.4	0.08	31	7	11	11	0.01	0.48	58	1.25	2,056
9	Waste	PB	< 0.02	< 0.3	6.9	130	NA	255	< 5	< 10	6.0	< 5	45	150	60	9.2	<0.1	0.88	20	1.68	2,400
10	Waste	PB	< 0.02	< 0.3	7.6	80	NA	150	< 5	< 10	4.6	< 5	55	170	78	8.6	<0.1	0.57	40	1.28	1,800
19	Waste	PB	0.19	0.08	5.8	23	<5	113	1.0	0.04	5.7	0.08	45	97	85	8.3	0.04	2.06	24	3.14	1,431
30	ore	GMD	0.47	0.07	5.0	48	<5	147	1.1	<0.01	4.4	0.06	29	32	11	11	0.05	0.65	11	1.39	1,998
32	ore	GMD	21*	0.52	4.6	122	<5	92	0.38	<0.01	4.2	0.11	37	47	68	9.0	3.79	0.33	66	1.53	1,594
15	ore	BFS	1.1	0.62	7.2	301	<5	604	2.6	0.12	4.2	0.06	27	63	162	4.6	0.21	3.21	14	2.23	617
Average Crustal Concentration			**0.004**	**0.07**	**8.2**	**25**	**10**	**425**	**2.8**	**0.17**	**4.1**	**0.2**	**25**	**100**	**55**	**4.1**	**0.1**	**2.1**	**20**	**2.3**	**950**

** Total Au by fire sssay. ** Total concentration by aqua regia digestion. NA = Not Analysed*

Table A3-3: Total Metal and Metalloid Concentrations, Continued

Sample ID	Type	Lithology	Mo	Na	Ni	P	Pb	Rb	Sb	Se	Si	Sr	Sn	Te	Ti	Th	Tl	U	V	Y	Zn
			mg/kg	%	mg/kg																
4	Waste	BFS	< 5	0.61	35	500	35	NA	10	NA	27	246	NA	0.2	3,000	NA	NA	NA	82	<100	324
3	Waste	BFS	< 5	0.43	65	300	< 5	NA	18	NA	28	244	NA	1.6	2,200	NA	NA	NA	58	<100	636
13	Waste	BFS	1	0.70	98	1,047*	10.2	100	6.5	0.9	NA	245*	0.9	<0.2	10*	4.3	1.2	1.1	82	5.5*	106
33	Waste	GMD	0.3	1.86	23	434*	0.8	13	7.4	<0.5	NA	42*	0.4	<0.2	106*	0.5	0.1	0.2	313	5.9*	89
34	Waste	GMD	1.1	1.61	17	472*	3.6	17	7.1	<0.5	NA	53*	0.5	<0.2	542*	0.5	0.1	0.1	234	7.5*	98
35	Waste	GMD	0.2	0.58	18	273*	1	26	3.5	<0.5	NA	75*	0.3	<0.2	0.06*	0.3	0.2	0.1	210	6.3*	74
1	Waste	GMD	< 5	1.15	185	600	20	NA	3.3	NA	22	118	NA	< 0.2	5,400	NA	NA	NA	224	<100	116
5	Waste	GMD	< 5	1.43	40	600	10	NA	1.9	NA	21	88	NA	< 0.2	60,000	NA	NA	NA	250	<100	108
6	Waste	GMD	< 5	1.51	< 5	1,300	< 5	NA	6.9	NA	23	72	NA	0.2	11,400	NA	NA	NA	4	<100	88
21	Waste	GMD	0.3	1.57	21	451*	0.9	29	5.0	<0.5	NA	56*	0.4	<0.2	379*	0.54	0.15	0.15	538	6.2*	97
7	Waste	GMD	< 5	1.34	< 5	600	< 5	NA	3.4	NA	20	146	NA	0.4	13,800	NA	NA	NA	514	<100	110
2	Waste	GMD	< 5	1.45	25	700	< 5	NA	1.1	NA	22	88	NA	< 0.2	9,600	NA	NA	NA	330	<100	100
11	Waste	GMD	< 5	1.50	5	500	10	NA	2.1	NA	19	102	NA	< 0.2	15,200	NA	NA	NA	214	<100	108
8	Waste	GMD	< 5	2.45	40	600	< 5	NA	0.9	NA	23	162	NA	< 0.2	7,600	NA	NA	NA	332	<100	76
12	Waste	GMD	< 5	2.26	40	400	20	NA	1.3	NA	22	106	NA	< 0.2	7,400	NA	NA	NA	300	<100	118
26	Waste	GMD	0.5	1.59	2	865*	1.4	22	5.6	<0.5	NA	61*	0.6	<0.2	586*	1.0	0.2	0.3	7	9.6*	134
9	Waste	PB	< 5	1.33	85	1,000	10	NA	3.5	NA	21	192	NA	< 0.2	9,600	NA	NA	NA	252	<100	102
10	Waste	PB	< 5	1.45	100	900	5	NA	3.0	NA	22	146	NA	< 0.2	8,600	NA	NA	NA	250	<100	112
19	Waste	PB	0.2	0.65	82	285*	2.3	73	3.0	0.5	NA	165*	0.8	0.5	11*	0.4	0.6	0.1	241	3.6*	85
30	ore	GMD	0.2	2.74	3	745*	2.3	24	4.9	<0.5	NA	92*	0.6	<0.2	491*	1.0	0.3	0.3	69	7.8*	78
32	ore	GMD	56	1.41	27	387*	5.3	13	18	<0.5	NA	72*	0.5	4.1	89*	0.5	0.1	0.1	432	6.5*	115
15	ore	BFS	1.7	0.23	56	1,153*	8.2	101	86	1.2	NA	387*	1	1.6	11*	5.9	1.0	1.5	152	8.3*	39
Average Crustal Concentration			**1.5**	**2.3**	**75**	**1,200**	**13**	**90**	**0.2**	**0.2**		**375**	**2.0**	**0.001**	**5,700**	**10**	**0.45**	**2.7**	**135**	**30**	**70**

* *Total concentration by aqua regia digestion. NA = Not Analysed*

Table A3-4: Global Abundance Index (GAI)*

Sample ID	Type	Lithology	Au	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li	Mg	Mn	Mo
4	Waste	BFS	2	1	0	2		0	0	4	0	3	0	0	2	0	2	0	0	0	0	0
3	Waste	BFS	6	3	0	2		0	0	4	0	3	1	0	2	0	4	0	0	0	0	0
13	Waste	BFS	2	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
33	Waste	GMD	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0
34	Waste	GMD	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
35	Waste	GMD	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	0
1	Waste	GMD	2	1	0	0		0	0	4	0	3	1	0	1	1	3	0	0	1	0	0
5	Waste	GMD	1	1	0	0		0	0	4	0	3	0	0	1	0	1	0	1	0	0	0
6	Waste	GMD	5	2	0	2		0	0	4	0	3	0	0	0	1	1	0	0	0	0	0
21	Waste	GMD	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7	Waste	GMD	6	2	0	2		0	0	4	0	3	1	0	0	1	0	0	1	0	0	0
2	Waste	GMD	1	2	0	0		0	0	4	0	3	0	0	0	1	0	0	1	0	0	0
11	Waste	GMD	1	1	0	0		0	0	4	0	3	1	0	0	1	0	0	1	0	1	0
8	Waste	GMD	1	1	0	1		0	0	4	0	3	1	0	0	1	0	0	0	0	0	0
12	Waste	GMD	1	1	0	0		0	0	4	0	3	0	0	1	1	0	0	1	0	0	0
26	Waste	GMD	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
9	Waste	PB	1	1	0	2		0	0	4	0	3	0	0	0	1	0	0	0	0	1	0
10	Waste	PB	1	1	0	1		0	0	4	0	3	1	0	0	0	0	0	0	0	0	0
19	Waste	PB	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	ore	GMD	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
32	ore	GMD	6	2	0	2	0	0	0	0	0	0	0	0	0	1	5	0	1	0	0	5
15	ore	BFS	6	3	0	3	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

* *Highlighted cells denote significant enrichment (GAI equal or greater than 3).*

Table A3-4: Global Abundance Index (GAI)*, Continued

Sample ID	Type	Lithology	Na	Ni	P	Pb	Rb	Sb	Se	Si	Sr	Sn	Te	Ti	Th	Tl	U	V	Y	Zn
4	Waste	BFS	0	0	0	1		5			0		6	0				0	0	2
3	Waste	BFS	0	0	0	0		6			0		6	0				0	0	3
13	Waste	BFS	0	0	0	0	0	4	2		0	0	6	0	0	1	0	0	0	0
33	Waste	GMD	0	0	0	0	0	5	0		0	0	6	0	0	0	0	1	0	0
34	Waste	GMD	0	0	0	0	0	5	0		0	0	6	0	0	0	0	0	0	0
35	Waste	GMD	0	0	0	0	0	4	0		0	0	6	0	0	0	0	0	0	0
1	Waste	GMD	0	1	0	0		3			0		6	0				0	0	0
5	Waste	GMD	0	0	0	0		3			0		6	3				0	0	0
6	Waste	GMD	0	0	0	0		5			0		6	0				0	0	0
21	Waste	GMD	0	0	0	0	0	4	0		0	0	6	0	0	0	0	1	0	0
7	Waste	GMD	0	0	0	0		4			0		8	1				1	0	0
2	Waste	GMD	0	0	0	0		2			0		6	0				1	0	0
11	Waste	GMD	0	0	0	0		3			0		6	1				0	0	0
8	Waste	GMD	0	0	0	0		2			0		6	0				1	0	0
12	Waste	GMD	0	0	0	0		2			0		6	0				1	0	0
26	Waste	GMD	0	0	0	0	0	4	0		0	0	6	0	0	0	0	0	0	0
9	Waste	PB	0	0	0	0		4			0		6	0				0	0	0
10	Waste	PB	0	0	0	0		3			0		6	0				0	0	0
19	Waste	PB	0	0	0	0	0	3	1		0	0	6	0	0	0	0	0	0	0
30	Ore	GMD	0	0	0	0	0	4	0		0	0	6	0	0	0	0	0	0	0
32	Ore	GMD	0	0	0	0	0	6	0		0	0	6	0	0	0	0	1	0	0
15	Ore	BFS	0	0	0	0	0	8	2		0	0	6	0	0	1	0	0	0	0

* *Highlighted cells denote significant enrichment (GAI equal or greater than 3). Empty cells denote no GAI calculation due to element not analysed, or concentrations less than the laboratory limit of reporting (LOR) still resulted in GAI ≥ 3 using half the LOR due to very low crustal average concentration.*

Table A3-5: Water Leachate (1:5 Ratio) pH, EC, Major Ions and Alkalinity

Sample ID	Type	Lith.	pH	EC	TDS	Ca	Mg	Na	K	F	SO_4	Cl	OH	CO_3	HCO_3	Total Alk
				µS/cm	mg/L									$CaCO_3$ mg/L		
4	Waste	BFS	8.6	1,510	1,012	10	7	4	31		11	11	<1	<1	9	9
3	Waste	BFS	8.6	1,480	992	10	6	4	20		14	15	<1	<1	9	9
13	Waste	BFS	9.3	118	79	8	4	7	5	0.11		10	<5	22	82	104*
1	Waste	GMD	8.8	1,540	1,032	6	2	4	3		2	2	<1	<1	10	10
5	Waste	GMD	8.6	1,130	757	14	6	7	6		26	2	<1	<1	10	10
6	Waste	GMD	8.5	407	273	20	8	5	25		4	4	<1	<1	7	7
21	Waste	GMD	9.1	150	101	12	5	13	0.6	0.1		5	<8	22	56	78
7	Waste	GMD	8.5	1,600	1,072	23	12	12	14		4	6	<1	<1	7	7
2	Waste	GMD	8.7	1,590	1,065	10	4	3	3		2	2	<1	<1	16	16
11	Waste	GMD	8.5	362	243	21	15	9	8		2	4	<1	<1	26	27
8	Waste	GMD	9.1	383	257	6	2	6	5		2	4	<1	5	9	14
12	Waste	GMD	9.0	1,360	911	7	3	4	<1		1	2	<1	<1	8	8
9	Waste	PB	8.7	755	506	15	4	30	5		2	6	<1	<1	4	4
10	Waste	PB	8.7	376	252	13	4	29	3		2	3	<1	<1	14	14
19	Waste	PB	9.3	158	106	12	5	8	8.5	0.07		9	<7	29	41	70
15	Ore	BFS	9.2	129	86	10	4	5	8	0.13		10	<6	16	24	41
30	Ore	GMD	8.9	167	112	17	6	9	0.6	0.07		12	<9	18	44	62
Livestock Drinking Water DGV (ANZECC 2000)			**N/G**	**N/G**	**4,000 (cattle)**	**1,000**	**2,000**	**N/G**	**N/G**	**2**	**1,000**	**N/G**	**N/G**	**N/G**	**N/G**	**N/G**
Non-potable Groundwater Use (DER 2014)			**N/G**	**N/G**	**N/G**	**N/G**	**N/G**	**N/G**	**N/G**	**15**	**1,000**	**250**	**N/G**	**N/G**	**N/G**	**N/G**

*N/G = No Guideline. * TDS calculated from EC using conversion factor of 0.67 (ANZECC 2000). ** Calculated from dissolved sulfur using conversion factor of 3.*

Table A3-6: Water Leachate (1:5 Ratio) Metal and Metalloid Concentrations (mg/L Unless Specified)

Sample ID	Type	Lithology	Ag	Al	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	Li
4	Waste	BFS	<1	1.0	0.031	<0.001	N/A	0.005	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.003
3	Waste	BFS	<1	0.68	0.018	<0.001	N/A	0.004	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.006
13	Waste	BFS	0.02	0.67	0.0696	N/A	0.01	0.0010	<0.0001	<0.001	<0.00002	<0.0001	<0.01	<0.01	<0.01	<0.0001	0.00173
1	Waste	GMD	<1	1.46	0.002	<0.001	N/A	0.056	<0.001	<0.001	<0.0001	<0.001	0.002	<0.001	<0.05	<0.0001	<0.001
5	Waste	GMD	<1	1.36	0.002	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.002
6	Waste	GMD	<1	0.83	0.002	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.013
21	Waste	GMD	0.03	0.64	0.005	N/A	<0.01	0.0009	<0.0001	<0.001	<0.00002	<0.0001	<0.01	<0.01	<0.01	<0.0001	0.0083
7	Waste	GMD	<1	0.68	0.003	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	0.002	<0.05	<0.0001	0.018
2	Waste	GMD	<1	1.82	<0.001	<0.001	N/A	0.013	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.003
11	Waste	GMD	<1	0.6	<0.001	<0.001	N/A	0.006	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.024
8	Waste	GMD	<1	1.82	0.005	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	<0.001
12	Waste	GMD	<1	1.87	<0.001	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.002
9	Waste	PB	<1	0.96	0.189	<0.001	N/A	0.002	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.005
10	Waste	PB	<1	1.21	0.022	<0.001	N/A	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.0001	0.011
19	Waste	PB	<0.01	0.66	0.0126	N/A	<0.01	0.0005	<0.0001	<0.001	<0.00002	0.0029	<0.01	<0.01	<0.01	<0.0001	0.0037
15	ore	BFS	0.02	0.71	0.0246	N/A	<0.01	0.00214	<0.0001	<0.001	<0.00002	<0.0001	<0.01	<0.01	<0.01	<0.0001	0.0055
30	ore	GMD	0.02	0.33	0.0015	N/A	<0.01	0.0011	<0.0001	<0.001	<0.00002	<0.0001	<0.01	<0.01	<0.01	<0.0001	0.0036
Livestock Drinking Water DGV (ANZECC 2000)			**N/G**	**5**	**0.5**	**N/G**	**5**	**N/G**	**N/G**	**N/G**	**0.2**	**1**	**1**	**1****	**N/G**	**0.002**	**2.5***
Non-potable Groundwater Use (DER 2014)			**0.001**	**0.2**	**0.1**	**N/G**	**40**	**20**	**0.6**	**N/G**	**0.02**	**N/G**	**0.5 (CrVI)**	**20**	**0.3**	**0.01**	**N/G**

*DGV = Default Guideline Value as per ANZECC (2000). N/G = No applicable guideline. * As Cr(VI).*

Table A3-6: Water Leachate (1:5 Ratio) Metal and Metalloid Concentrations (mg/L Unless Specified), Continued

Sample ID	Type	Lithology	Mn	Mo	Ni	Pb	Rb (ug/L)	Sb	Se	Si	Sr	Te	Ti	U (ug/L)	V	Y	Zn
4	Waste	BFS	0.002	0.004	<0.001	<0.001	N/A	0.088	N/A	3.9	0.083	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
3	Waste	BFS	0.002	0.014	<0.001	<0.001	N/A	0.148	N/A	3.3	0.084	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
13	Waste	BFS	<0.001	0.00122	<0.01	<0.0005	6.69	0.014	1.8	N/A	N/A	<0.0001	N/A	<0.005	<0.01	N/A	<0.01
1	Waste	GMD	<0.001	<0.001	<0.001	<0.001	N/A	0.013	N/A	3.3	0.011	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
5	Waste	GMD	0.003	<0.001	<0.001	<0.001	N/A	0.006	N/A	2.1	0.059	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
6	Waste	GMD	0.018	<0.001	<0.001	<0.001	N/A	0.035	N/A	2.7	0.039	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
21	Waste	GMD	0.004	0.00013	<0.01	0.0008	2.35	0.002	<0.1	N/A	N/A	<0.0001	N/A	<0.005	<0.01	N/A	<0.01
7	Waste	GMD	0.021	<0.001	<0.001	<0.001	N/A	0.007	N/A	2.8	0.072	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
2	Waste	GMD	0.003	<0.001	<0.001	<0.001	N/A	0.003	N/A	1.0	0.049	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
11	Waste	GMD	0.017	<0.001	<0.001	<0.001	N/A	0.004	N/A	1.7	0.05	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
8	Waste	GMD	0.001	<0.001	<0.001	<0.001	N/A	0.002	N/A	3.3	0.01	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
12	Waste	GMD	<0.001	<0.001	<0.001	<0.001	N/A	0.003	N/A	1.6	0.019	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
9	Waste	PB	0.01	<0.001	<0.001	<0.001	N/A	0.029	N/A	4.3	0.035	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
10	Waste	PB	0.011	<0.001	<0.001	<0.001	N/A	0.015	N/A	3.4	0.02	<0.005	<0.01	N/A	<0.01	<0.001	<0.005
19	Waste	PB	<0.001	0.00029	0.01	0.0007	11.66	0.012	0.5	N/A	N/A	<0.0001	N/A	<0.005	<0.01		<0.01
15	ore	BFS	<0.001	0.007	<0.01	0.0087	12.27	0.225	2.1	N/A	N/A	<0.0001	N/A	0.014	<0.01	N/A	<0.01
30	ore	GMD	0.008	0.00015	<0.01	0.0029	1.92	0.003	<0.1	N/A	N/A	<0.0001	N/A	0.012	<0.01	N/A	<0.01
Livestock drinking DGV (ANZECC 2000)			**N/G**	**0.15**	**1**	**0.1**	**N/G**	**N/G**	**20**	**N/G**	**N/G**	**N/G**	**N/G**	**0.2**	**N/G**	**N/G**	**20**
Non-potable groundwater use (DER 2014)			**5**	**0.5**	**0.2**	**0.1**	**N/G**	**0.03**	**100**	**N/G**	**N/G**	**N/G**	**N/G**	**0.17**	**N/G**	**N/G**	**3**

*DGV = Default Guideline Value as per ANZECC (2000). N/G = No applicable guideline. * Maximum Contaminant Level (MCL) for thallium (US EPA 2020).*

Table A3-7: NAG Liquor Metal and Metalloid Concentrations (mg/L)

Sample ID	Type	Lithology	Ag	Al	As	Au	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg
9	Waste	PB	<0.001	16	0.20	<0.001	0.11	<0.001	<0.001	0.0004	0.07	0.07	0.13	121	<0.0001
10	Waste	PB	<0.001	48	0.59	<0.001	0.19	<0.001	0.002	0.001	0.38	0.19	0.64	328	<0.0001
8	Waste	GMD	<0.001	99	0.20	<0.001	0.23	<0.001	0.001	0.0003	0.12	0.05	0.51	166	<0.0001
7	Waste	GMD	<0.001	51	0.48	<0.001	0.09	<0.001	<0.001	0.0005	0.20	0.01	0.15	254	<0.0001
3	Waste	BFS	0.003	42	1.2	<0.001	0.45	0.003	0.004	0.017	0.64	0.10	4.4	505	<0.0001
4	Waste	BFS	<0.001	30	1.2	<0.001	0.37	0.001	0.003	0.003	0.10	0.05	4.0	135	<0.0001

Sample ID	Type	Lithology	Li	Mn	Mo	Ni	Pb	Sb	Si	Sr	Te	Ti	V	Yb	Zn
9	Waste	PB	0.01	3.8	0.003	0.15	0.008	0.004	51	0.14	<0.005	0.16	0.11	<0.001	0.2
10	Waste	PB	0.06	8.8	0.005	0.69	0.02	0.004	128	0.39	<0.005	0.09	0.30	0.002	1.0
8	Waste	GMD	0.12	3.4	0.005	0.12	0.007	0.002	355	0.08	<0.005	11	0.52	0.002	0.3
7	Waste	GMD	0.17	5.8	0.003	0.02	0.01	0.006	182	0.45	<0.005	0.16	0.46	0.001	0.5
3	Waste	BFS	0.06	3.7	0.036	0.71	0.18	0.08	41	2.0	0.019	0.08	0.08	0.002	7.3
4	Waste	BFS	0.03	4.2	0.013	0.48	0.13	0.02	96	1.1	<0.005	0.09	0.07	0.001	4.1

Table A3-8: FS Project Materials Metal/Metalloid Solubility Under Specialised Leaching Conditions (mg/L*)

Sample ID	Material Type	Leaching Fluid	Final pH	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu
13	BF shale waste	Deionised water (1:20)	9.2	<0.0001	1.1	0.11	0.01	0.003	<0.0001	<0.0001	11	<0.0001	0.0002	<0.0005	0.0002
		1% NaCl	9.2	<0.0001	1.5	0.11	0.01	0.056	<0.0001	<0.0002	24	<0.0001	0.0004	0.0008	<0.0001
		5% NaCl	9.1	<0.0010	1.7	0.14	<0.050	0.29	<0.0010	<0.0010	37	<0.0010	<0.0010	<0.0050	<0.0010
		Hydroxylamine	1.0	0.0029	92	0.08	0.05	1.1	0.0098	0.0047	1,740	0.0024	0.056	0.24	0.19
		Aqua regia	N/A	0.19	6,150	131	<5	54	0.3	0.19	38,610	0.14	29	17	75
21	GMD waste	Deionised water (1:20)	8.8	<0.0001	0.82	0.003	0.009	0.0012	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0005	0.0002
		1% NaCl	8.8	<0.0001	1.0	0.004	0.01	0.032	<0.0001	<0.0002	27	<0.0001	0.0002	<0.0005	<0.0001
		5% NaCl	8.8	<0.0010	0.92	<0.010	<0.050	0.097	<0.0010	<0.0010	40	<0.0010	<0.0010	<0.0050	<0.0010
		Hydroxylamine	2.5	0.0008	60	0.12	0.02	0.52	0.003	<0.0001	2,540	0.0033	0.45	0.07	0.18
		Aqua regia	N/A	0.03	4,710	31	<5	18	0.15	<0.02	49,060	0.09	49	7.4	96
19	PB waste	Deionised water (1:20)	9.0	<0.0001	1.0	0.006	0.008	0.0013	<0.0001	<0.0001	11	<0.0001	0.0004	<0.0005	0.0006
		1% NaCl	9.1	<0.0001	1.5	0.01	0.01	0.021	<0.0001	<0.0002	23	<0.0001	0.0005	<0.0005	0.0004
		5% NaCl	9.1	<0.0010	1.7	<0.010	<0.050	0.074	<0.0010	<0.0010	39	<0.0010	<0.0010	<0.0050	0.012
		Hydroxylamine	4.1	0.0005	38	0.048	0.02	0.39	0.011	<0.0001	2,700	0.004	0.25	0.14	0.075
		Aqua regia	N/A	0.07	9,210	21	<5	16	0.42	0.04	56,050	0.11	45	29	85
15	BF shale ore	Deionised water (1:20)	9.1	<0.0001	0.87	0.044	0.008	0.0033	<0.0001	<0.0001	12	<0.0001	<0.0001	<0.0005	0.0001
		1% NaCl	9.1	<0.0001	1.3	0.072	0.01	0.094	<0.0001	<0.0002	22	<0.0001	0.0001	0.0007	<0.0001
		5% NaCl	9.0	<0.0010	1.2	0.065	<0.050	0.49	<0.0010	<0.0010	30	<0.0010	<0.0010	<0.0050	<0.0010
		Hydroxylamine	1.2	0.0027	79	0.17	0.032	1.3	0.011	0.0022	2030	0.0015	0.087	0.21	0.46
		Aqua regia	N/A	0.71	6,420	315	<5	33	0.47	0.13	40,880	0.06	28	8.3	163
30	GMD ore	Deionised water (1:20)	8.7	<0.0001	0.46	<0.001	0.005	0.0024	<0.0001	<0.0001	18	<0.0001	0.0001	<0.0005	0.0002

Sample ID	Material Type	Leaching Fluid	Final pH	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu
		1% NaCl	8.6	<0.0001	0.49	0.001	0.007	0.026	<0.0001	<0.0002	34	<0.0001	0.0002	<0.0005	<0.0001
		5% NaCl	8.6	<0.0010	0.43	<0.010	<0.050	0.065	<0.0010	<0.0010	46	<0.0010	<0.0010	<0.0050	<0.0010
		Hydroxylamine	1.5	0.0003	38	0.12	0.01	0.45	0.012	<0.0001	2,230	0.002	0.28	0.14	0.022
		Aqua regia	N/A	0.03	6,130	44	<5	19	0.41	<0.02	42,420	0.061	29	14	9.6
32	GMD ore (high grade)	Deionised water (1:20)	8.9	<0.0001	0.68	0.002	0.008	0.0017	<0.0001	<0.0001	12	<0.0001	<0.0001	<0.0005	<0.0001
		1% NaCl	8.9	<0.0001	0.92	0.003	0.01	0.032	<0.0001	<0.0002	25	<0.0001	<0.0001	<0.0005	0.0001
		Hydroxylamine	0.9	0.0041	130	0.2	0.022	0.47	0.0056	0.0002	2,110	0.0032	0.17	0.12	0.24
		Aqua regia	N/A	1.1	23,090	118	<5	15	0.17	<0.02	40,690	0.111	39	12	68

* *Aqua regia results reported in mg/kg.*

N/A = Not Analysed.

Table A3-8: FS Project Materials Metal/Metalloid Solubility Under Specialised Leaching Conditions (mg/L*), Continued

Sample ID	Material Type	Leaching Fluid	Fe	Hg	K	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
13	BF shale waste	Deionised water (1:20)	0.006	<0.0001	19	0.002	3.6	0.0012	<0.001	6.5	<0.0002	<0.001	<0.1	<0.0001	0.035
		1% NaCl	0.014	<0.0002	36	0.0049	9.3	0.0023	<0.001	N/A	<0.0002	0.002	<0.1	<0.0002	0.068
		5% NaCl	<0.050	<0.0010	48	0.0061	14	0.0048	<0.010	N/A	<0.0020	<0.010	<1.0	<0.0010	0.085
		Hydroxylamine	790	0.0002	60	0.082	741	21	<0.001	14	<0.0002	0.34	39	0.23	0.18
		Aqua regia	36,590	0.25	2,770	4.14	17,910	640	0.92	390	N/A	87.9	1,047	7.1	10
21	GMD waste	Deionised water (1:20)	0.006	<0.0001	3.1	0.011	6.4	0.0072	<0.001	20	<0.0002	<0.001	<0.1	<0.0001	0.0057
		1% NaCl	0.011	<0.0002	8.8	0.023	13	0.0059	<0.001	NA	<0.0002	<0.001	<0.1	<0.0002	0.023
		5% NaCl	<0.050	<0.0010	11	0.024	16.7	0.042	<0.010	NA	<0.0020	<0.010	<1.0	<0.0010	0.028
		Hydroxylamine	2,000	<0.0001	14	0.13	679	56	<0.001	33	<0.0002	0.26	10	0.0095	0.075
		Aqua regia	104,580	0.02	780	8.0	18,200	1,734	0.28	1,130	N/A	19	451	0.5	3.9
19	PB waste	Deionised water (1:20)	0.008	<0.0001	18	0.003	5.3	0.004	<0.001	5.8	<0.0002	0.003	<0.1	<0.0001	0.033
		1% NaCl	0.001	<0.0002	33	0.006	12	0.005	<0.001	N/A	<0.0002	0.004	<0.1	<0.0002	0.06
		5% NaCl	<0.050	<0.0010	45	0.007	17	0.008	<0.010	N/A	<0.0020	<0.010	<1.0	<0.0010	0.072
		Hydroxylamine	1,400	<0.0001	53	0.12	1,040	46	<0.001	12	<0.0002	0.84	0.5	0.04	0.16
		Aqua regia	79,020	0.04	2,400	22	30,210	1516	0.16	380	N/A	77	285	1.5	8.1
15	BF shale ore	Deionised water (1:20)	<0.005	<0.0001	18	0.004	3.8	0.001	0.003	4.1	<0.0002	<0.001	<0.1	<0.0001	0.028
		1% NaCl	0.003	<0.0002	35	0.010	9.0	0.002	0.004	N/A	<0.0002	<0.001	<0.1	<0.0002	0.054
		5% NaCl	<0.050	<0.0010	44	0.011	13	0.007	<0.010	N/A	<0.0020	<0.010	<1.0	<0.0010	0.068
		Hydroxylamine	450	0.0005	52	0.092	892	24	0.004	8.5	<0.0002	0.32	51	0.15	0.16
		Aqua regia	43,960	0.21	2,960	5.0	19,320	621	1.8	260	N/A	52	1,153	7.0	9.1
30	GMD ore	Deionised water (1:20)	<0.005	<0.0001	6.9	0.004	10	0.017	<0.001	8.7	<0.0002	<0.001	<0.1	<0.0001	0.012

Sample ID	Material Type	Leaching Fluid	Fe	Hg	K	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
		1% NaCl	0.003	<0.0002	13	0.009	17	0.040	<0.001	N/A	<0.0002	<0.001	<0.1	<0.0002	0.026
		5% NaCl	<0.050	<0.0010	15	0.008	19	0.078	<0.010	N/A	<0.0020	<0.010	<1.0	<0.0010	0.03
		Hydroxylamine	2,000	0.0002	16	0.076	480	62	<0.001	17	<0.0002	0.04	30	0.023	0.072
		Aqua regia	100,880	0.05	750	11	13,290	1,952	0.23	360	N/A	2.7	745	0.7	3.0
32	GMD ore (high grade)	Deionised water (1:20)	<0.005	<0.0001	3	0.007	7.5	0.009	0.014	9.8	<0.0002	<0.001	<0.1	<0.0001	0.005
		1% NaCl	<0.005	<0.0002	7.3	0.013	13	0.033	0.016	N/A	<0.0002	<0.001	<0.1	<0.0002	0.014
		Hydroxylamine	1,200	0.068	9	0.39	452	69	0.007	14	<0.0002	0.12	17	0.051	0.037
		Aqua regia	85,560	3.79	450	74	14,550	1,565	62	390	N/A	24	387	1.9	1.8

* *Aqua regia results reported in mg/kg.*

N/A = Not Analysed.

Table A3-8: FS Project Materials Metal/Metalloid Solubility Under Specialised Leaching Conditions (mg/L), Continued

Sample ID	Material Type	Leaching Fluid	S	Sb	Sc	Se	Si	Sn	Te	Th	Ti	Tl	U	V	Zn
13	BF shale waste	Deionised water (1:20)	6.6	0.026	<0.0005	0.002	1.6	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	0.005	0.005
		1% NaCl	9.9	0.031	<0.0005	0.002	0.88	<0.0001	<0.0001	<0.0002	0.0006	0.0002	<0.0002	<0.005	0.005
		5% NaCl	9.8	0.037	<0.0050	<0.010	<0.50	<0.0010	<0.0010	<0.0010	<0.0050	<0.0010	<0.0010	<0.050	0.002
		Hydroxylamine	2.4	0.007	0.095	0.002	57	0.0001	0.001	0.007	0.14	0.0028	0.0022	0.35	1.5
		Aqua regia	N/A	2.2	N/A	1.1	N/A	0.12	0.12	2.5	10	0.17	0.39	15	93
21	GMD waste	Deionised water (1:20)	2.7	0.004	<0.0005	<0.001	0.96	<0.0001	<0.0001	<0.0001	0.0007	<0.0001	<0.0001	<0.005	0.008
		1% NaCl	4.7	0.004	<0.0005	<0.001	0.57	<0.0001	<0.0001	<0.0002	0.0009	<0.0002	<0.0002	<0.005	0.005
		5% NaCl	3.2	0.005	<0.0050	<0.010	<0.50	<0.0010	<0.0010	<0.0010	<0.0050	<0.0010	<0.0010	<0.050	0.002
		Hydroxylamine	1.0	0.002	0.13	<0.001	39	<0.0001	<0.0001	<0.0001	0.0058	0.0004	0.0003	0.96	1.8
		Aqua regia	N/A	0.74	N/A	0.55	N/A	0.06	<0.02	0.12	379	0.03	0.024	176	86
19	PB waste	Deionised water (1:20)	5.5	0.010	<0.0005	<0.001	1.2	<0.0001	<0.0001	<0.0001	0.0007	<0.0001	<0.0001	<0.005	0.015
		1% NaCl	11	0.010	<0.0005	<0.001	0.68	<0.0001	<0.0001	<0.0002	0.0007	<0.0002	<0.0002	<0.005	0.004
		5% NaCl	8.6	0.011	<0.0050	<0.010	<0.50	<0.0010	<0.0010	<0.0010	<0.0050	<0.0010	<0.0010	<0.050	0.001
		Hydroxylamine	1.4	0.004	0.017	<0.001	33	<0.0001	0.0005	0.0001	0.003	0.0015	0.0002	0.7	1.3
		Aqua regia	N/A	0.61	N/A	0.62	N/A	0.08	0.42	0.13	11	0.09	0.017	55	77
15	BF shale ore	Deionised water (1:20)	15	0.25	<0.0005	0.001	1.7	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	0.009	0.005
		1% NaCl	24	0.27	<0.0005	0.002	0.95	<0.0001	<0.0001	<0.0002	0.0013	<0.0002	<0.0002	0.008	0.006
		5% NaCl	25	0.38	<0.0050	<0.010	<0.50	<0.0010	<0.0010	<0.0010	<0.0050	<0.0010	<0.0010	<0.050	0.002
		Hydroxylamine	5.1	0.07	0.084	0.002	45	<0.0001	0.013	0.009	0.16	0.0017	0.0023	0.61	0.61
		Aqua regia	N/A	42	N/A	1.48	N/A	0.1	1.7	2.6	11	0.12	0.75	23	31
30	GMD ore	Deionised water (1:20)	5.4	0.004	<0.0005	<0.001	0.74	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.005	0.006

Sample ID	Material Type	Leaching Fluid	S	Sb	Sc	Se	Si	Sn	Te	Th	Ti	Tl	U	V	Zn
		1% NaCl	9.2	0.004	<0.0005	<0.001	0.56	<0.0001	<0.0001	<0.0002	0.0006	<0.0002	<0.0002	<0.005	0.005
		5% NaCl	8.3	0.005	<0.0050	<0.010	<0.50	<0.0010	<0.0010	<0.0010	<0.0050	<0.0010	<0.0010	<0.050	0.01
		Hydroxylamine	1.8	0.004	0.39	<0.001	26	0.0002	0.0007	0.0011	0.15	0.0007	0.0004	0.19	1.4
		Aqua regia	N/A	1.3	N/A	0.4	N/A	0.09	0.07	0.21	491	0.04	0.039	33	65
32	GMD ore (high grade)	Deionised water (1:20)	2.5	0.008	<0.0005	<0.001	0.62	<0.0001	<0.0001	<0.0001	N/A	<0.0001	<0.0001	<0.005	<0.001
		1% NaCl	4.5	0.008	<0.0005	<0.001	0.45	<0.0001	<0.0001	<0.0002	N/A	<0.0002	<0.0002	<0.005	<0.001
		Hydroxylamine	<1.0	0.007	0.35	0.001	89	0.0002	0.019	0.0018	N/A	0.0004	0.0005	1.8	1.0
		Aqua regia	N/A	4.4	N/A	0.64	N/A	<0.05	4.1	0.14	89	0.03	0.026	262	106

* *Aqua regia results reported in mg/kg.*

N/A = Not Analysed.

APPENDIX 4: LABORATORY REPORTS

ChemCentre
Scientific Services Division
Amended Report

Accredited for compliance with ISO/IEC 17025 - Testing, Accreditation No. 8

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www.chemcentre.wa.gov.au
ABN 40 991 885 705

Purchase Order: KCGMFWRC2
ChemCentre Reference: 19S4715 R1

MBS Environmental
4 Cook St
West Perth WA 6005

Attention: Thomas Robson

Report on: 24 samples received on 07/05/2020

LAB ID	Material	Client ID and Description
19S4715 / 001	leachate	BLANK Blank - DI ASLP
19S4715 / 002	leachate	SCGD033C1_1311 (SXT_MET_021) BFS Waste - DI ASLP
19S4715 / 003	leachate	SCGD038E1_1106 (SXT_MET_023) BFS LG Ore - DI ASLP
19S4715 / 004	leachate	SCGD032_800.4 (SXT_MET_028) PB Waste - DI ASLP
19S4715 / 005	leachate	SCGD046A3_750 (SXT_MET_030) GMD Waste - DI ASLP
19S4715 / 006	leachate	SCGD039A2_726.25 (SXT_MET_039) GMD LG Ore - DI ASLP
19S4715 / 007	leachate	BLANK Blank - 1% NaCl ASLP
19S4715 / 008	leachate	SCGD033C1_1311 (SXT_MET_021) BFS Waste - 1% NaCl ASLP
19S4715 / 009	leachate	SCGD038E1_1106 (SXT_MET_023) BFS LG Ore - 1% NaCl ASLP
19S4715 / 010	leachate	SCGD032_800.4 (SXT_MET_028) PB Waste - 1% NaCl ASLP
19S4715 / 011	leachate	SCGD046A3_750 (SXT_MET_030) GMD Waste - 1% NaCl ASLP
19S4715 / 012	leachate	SCGD039A2_726.25 (SXT_MET_039) GMD LG Ore - 1% NaCl ASLP
19S4715 / 013	leachate	BLANK Blank - 5% NaCl ASLP
19S4715 / 014	leachate	SCGD033C1_1311 (SXT_MET_021) BFS Waste - 5% NaCl ASLP
19S4715 / 015	leachate	SCGD038E1_1106 (SXT_MET_023) BFS LG Ore - 5% NaCl ASLP
19S4715 / 016	leachate	SCGD032_800.4 (SXT_MET_028) PB Waste - 5% NaCl ASLP
19S4715 / 017	leachate	SCGD046A3_750 (SXT_MET_030) GMD Waste - 5% NaCl ASLP
19S4715 / 018	leachate	SCGD039A2_726.25 (SXT_MET_039) GMD LG Ore - 5% NaCl ASLP
19S4715 / 019	leachate	BLANK Blank - Hydroxylamine HCl Extract
19S4715 / 020	leachate	SCGD033C1_1311 (SXT_MET_021) BFS Waste - Hydroxylamine HCl Extract
19S4715 / 021	leachate	SCGD038E1_1106 (SXT_MET_023) BFS LG Ore - Hydroxylamine HCl Extract
19S4715 / 022	leachate	SCGD032_800.4 (SXT_MET_028) PB Waste - Hydroxylamine HCl Extract
19S4715 / 023	leachate	SCGD046A3_750 (SXT_MET_030) GMD Waste - Hydroxylamine HCl Extract
19S4715 / 024	leachate	SCGD039A2_726.25 (SXT_MET_039) GMD LG Ore - Hydroxylamine HCl Extract

LAB ID			001	002	003	004
Client ID			BLANK	SCGD033C1_1311 (SXT_MET_021)	SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)
Sampled						
Analyte	**Method**	**Unit**				
Aluminium	iMET1WCICP	mg/L	<0.005	1.1	0.87	1.0
Antimony	iMET1WCMS	mg/L	<0.0001	0.026	0.25	0.0095
Arsenic	iMET1WCMS	mg/L	<0.001	0.11	0.044	0.006

LAB ID			001	002	003	004
Client ID			BLANK	SCGD033C1_1311 (SXT_MET_021)	SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)
Sampled						
Analyte	**Method**	**Unit**				
Barium	iMET1WCMS	mg/L	<0.0001	0.0030	0.0033	0.0013
Beryllium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth*	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Boron	iMET1WCMS	mg/L	<0.005	0.010	0.008	0.008
Cadmium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Calcium	iMET1WCICP	mg/L	<0.1	11.4	11.5	11.1
Chromium	iMET1WCMS	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	iMET1WCMS	mg/L	<0.0001	0.0002	<0.0001	0.0004
Copper	iMET1WCMS	mg/L	<0.0001	0.0002	0.0001	0.0006
Iron	iMET1WCICP	mg/L	<0.005	0.006	<0.005	0.008
Lead	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Lithium	iMET1WCMS	mg/L	<0.0001	0.0020	0.0044	0.0027
Magnesium	iMET1WCICP	mg/L	<0.1	3.6	3.8	5.3
Manganese	iMET1WCMS	mg/L	<0.0001	0.0012	0.0013	0.0035
Mercury	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	iMET1WCMS	mg/L	<0.001	<0.001	0.003	<0.001
Nickel	iMET1WCMS	mg/L	<0.001	<0.001	<0.001	0.003
Niobium*	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
pH	iPH1WASE		5.7	9.2	9.1	9.0
Phosphorus	iMET1WCICP	mg/L	<0.1	<0.1	<0.1	<0.1
Potassium	iMET1WCICP	mg/L	<0.1	19.1	17.7	17.6
Rubidium*	iMET1WCMS	mg/L	<0.0001	0.035	0.028	0.033
Scandium*	iMET1WCMS	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	iMET1WCMS	mg/L	<0.001	0.002	0.001	<0.001
Silicon	iMET1WCICP	mg/L	<0.05	1.6	1.7	1.2
Silver	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium	iMET1WCICP	mg/L	<0.1	6.5	4.1	5.8
Sulfur	iMET1WCICP	mg/L	<0.1	6.6	15	5.5
Tellurium*	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Thorium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Tin	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	iMET1WCMS	mg/L	<0.0005	<0.0005	0.0006	0.0007
Uranium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	iMET1WCICP	mg/L	<0.005	0.005	0.009	<0.005
Zinc	iMET1WCMS	mg/L	<0.001	0.005	0.005	0.015
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		19/5/2020	21/5/2020	21/5/2020	19/5/2020
	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

LAB ID			005	006	007	008
Client ID			SCGD046A3_750 (SXT_MET_030)	SCGD039A2_726.25 (SXT_MET_039)	BLANK	SCGD033C1_1311 (SXT_MET_021)
Sampled						
Analyte	**Method**	**Unit**				
Aluminium	iMET1WCICP	mg/L	0.82	0.46	<0.005	1.5
Antimony	iMET1WCMS	mg/L	0.0035	0.0036	<0.0001	0.031
Arsenic	iMET1WCICP	mg/L				0.11
Arsenic	iMET1WCMS	mg/L	0.003	<0.001	<0.001	
Barium	iMET1WCMS	mg/L	0.0012	0.0024	0.0014	0.057
Beryllium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth*	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	<0.0002
Boron	iMET1WCMS	mg/L	0.009	0.005	<0.005	0.011
Cadmium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Calcium	iMET1WCICP	mg/L	13.0	18.2	<0.1	24.1
Chromium	iMET1WCMS	mg/L	<0.0005	<0.0005	<0.0005	0.0008
Cobalt	iMET1WCMS	mg/L	<0.0001	0.0001	<0.0001	0.0004
Copper	iMET1WCMS	mg/L	0.0002	0.0002	0.0003	0.0003
Iron	iMET1WCICP	mg/L	0.006	<0.005	0.006	0.020
Lead	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	<0.0002
Lithium	iMET1WCMS	mg/L	0.011	0.0044	<0.0001	0.0049
Magnesium	iMET1WCICP	mg/L	6.4	10.3	<0.1	9.3
Manganese	iMET1WCMS	mg/L	0.0072	0.017	0.0003	0.0023
Mercury	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	<0.0002
Molybdenum	iMET1WCMS	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel	iMET1WCMS	mg/L	<0.001	<0.001	<0.001	0.002
Niobium*	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
pH	iPH1WASE		8.8	8.7	6.2	9.2
Phosphorus	iMET1WCICP	mg/L	<0.1	<0.1	<0.1	<0.1
Potassium	iMET1WCICP	mg/L	3.1	6.9	0.2	36.3
Rubidium*	iMET1WCMS	mg/L	0.0057	0.012	0.0002	0.068
Scandium*	iMET1WCMS	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	iMET1WCMS	mg/L	<0.001	<0.001	<0.001	0.002
Silicon	iMET1WCICP	mg/L	0.96	0.74	<0.05	0.88
Silver	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium	iMET1WCICP	mg/L	19.7	8.7		
Sulfur	iMET1WCICP	mg/L	2.7	5.4	0.1	10
Tellurium*	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	0.0002
Thorium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	<0.0002
Tin	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	iMET1WCMS	mg/L	0.0007	0.0006	<0.0005	0.0006
Uranium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0002	<0.0002
Vanadium	iMET1WCICP	mg/L	<0.005	<0.005	<0.005	<0.005
Zinc	iMET1WCMS	mg/L	0.008	0.006	0.013	0.005
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		19/5/2020	19/5/2020	28/5/2020	21/5/2020
	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

LAB ID			009	010	011	012
Client ID			SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)	SCGD046A3_750 (SXT_MET_030)	SCGD039A2_726.25 (SXT_MET_039)
Sampled						
Analyte	**Method**	**Unit**				
Aluminium	iMET1WCICP	mg/L	1.3	1.5	1.0	0.49
Antimony	iMET1WCICP	mg/L	0.27			
Antimony	iMET1WCMS	mg/L		0.010	0.0040	0.0040
Arsenic	iMET1WCMS	mg/L	0.072	0.010	0.004	0.001
Barium	iMET1WCMS	mg/L	0.095	0.022	0.033	0.027
Beryllium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth*	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Boron	iMET1WCMS	mg/L	0.010	0.010	0.010	0.007
Cadmium	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Calcium	iMET1WCICP	mg/L	22.3	23.1	27.1	34.4
Chromium	iMET1WCMS	mg/L	0.0007	<0.0005	<0.0005	<0.0005
Cobalt	iMET1WCMS	mg/L	0.0001	0.0005	0.0002	0.0002
Copper	iMET1WCMS	mg/L	0.0003	0.0007	0.0003	0.0002
Iron	iMET1WCICP	mg/L	0.009	0.007	0.017	0.009
Lead	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Lithium	iMET1WCMS	mg/L	0.0097	0.0062	0.023	0.0086
Magnesium	iMET1WCICP	mg/L	9.0	12.0	13.0	16.5
Manganese	iMET1WCMS	mg/L	0.0035	0.0087	0.027	0.053
Mercury	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	iMET1WCMS	mg/L	0.004	<0.001	<0.001	<0.001
Nickel	iMET1WCMS	mg/L	<0.001	0.004	<0.001	<0.001
Niobium*	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
pH	iPH1WASE		9.1	9.1	8.8	8.6
Phosphorus	iMET1WCICP	mg/L	<0.1	<0.1	<0.1	<0.1
Potassium	iMET1WCICP	mg/L	35.0	33.4	9.0	13.4
Rubidium*	iMET1WCMS	mg/L	0.054	0.060	0.023	0.026
Scandium*	iMET1WCMS	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	iMET1WCMS	mg/L	0.002	<0.001	<0.001	<0.001
Silicon	iMET1WCICP	mg/L	0.95	0.68	0.57	0.56
Silver	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sulfur	iMET1WCICP	mg/L	24	11	4.8	9.3
Tellurium*	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Thorium	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Tin	iMET1WCMS	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	iMET1WCMS	mg/L	0.0013	0.0007	0.0009	0.0006
Uranium	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Vanadium	iMET1WCICP	mg/L	0.008	<0.005	<0.005	<0.005
Zinc	iMET1WCMS	mg/L	0.006	0.004	0.005	0.005
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		21/5/2020	21/5/2020	21/5/2020	21/5/2020
	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

LAB ID			013	014	015	016
Client ID			BLANK	SCGD033C1_1311 (SXT_MET_021)	SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)
Sampled						
Analyte	**Method**	**Unit**				
Aluminium	iMET1WCICP	mg/L	<0.050	1.7	1.2	1.7
Antimony	iMET1WCMS	mg/L	<0.0010	0.037	0.38	0.011
Arsenic	iMET1WCMS	mg/L	<0.010	0.14	0.065	<0.010
Barium	iMET1WCMS	mg/L	<0.0010	0.29	0.49	0.074
Beryllium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Bismuth*	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Boron	iMET1WCMS	mg/L	<0.050	<0.050	<0.050	<0.050
Cadmium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Calcium	iMET1WCICP	mg/L	<1.0	36.8	30.1	39.0
Chromium	iMET1WCMS	mg/L	<0.0050	<0.0050	<0.0050	<0.0050
Cobalt	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Copper	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	0.012
Iron	iMET1WCICP	mg/L	<0.050	<0.050	<0.050	<0.050
Lead	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Lithium	iMET1WCMS	mg/L	<0.0010	0.0061	0.011	0.0074
Magnesium	iMET1WCICP	mg/L	<1.0	14.2	13.0	17.3
Manganese	iMET1WCMS	mg/L	0.0025	0.0048	0.0072	0.0084
Mercury	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum	iMET1WCMS	mg/L	<0.010	<0.010	<0.010	<0.010
Nickel	iMET1WCMS	mg/L	<0.010	<0.010	<0.010	<0.010
Niobium*	iMET1WCMS	mg/L	<0.0020	<0.0020	<0.0020	<0.0020
pH	iPH1WASE		6.9	9.1	9.0	9.1
Phosphorus	iMET1WCICP	mg/L	<1.0	<1.0	<1.0	<1.0
Potassium	iMET1WCICP	mg/L	<1.0	47.7	44.3	45.1
Rubidium*	iMET1WCMS	mg/L	<0.0010	0.085	0.068	0.072
Scandium*	iMET1WCMS	mg/L	<0.0050	<0.0050	<0.0050	<0.0050
Selenium	iMET1WCMS	mg/L	<0.010	<0.010	<0.010	<0.010
Silicon	iMET1WCICP	mg/L	<0.50	<0.50	<0.50	<0.50
Silver	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Sulfur	iMET1WCICP	mg/L	<1.0	9.8	25	8.6
Tellurium*	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Thallium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Thorium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Tin	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Titanium	iMET1WCMS	mg/L	<0.0050	<0.0050	<0.0050	<0.0050
Uranium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0010	<0.0010
Vanadium	iMET1WCICP	mg/L	<0.050	<0.050	<0.050	<0.050
Zinc	iMET1WCMS	mg/L	0.027	0.029	0.029	0.028
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		21/5/2020	19/5/2020	19/5/2020	19/5/2020
	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

LAB ID			017	018	019	020
Client ID			SCGD046A3_750 (SXT_MET_030)	SCGD039A2_726.25 (SXT_MET_039)	BLANK	SCGD033C1_1311 (SXT_MET_021)
Sampled						
Analyte	**Method**	**Unit**				
Aluminium	iMET1WCICP	mg/L	0.92	0.43	0.012	92
Antimony	iMET1WCMS	mg/L	0.0045	0.0047	<0.0001	0.0068
Arsenic	iMET1WCMS	mg/L	<0.010	<0.010	<0.001	0.081
Barium	iMET1WCICP	mg/L				1.1
Barium	iMET1WCMS	mg/L	0.097	0.065	0.0010	
Beryllium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0098
Bismuth*	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0047
Boron	iMET1WCMS	mg/L	<0.050	<0.050	0.006	0.058
Cadmium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0024
Calcium	iMET1WCICP	mg/L	39.6	46.2	0.1	1740
Chromium	iMET1WCICP	mg/L				0.24
Chromium	iMET1WCMS	mg/L	<0.0050	<0.0050	0.0005	
Cobalt	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.056
Copper	iMET1WCICP	mg/L				0.19
Copper	iMET1WCMS	mg/L	<0.0010	<0.0010	0.0014	
Iron	iMET1WCICP	mg/L	<0.050	<0.050	0.011	790
Lead	iMET1WCMS	mg/L	<0.0010	<0.0010	0.0006	0.23
Lithium	iMET1WCMS	mg/L	0.024	0.0084	<0.0001	0.082
Magnesium	iMET1WCICP	mg/L	16.7	19.0	<0.1	741
Manganese	iMET1WCICP	mg/L				21
Manganese	iMET1WCMS	mg/L	0.042	0.078	0.0007	
Mercury	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0002
Molybdenum	iMET1WCMS	mg/L	<0.010	<0.010	<0.001	<0.001
Nickel	iMET1WCICP	mg/L				0.34
Nickel	iMET1WCMS	mg/L	<0.010	<0.010	<0.001	
Niobium*	iMET1WCMS	mg/L	<0.0020	<0.0020	<0.0002	<0.0002
pH	iPH1WASE		8.8	8.6	0.6	1.0
Phosphorus	iMET1WCICP	mg/L	<1.0	<1.0	<0.1	39
Potassium	iMET1WCICP	mg/L	10.8	15.4	0.2	59.7
Rubidium*	iMET1WCMS	mg/L	0.028	0.030	<0.0001	0.18
Scandium*	iMET1WCMS	mg/L	<0.0050	<0.0050	<0.0005	0.095
Selenium	iMET1WCMS	mg/L	<0.010	<0.010	<0.001	0.002
Silicon	iMET1WCICP	mg/L	<0.50	<0.50	<0.05	57
Silver	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0029
Sodium	iMET1WCICP	mg/L			<0.1	13.7
Sulfur	iMET1WCICP	mg/L	3.2	8.3	<0.1	2.4
Tellurium*	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0010
Thallium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0028
Thorium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0068
Tin	iMET1WCMS	mg/L	<0.0010	<0.0010	0.0002	0.0003
Titanium	iMET1WCICP	mg/L				0.14
Titanium	iMET1WCMS	mg/L	<0.0050	<0.0050	0.0006	
Uranium	iMET1WCMS	mg/L	<0.0010	<0.0010	<0.0001	0.0022
Vanadium	iMET1WCICP	mg/L	<0.050	<0.050	<0.005	0.35
Zinc	iMET1WCICP	mg/L				1.5
Zinc	iMET1WCMS	mg/L	0.029	0.037	0.007	
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		19/5/2020	19/5/2020	19/5/2020	26/5/2020

LAB ID			017	018	019	020
Client ID						
Sampled						
Analyte	Method	Unit				
Date Analysed	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

LAB ID			021	022	023	024
Client ID			SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)	SCGD046A3_750 (SXT_MET_030)	SCGD039A2_726.25 (SXT_MET_039)
Sampled						
Analyte	Method	Unit				
Aluminium	iMET1WCICP	mg/L	79	38	60	38
Antimony	iMET1WCMS	mg/L	0.069	0.0042	0.0017	0.0039
Arsenic	iMET1WCMS	mg/L	0.17	0.048	0.12	0.12
Barium	iMET1WCICP	mg/L	1.3			
Barium	iMET1WCMS	mg/L		0.39	0.52	0.45
Beryllium	iMET1WCMS	mg/L	0.011	0.011	0.0033	0.012
Bismuth*	iMET1WCMS	mg/L	0.0022	<0.0001	<0.0001	<0.0001
Boron	iMET1WCMS	mg/L	0.038	0.026	0.026	0.016
Cadmium	iMET1WCMS	mg/L	0.0015	0.0042	0.0033	0.0020
Calcium	iMET1WCICP	mg/L	2030	2700	2540	2230
Chromium	iMET1WCMS	mg/L	0.21	0.14	0.070	0.14
Cobalt	iMET1WCMS	mg/L	0.087	0.25	0.45	0.28
Copper	iMET1WCMS	mg/L	0.46	0.075	0.18	0.023
Iron	iMET1WCICP	mg/L	450	1400	2000	2000
Lead	iMET1WCMS	mg/L	0.15	0.040	0.0095	0.023
Lithium	iMET1WCMS	mg/L	0.092	0.12	0.13	0.076
Magnesium	iMET1WCICP	mg/L	892	1040	679	480
Manganese	iMET1WCICP	mg/L	24	46	56	62
Mercury	iMET1WCMS	mg/L	0.0005	<0.0001	<0.0001	0.0002
Molybdenum	iMET1WCMS	mg/L	0.004	<0.001	<0.001	<0.001
Nickel	iMET1WCMS	mg/L	0.32	0.84	0.26	0.040
Niobium*	iMET1WCMS	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
pH	iPH1WASE		1.2	4.1	2.5	1.5
Phosphorus	iMET1WCICP	mg/L	51	0.5	10	30
Potassium	iMET1WCICP	mg/L	52.0	53.6	14.2	16.1
Rubidium*	iMET1WCMS	mg/L	0.16	0.16	0.075	0.072
Scandium*	iMET1WCMS	mg/L	0.084	0.017	0.13	0.39
Selenium	iMET1WCMS	mg/L	0.002	<0.001	<0.001	<0.001
Silicon	iMET1WCICP	mg/L	45	33	39	26
Silver	iMET1WCMS	mg/L	0.0027	0.0005	0.0008	0.0003
Sodium	iMET1WCICP	mg/L	8.5	12.3	32.8	16.7
Sulfur	iMET1WCICP	mg/L	5.1	1.4	1.0	1.8
Tellurium*	iMET1WCMS	mg/L	0.013	0.0005	<0.0001	0.0007
Thallium	iMET1WCMS	mg/L	0.0017	0.0015	0.0004	0.0007
Thorium	iMET1WCMS	mg/L	0.0090	0.0001	<0.0001	0.0011
Tin	iMET1WCMS	mg/L	0.0001	<0.0001	<0.0001	0.0004
Titanium	iMET1WCMS	mg/L	0.16	0.0030	0.0058	0.15
Uranium	iMET1WCMS	mg/L	0.0023	0.0002	0.0003	0.0004
Vanadium	iMET1WCICP	mg/L	0.61	0.70	0.96	0.19

Analyte	Method	Unit	LAB ID 021	LAB ID 022	LAB ID 023	LAB ID 024
Client ID			SCGD038E1_1106 (SXT_MET_023)	SCGD032_800.4 (SXT_MET_028)	SCGD046A3_750 (SXT_MET_030)	SCGD039A2_726.25 (SXT_MET_039)
Sampled						
Zinc	iMET1WCICP	mg/L		1.3	1.8	1.4
Zinc	iMET1WCMS	mg/L	0.61			
Date Analysed	iMET1WCICP		18/5/2020	18/5/2020	18/5/2020	18/5/2020
	iMET1WCMS		21/5/2020	21/5/2020	21/5/2020	21/5/2020
	iPH1WASE		13/5/2020	13/5/2020	13/5/2020	13/5/2020
Sample Condition			Ambient	Ambient	Ambient	Ambient

Method	Method Description
iMET1WCICP	Total dissolved metals by ICPAES.
iMET1WCMS	Total dissolved metals by ICPMS.
iPH1WASE	pH in water by pH meter.

Please note: This is an amended report that contains information that is different from the original report (Antimoney for sample 9 how inlcuded). The original report must be destroyed and replaced with this corrected version.

These results apply only to the sample(s) as received. Unless arrangements are made to the contrary, these samples will be disposed of after 30 days of the issue of this report.
This report may only be reproduced in full.

*Analysis not covered by scope of ChemCentre's NATA accreditation.

Hannah Burton
Team Leader
SSD-Inorganic Chemistry
29-May-2020

MINERALS
TEST REPORT

CLIENT

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

JOB INFORMATION

JOB CODE	:	282.0/2007224
NO. SAMPLES	:	23
NO. ELEMENTS	:	75
CLIENT ORDER NO.	:	KCGMFWRC2 (Job 1 of 1)
SAMPLE SUBMISSION NO.	:	Q190646
PROJECT	:	KCGMFWRC2
SAMPLE TYPE	:	Drill core
DATE RECEIVED	:	28/04/2020
DATE TESTED	:	07/05/2020 - 20/05/2020
DATE REPORTED	:	20/05/2020
DATE PRINTED	:	20/05/2020

REPORT NOTES

TESTED BY

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APPROVED SIGNATURE FOR

Craig RITCHIE
Operations Manager - Perth

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.

MEASUREMENT OF UNCERTAINTY

Measurement of uncertainty estimates are available for most tests upon request.

SAMPLE STORAGE

All solid samples (assay pulps, bulk pulps and residues) will be stored for 60 days without charge. Following this samples wil 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 for return or collection is received.

LEGEND	X	= Less than Detection Limit	NA	= Not Analysed
	SNR	= Sample Not Received	UA	= Unable to Assay
	*	= Result Checked	>	= Value beyond Limit of Method
	DTF	= Result still to come	+	= Extra Sample Received Not Listed
	IS	= Insufficient Sample for Analysis		

ELEMENTS	Au	Au-Rp1	Ag	Ag	Ag	Al
UNITS	ppb	ppm	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.1	0.005	0.05	0.02	0.01	50
DIGEST	AR005/	FA25/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	20.2		0.25	0.19	0.02	7.06%
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	1091.0		0.62	0.71	0.02	7.24%
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	188.6		0.08	0.07	X	5.83%
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	8.8		X	0.03	0.03	5.15%
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	1.1		X	X		5.19%
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	467.2		0.07	0.03	0.02	5.03%
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	>2000.0	21.017	0.52	1.10		4.61%
0021 Grab 2 (SXT_MET_042)	40.2		X	X		6.61%
0022 Grab 3 (SXT_MET_043)	54.1		0.12	X		5.63%
0023 Grab 4 (SXT_MET_044)	262.0		X	0.04		3.84%

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	1.6		0.05	X		5.21%
0004 (SXT_MET_030)					X	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988		14.628				
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			10.44			6.98%
0006 OREAS 25a	1.2			0.03		
0007 TMDW					1.85	

ELEMENTS	Al	Al	ANC	As	As	As
UNITS	%	mg/l	kgH2SO4/t	ppm	ppm	ug/l
DETECTION LIMIT	0.005	0.01	1	0.5	0.05	0.1
DIGEST	AR005/	ASLP5/	ANCx/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	OE	VOL	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.615	0.67	166	138.9	130.81	69.6
0002 (SXT_MET_022)			57			
0003 (SXT_MET_023)	0.642	0.71	184	300.5	315.49	24.6
0004 (SXT_MET_024)			249			
0005 (SXT_MET_026)			195			
0006 (SXT_MET_027)			276			
0007 (SXT_MET_028)	0.921	0.66	258	22.6	21.09	12.6
0008 (SXT_MET_029)			212			
0009 (SXT_MET_030)	0.471	0.64	215	39.3	31.16	5.0
0010 (SXT_MET_031)			127			
0011 (SXT_MET_032)			180			
0012 (SXT_MET_033)			253			
0013 (SXT_MET_034)			179			
0014 (SXT_MET_035)	1.508		156	25.7	20.94	
0015 (SXT_MET_036)			43			
0016 (SXT_MET_037)			181			
0017 (SXT_MET_038)			161			
0018 (SXT_MET_039)	0.613	0.33	183	47.8	43.97	1.5
0019 (SXT_MET_040)			205			
0020 Grab 1 (SXT_MET_041)	2.309		162	121.8	118.03	
0021 Grab 2 (SXT_MET_042)	3.129		171	13.5	7.43	
0022 Grab 3 (SXT_MET_043)	2.058		170	24.1	21.07	
0023 Grab 4 (SXT_MET_044)	1.154		316	48.1	45.55	

CHECKS						
0001 (SXT_MET_033)			227			
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	1.461			26.0	21.16	
0004 (SXT_MET_030)		0.72				5.0
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4			95			
0004 NAG Std 3						
0005 OREAS 630				689.1		
0006 OREAS 25a	5.773				2.03	
0007 TMDW						80.7

ELEMENTS	B	B	Ba	Ba	Ba	Be
UNITS	ppm	mg/l	ppm	ppm	ug/l	ppm
DETECTION LIMIT	5	0.01	0.1	0.05	0.05	0.05
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	X	0.01	490.1	53.51	0.99	1.23
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	X	X	604.4	32.89	2.14	2.63
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	X	X	113.2	15.89	0.52	1.02
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	X	X	105.3	18.01	0.87	0.55
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	X		93.4	12.08		0.72
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	X	X	147.3	19.40	1.10	1.05
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	X		91.6	14.78		0.38
0021 Grab 2 (SXT_MET_042)	X		61.0	7.00		0.39
0022 Grab 3 (SXT_MET_043)	X		92.8	20.32		0.54
0023 Grab 4 (SXT_MET_044)	X		95.1	11.53		0.65
CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	X		97.3	11.98		0.61
0004 (SXT_MET_030)		X			0.80	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			1760.8			1.45
0006 OREAS 25a	X			57.49		
0007 TMDW					51.09	

ELEMENTS	Be	Be	Bi	Bi	Bi	C
UNITS	ppm	ug/l	ppm	ppm	ug/l	%
DETECTION LIMIT	0.02	0.1	0.01	0.02	0.005	0.01
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	
ANALYTICAL FINISH	MS	MS	MS	MS	MS	/CSA
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.30	X	0.19	0.19	X	2.72
0002 (SXT_MET_022)						1.00
0003 (SXT_MET_023)	0.47	X	0.12	0.13	X	2.68
0004 (SXT_MET_024)						4.43
0005 (SXT_MET_026)						3.08
0006 (SXT_MET_027)						4.75
0007 (SXT_MET_028)	0.42	X	0.04	0.04	X	4.58
0008 (SXT_MET_029)						2.94
0009 (SXT_MET_030)	0.15	X	X	X	X	4.61
0010 (SXT_MET_031)						3.80
0011 (SXT_MET_032)						2.73
0012 (SXT_MET_033)						3.81
0013 (SXT_MET_034)						2.62
0014 (SXT_MET_035)	0.21		X	X		2.98
0015 (SXT_MET_036)						0.30
0016 (SXT_MET_037)						2.01
0017 (SXT_MET_038)						2.12
0018 (SXT_MET_039)	0.41	X	X	X	X	3.81
0019 (SXT_MET_040)						2.18
0020 Grab 1 (SXT_MET_041)	0.17		X	X		2.24
0021 Grab 2 (SXT_MET_042)	0.08		X	X		2.39
0022 Grab 3 (SXT_MET_043)	0.17		X	X		2.57
0023 Grab 4 (SXT_MET_044)	0.19		X	X		5.90
CHECKS						
0001 (SXT_MET_033)						3.94
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	0.21		X	X		
0004 (SXT_MET_030)		X			X	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						3.63
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			7.56			
0006 OREAS 25a	0.64			0.29		
0007 TMDW		20.4			9.982	

ELEMENTS	CO3	C-Acinsol	C-CO3	Ca	Ca	Ca
UNITS	mgCaCO3/L	%	%	ppm	%	mg/l
DETECTION LIMIT	5	0.01	0.01	50	0.005	0.01
DIGEST	ASLP5/	C71/		4A/	AR005/	ASLP5/
ANALYTICAL FINISH	VOL	CSA	/CALC	MS	MS	OE
SAMPLE NUMBERS						
0001 (SXT_MET_021)	22	X	2.72	3.96%	3.861	7.65
0002 (SXT_MET_022)		X	1.00			
0003 (SXT_MET_023)	16	0.12	2.56	4.22%	4.088	9.60
0004 (SXT_MET_024)		0.02	4.42			
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	29			5.71%	5.605	12.19
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	22			4.96%	4.906	12.17
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)				3.39%	3.283	
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	18			4.43%	4.242	16.99
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)				4.17%	4.069	
0021 Grab 2 (SXT_MET_042)				4.65%	4.443	
0022 Grab 3 (SXT_MET_043)				4.89%	4.604	
0023 Grab 4 (SXT_MET_044)				6.42%	6.153	

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)				3.48%	3.202	
0004 (SXT_MET_030)	20					11.90
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)		0.01				

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630				1.57%		
0006 OREAS 25a					0.151	
0007 TMDW	X					

ELEMENTS	Cd	Cd	Cd	Ce	Cl	Co
UNITS	ppm	ppm	ug/l	ppm	mg/l	ppm
DETECTION LIMIT	0.02	0.005	0.02	0.002	2	0.1
DIGEST	4A/	AR005/	ASLP5/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	MS	MS	MS	VOL	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.15	0.144	X	43.308	10	29.9
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	0.06	0.060	X	20.987	10	27.3
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	0.08	0.110	X	2.435	9	45.1
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	0.07	0.092	X	5.984	5	47.4
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	0.08	0.071		10.161		31.2
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	0.06	0.061	X	7.386	12	29.2
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	0.11	0.111		7.173		36.9
0021 Grab 2 (SXT_MET_042)	0.05	0.044		10.576		35.2
0022 Grab 3 (SXT_MET_043)	0.06	0.059		8.590		40.8
0023 Grab 4 (SXT_MET_044)	0.08	0.072		5.299		31.8

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	0.10	0.080		10.018		31.7
0004 (SXT_MET_030)			X		5	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630	12.82					5.7
0006 OREAS 25a		0.040		32.419		
0007 TMDW			10.21		28	

ELEMENTS	Co	Co	ColourChange	Cr	Cr	Cr
UNITS	ppm	ug/l	NONE	ppm	ppm	mg/l
DETECTION LIMIT	0.01	0.1	0	1	0.2	0.01
DIGEST	AR005/	ASLP5/	ANCx/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	QUAL	MS	MS	OE
SAMPLE NUMBERS						
0001 (SXT_MET_021)	29.05	X	Yes	107	17.1	X
0002 (SXT_MET_022)			Yes			
0003 (SXT_MET_023)	27.70	X	Yes	63	8.3	X
0004 (SXT_MET_024)			Yes			
0005 (SXT_MET_026)			Yes			
0006 (SXT_MET_027)			Yes			
0007 (SXT_MET_028)	45.44	2.9	Yes	97	29.4	X
0008 (SXT_MET_029)			Yes			
0009 (SXT_MET_030)	48.93	X	Yes	12	7.4	X
0010 (SXT_MET_031)			Yes			
0011 (SXT_MET_032)			Yes			
0012 (SXT_MET_033)			Yes			
0013 (SXT_MET_034)			Yes			
0014 (SXT_MET_035)	30.59		Yes	7	3.8	
0015 (SXT_MET_036)			Yes			
0016 (SXT_MET_037)			Yes			
0017 (SXT_MET_038)			Yes			
0018 (SXT_MET_039)	28.94	X	Yes	32	13.8	X
0019 (SXT_MET_040)			Yes			
0020 Grab 1 (SXT_MET_041)	38.82		Yes	47	12.4	
0021 Grab 2 (SXT_MET_042)	36.46		Yes	12	9.7	
0022 Grab 3 (SXT_MET_043)	42.91		Yes	21	6.5	
0023 Grab 4 (SXT_MET_044)	32.49		Yes	14	6.6	

CHECKS						
0001 (SXT_MET_033)			Yes			
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	30.89			11	5.5	
0004 (SXT_MET_030)		X				X
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630				19		
0006 OREAS 25a	5.58				74.5	
0007 TMDW		25.8				

ELEMENTS	Cs	Cu	Cu	Cu	EC	EC
UNITS	ppm	ppm	ppm	mg/l	uS/cm	uS/cm
DETECTION LIMIT	0.01	0.5	0.05	0.01	10	10
DIGEST	AR005/	4A/	AR005/	ASLP5/	Ws5/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	OE	MTR	MTR
SAMPLE NUMBERS						
0001 (SXT_MET_021)	1.64	72.2	74.69	X	82	118
0002 (SXT_MET_022)					73	
0003 (SXT_MET_023)	2.86	161.7	163.43	X	123	129
0004 (SXT_MET_024)					85	
0005 (SXT_MET_026)					61	
0006 (SXT_MET_027)					75	
0007 (SXT_MET_028)	2.05	85.2	85.06	X	93	158
0008 (SXT_MET_029)					117	
0009 (SXT_MET_030)	4.23	94.8	96.44	X	90	150
0010 (SXT_MET_031)					74	
0011 (SXT_MET_032)					240	
0012 (SXT_MET_033)					140	
0013 (SXT_MET_034)					210	
0014 (SXT_MET_035)	2.84	11.0	9.80		70	
0015 (SXT_MET_036)					55	
0016 (SXT_MET_037)					59	
0017 (SXT_MET_038)					63	
0018 (SXT_MET_039)	0.84	10.6	9.62	X	81	167
0019 (SXT_MET_040)					254	
0020 Grab 1 (SXT_MET_041)	0.96	67.5	67.93		257	
0021 Grab 2 (SXT_MET_042)	1.30	28.8	26.37		172	
0022 Grab 3 (SXT_MET_043)	4.06	28.3	26.94		172	
0023 Grab 4 (SXT_MET_044)	1.65	34.7	36.14		183	
CHECKS						
0001 (SXT_MET_033)					132	
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	2.77	11.3	9.64			
0004 (SXT_MET_030)				X		144
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630		379.9				
0006 OREAS 25a	4.14		24.53			
0007 TMDW						323

ELEMENTS	F	Fe	Fe	Fe	Final-pH	Fizz-Rate
UNITS	mg/L	ppm	%	mg/l	NONE	NONE
DETECTION LIMIT	0.01	50	0.001	0.01	0.1	0
DIGEST	ASLP5/	4A/	AR005/	ASLP5/	ANCx/	ANCx/
ANALYTICAL FINISH	SIE	MS	MS	OE	MTR	QUAL
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.11	3.96%	3.659	X	1.1	2.0000000
0002 (SXT_MET_022)					1.3	2.0000000
0003 (SXT_MET_023)	0.13	4.57%	4.396	X	1.0	2.0000000
0004 (SXT_MET_024)					1.5	2.0000000
0005 (SXT_MET_026)					1.4	2.0000000
0006 (SXT_MET_027)					1.7	2.0000000
0007 (SXT_MET_028)	0.07	8.30%	7.902	X	1.7	2.0000000
0008 (SXT_MET_029)					1.3	2.0000000
0009 (SXT_MET_030)	0.10	11.30%	10.458	X	1.5	2.0000000
0010 (SXT_MET_031)					1.3	2.0000000
0011 (SXT_MET_032)					1.3	2.0000000
0012 (SXT_MET_033)					0.8	2.0000000
0013 (SXT_MET_034)					1.4	3.0000000
0014 (SXT_MET_035)		11.10%	9.743		1.4	2.0000000
0015 (SXT_MET_036)					1.4	2.0000000
0016 (SXT_MET_037)					1.4	3.0000000
0017 (SXT_MET_038)					1.5	3.0000000
0018 (SXT_MET_039)	0.07	11.43%	10.088	X	0.6	3.0000000
0019 (SXT_MET_040)					1.3	3.0000000
0020 Grab 1 (SXT_MET_041)		9.04%	8.556		1.4	3.0000000
0021 Grab 2 (SXT_MET_042)		9.12%	8.567		1.3	3.0000000
0022 Grab 3 (SXT_MET_043)		11.09%	9.821		1.4	2.0000000
0023 Grab 4 (SXT_MET_044)		15.65%	14.892		0.8	2.0000000

CHECKS						
0001 (SXT_MET_033)					0.8	2.0000000
0002 (SXT_MET_032)						
0003 (SXT_MET_035)		11.12%	9.595			
0004 (SXT_MET_030)	0.10			X		
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4					1.3	
0004 NAG Std 3						
0005 OREAS 630		8.53%				
0006 OREAS 25a			5.991			
0007 TMDW	0.59					

ELEMENTS	Ga	Ge	HCO3	Hf	Hg	Hg
UNITS	ppm	ppm	mgCaCO3/L	ppm	ppm	ug/l
DETECTION LIMIT	0.1	0.05	5	0.01	0.01	0.1
DIGEST	AR005/	AR005/	ASLP5/	AR005/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	VOL	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	1.7	X	82	0.05	0.25	X
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	1.9	X	24	0.04	0.21	X
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	2.8	X	41	0.05	0.04	X
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	2.4	X	56	0.06	0.02	X
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	10.2	0.06		0.12	0.01	
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	5.1	0.06	44	0.18	0.05	X
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	11.4	0.08		0.20	3.79	
0021 Grab 2 (SXT_MET_042)	13.7	0.06		0.20	0.07	
0022 Grab 3 (SXT_MET_043)	10.7	0.07		0.16	0.12	
0023 Grab 4 (SXT_MET_044)	4.4	0.07		0.12	0.21	

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	10.0	0.08		0.10	0.03	
0004 (SXT_MET_030)			54			X
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630						
0006 OREAS 25a	20.5	X		0.43	0.06	
0007 TMDW			99			X

ELEMENTS	In	K	K	K	La	Li
UNITS	ppm	ppm	%	mg/l	ppm	ppm
DETECTION LIMIT	0.01	20	0.001	0.1	0.002	0.1
DIGEST	AR005/	4A/	AR005/	ASLP5/	AR005/	4A/
ANALYTICAL FINISH	MS	MS	MS	OE	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.04	2.73%	0.277	5.0	18.418	9.6
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	0.03	3.21%	0.296	8.0	8.612	13.8
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	0.05	2.06%	0.240	8.5	0.901	23.9
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	0.08	5339	0.078	0.6	2.141	32.5
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	0.13	4777	0.056		3.620	58.3
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	0.09	6511	0.075	0.6	2.545	10.6
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	0.06	3334	0.045		2.533	66.1
0021 Grab 2 (SXT_MET_042)	0.07	3674	0.045		3.668	146.3
0022 Grab 3 (SXT_MET_043)	0.07	4319	0.060		3.163	59.3
0023 Grab 4 (SXT_MET_044)	0.08	6535	0.066		1.936	39.6

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	0.12	4881	0.054		3.525	56.6
0004 (SXT_MET_030)				0.6		
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630		3.12%				21.6
0006 OREAS 25a	0.08		0.134		13.373	
0007 TMDW						

ELEMENTS	Li	Li	Mg	Mg	Mg	Mn
UNITS	ppm	ug/l	ppm	%	mg/l	ppm
DETECTION LIMIT	0.05	0.05	20	0.001	0.01	1
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	MS	MS	MS	OE	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	4.14	1.73	2.02%	1.791	3.60	648
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	5.04	5.49	2.23%	1.932	4.23	617
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	22.08	3.65	3.14%	3.021	5.45	1431
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	8.01	8.32	1.89%	1.820	5.35	1702
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	47.16		1.25%	1.198		2056
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	11.49	3.59	1.39%	1.329	5.78	1998
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	73.95		1.53%	1.455		1594
0021 Grab 2 (SXT_MET_042)	145.51		2.43%	2.280		1317
0022 Grab 3 (SXT_MET_043)	53.84		1.89%	1.781		1806
0023 Grab 4 (SXT_MET_044)	29.96		2.91%	2.807		5989

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	45.88		1.29%	1.164		2106
0004 (SXT_MET_030)		7.56			4.89	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			1.06%			2.33%
0006 OREAS 25a	22.59			0.182		
0007 TMDW		20.15				

ELEMENTS	Mn	Mn	Mo	Mo	Mo	Na
UNITS	ppm	mg/l	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.2	0.001	0.1	0.02	0.05	20
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	639.7	X	1.0	0.92	1.22	7011
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	620.7	X	1.7	1.78	7.00	2293
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	1516.1	X	0.2	0.16	0.29	6510
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	1733.5	0.004	0.3	0.28	0.13	1.57%
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	2042.9		0.5	0.42		1.59%
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	1951.7	0.008	0.2	0.23	0.15	2.74%
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	1564.8		55.6	62.33		1.41%
0021 Grab 2 (SXT_MET_042)	1284.0		0.3	0.24		1.86%
0022 Grab 3 (SXT_MET_043)	1526.7		1.1	1.12		1.61%
0023 Grab 4 (SXT_MET_044)	6036.0		0.2	0.19		5802
CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	1987.3		0.4	0.49		1.63%
0004 (SXT_MET_030)		0.003			0.13	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			10.7			5207
0006 OREAS 25a	435.5			1.30		
0007 TMDW					100.51	

ELEMENTS	Na	Na	NAG	NAGpH	NAG(4.5)	Nb
UNITS	%	mg/l	kgH2SO4/t	NONE	kgH2SO4/t	ppm
DETECTION LIMIT	0.001	0.1	1	0.1	1	0.05
DIGEST	AR005/	ASLP5/	NAGx/	NAGx/	NAGx/	AR005/
ANALYTICAL FINISH	MS	OE	VOL	MTR	VOL	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.039	7.2	X	8.0	X	X
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	0.026	5.1	X	7.3	X	X
0004 (SXT_MET_024)			X	7.6	X	
0005 (SXT_MET_026)			X	8.3	X	
0006 (SXT_MET_027)			X	7.9	X	
0007 (SXT_MET_028)	0.038	7.9	X	8.3	X	X
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	0.113	13.1	X	8.6	X	X
0010 (SXT_MET_031)			X	8.5	X	
0011 (SXT_MET_032)			X	8.5	X	
0012 (SXT_MET_033)			X	8.4	X	
0013 (SXT_MET_034)			X	8.5	X	
0014 (SXT_MET_035)	0.061		X	8.4	X	X
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)			X	8.4	X	
0018 (SXT_MET_039)	0.036	8.6	X	8.3	X	X
0019 (SXT_MET_040)			X	10.3	X	
0020 Grab 1 (SXT_MET_041)	0.039		X	8.5	X	X
0021 Grab 2 (SXT_MET_042)	0.057		X	9.5	X	X
0022 Grab 3 (SXT_MET_043)	0.059		X	8.6	X	X
0023 Grab 4 (SXT_MET_044)	0.058		X	8.4	X	X
CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)			X	8.5	X	
0003 (SXT_MET_035)	0.059					X
0004 (SXT_MET_030)		12.3				
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3			25	2.5	21	
0005 OREAS 630						
0006 OREAS 25a	0.034					0.56
0007 TMDW						

ELEMENTS	Ni	Ni	Ni	OH	P	Pb
UNITS	ppm	ppm	mg/l	mgCaCO3/L	ppm	ppm
DETECTION LIMIT	0.5	0.1	0.01	5	10	0.5
DIGEST	4A/	AR005/	ASLP5/	ASLP5/	AR005/	4A/
ANALYTICAL FINISH	MS	MS	OE	VOL	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	97.6	87.9	X	X	1047	10.2
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	55.7	51.9	X	X	1153	8.2
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	82.2	76.6	0.01	X	285	2.3
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	20.9	19.1	X	X	451	0.9
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	1.9	1.3			865	1.4
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	3.3	2.7	X	X	745	2.3
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	26.9	24.0			387	5.3
0021 Grab 2 (SXT_MET_042)	22.6	21.5			434	0.8
0022 Grab 3 (SXT_MET_043)	16.6	14.9			472	3.6
0023 Grab 4 (SXT_MET_044)	17.5	16.3			273	1.0

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	2.0	1.2			817	1.6
0004 (SXT_MET_030)			X	X		
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630	11.1					2708.4
0006 OREAS 25a		27.8			360	
0007 TMDW				X		

ELEMENTS	Pb	Pb	Pd	NAG(7.0)	pH	pH
UNITS	ppm	ug/l	ppb	kgH2SO4/t	NONE	NONE
DETECTION LIMIT	0.2	0.5	1	1	0.1	0.1
DIGEST	AR005/	ASLP5/	AR005/	NAGx/	Ws5/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	VOL	MTR	MTR
SAMPLE NUMBERS						
0001 (SXT_MET_021)	7.1	X	1	X	9.3	9.3
0002 (SXT_MET_022)					9.2	
0003 (SXT_MET_023)	7.0	8.7	X	X	9.3	9.2
0004 (SXT_MET_024)				X	9.1	
0005 (SXT_MET_026)				X	9.2	
0006 (SXT_MET_027)				X	9.3	
0007 (SXT_MET_028)	1.5	0.7	X	X	9.3	9.3
0008 (SXT_MET_029)					9.3	
0009 (SXT_MET_030)	0.5	0.8	X	X	9.1	9.1
0010 (SXT_MET_031)				X	8.9	
0011 (SXT_MET_032)				X	8.5	
0012 (SXT_MET_033)				X	8.9	
0013 (SXT_MET_034)				X	8.6	
0014 (SXT_MET_035)	0.6		X	X	8.9	
0015 (SXT_MET_036)					9.2	
0016 (SXT_MET_037)					9.0	
0017 (SXT_MET_038)				X	9.0	
0018 (SXT_MET_039)	0.7	2.9	X	X	8.7	8.9
0019 (SXT_MET_040)				X	8.2	
0020 Grab 1 (SXT_MET_041)	1.9		X	X	9.0	
0021 Grab 2 (SXT_MET_042)	0.3		X	X	9.2	
0022 Grab 3 (SXT_MET_043)	0.2		X	X	9.2	
0023 Grab 4 (SXT_MET_044)	0.3		X	X	9.3	

CHECKS						
0001 (SXT_MET_033)					8.9	
0002 (SXT_MET_032)				X		
0003 (SXT_MET_035)	0.6		X			
0004 (SXT_MET_030)		X				9.1
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3				25		
0005 OREAS 630						
0006 OREAS 25a	21.0		X			
0007 TMDW		39.8				8.9

ELEMENTS	pH Drop	Pt	Rb	Rb	Rb	Re
UNITS	NONE	ppb	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.1	1	0.05	0.02	0.02	0.001
DIGEST	ANCx/	AR005/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MTR	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	2.9	X	100.38	10.17	6.69	X
0002 (SXT_MET_022)	3.2					
0003 (SXT_MET_023)	3.3	X	101.14	9.13	12.27	X
0004 (SXT_MET_024)	2.9					
0005 (SXT_MET_026)	3.0					
0006 (SXT_MET_027)	3.0					
0007 (SXT_MET_028)	2.8	X	72.88	8.06	11.66	X
0008 (SXT_MET_029)	3.5					
0009 (SXT_MET_030)	2.8	X	28.71	3.86	2.35	0.003
0010 (SXT_MET_031)	2.6					
0011 (SXT_MET_032)	3.1					
0012 (SXT_MET_033)	3.1					
0013 (SXT_MET_034)	3.1					
0014 (SXT_MET_035)	3.0	X	21.70	2.43		X
0015 (SXT_MET_036)	3.2					
0016 (SXT_MET_037)	3.1					
0017 (SXT_MET_038)	3.0					
0018 (SXT_MET_039)	2.8	X	23.73	2.95	1.92	X
0019 (SXT_MET_040)	3.2					
0020 Grab 1 (SXT_MET_041)	3.0	X	12.97	1.77		0.004
0021 Grab 2 (SXT_MET_042)	3.1	X	13.18	1.58		X
0022 Grab 3 (SXT_MET_043)	3.0	X	17.15	2.70		X
0023 Grab 4 (SXT_MET_044)	2.9	X	26.08	2.44		X

CHECKS						
0001 (SXT_MET_033)	3.0					
0002 (SXT_MET_032)						
0003 (SXT_MET_035)		X	22.37	2.41		X
0004 (SXT_MET_030)					2.00	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			180.70			
0006 OREAS 25a		1		31.51		X
0007 TMDW					10.30	

ELEMENTS	S	S	S	S	S-SO4	SO4
UNITS	%	%	%	mg/l	%	%
DETECTION LIMIT	0.01	0.02	0.05	0.05	0.01	0.03
DIGEST		SCR/	AR005/	ASLP5/	S71/	
ANALYTICAL FINISH	/CSA	VOL	MS	OE	OE	/CALC
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.78	0.53	0.77	8.26		2.33
0002 (SXT_MET_022)	0.18	0.14				0.53
0003 (SXT_MET_023)	3.94	2.80	4.01	13.82		11.80
0004 (SXT_MET_024)	2.97	2.50				8.90
0005 (SXT_MET_026)	0.45					1.35
0006 (SXT_MET_027)	0.87					2.61
0007 (SXT_MET_028)	1.09		1.11	11.24		3.25
0008 (SXT_MET_029)	0.14					0.43
0009 (SXT_MET_030)	0.28		0.30	5.00		0.85
0010 (SXT_MET_031)	0.23					0.68
0011 (SXT_MET_032)	0.41					1.23
0012 (SXT_MET_033)	0.50					1.49
0013 (SXT_MET_034)	0.23					0.68
0014 (SXT_MET_035)	0.25		0.26			0.75
0015 (SXT_MET_036)	0.09					0.27
0016 (SXT_MET_037)	0.22					0.67
0017 (SXT_MET_038)	0.55					1.64
0018 (SXT_MET_039)	0.87		0.87	12.17	0.03	2.62
0019 (SXT_MET_040)	1.38					4.15
0020 Grab 1 (SXT_MET_041)	0.57		0.55		0.02	1.70
0021 Grab 2 (SXT_MET_042)	0.04		X		X	0.11
0022 Grab 3 (SXT_MET_043)	0.09		0.10		X	0.28
0023 Grab 4 (SXT_MET_044)	0.25		0.26		0.02	0.74
CHECKS						
0001 (SXT_MET_033)	0.51					1.52
0002 (SXT_MET_032)						
0003 (SXT_MET_035)			0.27			
0004 (SXT_MET_030)				4.76		
0005 Grab 4 (SXT_MET_044)					0.03	
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130	6.53					19.57
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630						
0006 OREAS 25a			X			
0007 TMDW						

ELEMENTS	Sb	Sb	Sb	Sc	Se	Se
UNITS	ppm	ppm	ug/l	ppm	ppm	ppm
DETECTION LIMIT	0.05	0.02	0.01	0.02	0.5	0.05
DIGEST	4A/	AR005/	ASLP5/	AR005/	4A/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	6.50	2.20	13.94	3.47	0.9	1.12
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	85.90	41.91	225.45	3.24	1.2	1.48
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	3.02	0.61	12.24	12.17	0.5	0.62
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	4.96	0.74	1.71	19.54	X	0.55
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	5.64	2.33		17.99	X	0.61
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	4.86	1.29	2.59	15.13	X	0.40
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	18.39	4.41		21.09	X	0.64
0021 Grab 2 (SXT_MET_042)	7.39	0.42		24.85	X	0.27
0022 Grab 3 (SXT_MET_043)	7.05	2.14		23.51	X	0.40
0023 Grab 4 (SXT_MET_044)	3.54	0.54		11.68	X	0.44

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	6.01	2.21		17.67	X	0.68
0004 (SXT_MET_030)			1.54			
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630	44.50				X	
0006 OREAS 25a		0.11		8.71		0.69
0007 TMDW			10.35			

ELEMENTS	Se	Sn	Sn	Sn	Sr	Ta
UNITS	ug/l	ppm	ppm	ug/l	ppm	ppm
DETECTION LIMIT	0.5	0.1	0.05	0.1	0.05	0.01
DIGEST	ASLP5/	4A/	AR005/	ASLP5/	AR005/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	1.8	0.9	0.12	X	245.48	X
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	2.1	1.0	0.10	X	386.91	X
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	0.5	0.8	0.08	X	164.53	X
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	X	0.4	0.06	X	55.60	X
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)		0.6	0.07		61.40	X
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	X	0.6	0.09	X	91.75	X
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)		0.5	X		71.62	X
0021 Grab 2 (SXT_MET_042)		0.4	X		41.97	X
0022 Grab 3 (SXT_MET_043)		0.5	0.19		52.54	X
0023 Grab 4 (SXT_MET_044)		0.3	X		74.55	X

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)		0.6	0.08		60.84	X
0004 (SXT_MET_030)	X			X		
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630		3.2				
0006 OREAS 25a			2.75		17.13	X
0007 TMDW	10.4			X		

ELEMENTS	Te	Te	Te	Th	Th	Th
UNITS	ppm	ppm	ug/l	ppm	ppm	ug/l
DETECTION LIMIT	0.2	0.02	0.1	0.01	0.005	0.005
DIGEST	4A/	AR005/	ASLP5/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	X	0.12	X	4.29	2.500	X
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	1.6	1.68	X	5.87	2.620	X
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	0.5	0.42	X	0.40	0.130	X
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	X	X	X	0.54	0.124	X
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	X	X		0.96	0.177	
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	X	0.07	X	0.96	0.214	X
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	4.1	4.06		0.45	0.140	
0021 Grab 2 (SXT_MET_042)	X	0.06		0.53	0.131	
0022 Grab 3 (SXT_MET_043)	X	0.03		0.54	0.136	
0023 Grab 4 (SXT_MET_044)	X	0.04		0.30	0.056	
CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	X	X		1.03	0.167	
0004 (SXT_MET_030)			X			X
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						
STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630	X			13.91		
0006 OREAS 25a		X			10.296	
0007 TMDW			3.2			X

ELEMENTS	Ti	Tl	Tl	Tl	TotAlk	U
UNITS	ppm	ppm	ppm	ug/l	mgCaCO3/L	ppm
DETECTION LIMIT	5	0.02	0.01	0.01	5	0.01
DIGEST	AR005/	4A/	AR005/	ASLP5/		4A/
ANALYTICAL FINISH	MS	MS	MS	MS	/CALC	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	10	1.24	0.17	0.03	104	1.14
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	11	0.96	0.12	0.03	41	1.51
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	11	0.63	0.09	0.02	70	0.10
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	379	0.15	0.03	X	78	0.15
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	586	0.20	0.03			0.26
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	491	0.27	0.04	X	62	0.26
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	89	0.14	0.03			0.13
0021 Grab 2 (SXT_MET_042)	106	0.11	0.02			0.18
0022 Grab 3 (SXT_MET_043)	542	0.14	0.04			0.14
0023 Grab 4 (SXT_MET_044)	27	0.22	0.04			0.06

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	556	0.18	0.03			0.27
0004 (SXT_MET_030)				X	74	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630		52.28				7.37
0006 OREAS 25a	554		0.20			
0007 TMDW				10.18	99	

ELEMENTS	U	U	V	V	V	W
UNITS	ppm	ug/l	ppm	ppm	mg/l	ppm
DETECTION LIMIT	0.005	0.005	1	0.5	0.01	0.02
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	OE	MS
SAMPLE NUMBERS						
0001 (SXT_MET_021)	0.390	X	82	14.6	X	0.40
0002 (SXT_MET_022)						
0003 (SXT_MET_023)	0.745	0.014	152	22.6	X	0.58
0004 (SXT_MET_024)						
0005 (SXT_MET_026)						
0006 (SXT_MET_027)						
0007 (SXT_MET_028)	0.017	X	241	54.9	X	0.23
0008 (SXT_MET_029)						
0009 (SXT_MET_030)	0.024	X	538	176.3	X	0.11
0010 (SXT_MET_031)						
0011 (SXT_MET_032)						
0012 (SXT_MET_033)						
0013 (SXT_MET_034)						
0014 (SXT_MET_035)	0.025		7	2.9		0.25
0015 (SXT_MET_036)						
0016 (SXT_MET_037)						
0017 (SXT_MET_038)						
0018 (SXT_MET_039)	0.039	0.012	69	33.3	X	15.32
0019 (SXT_MET_040)						
0020 Grab 1 (SXT_MET_041)	0.026		432	261.6		12.53
0021 Grab 2 (SXT_MET_042)	0.047		313	230.4		0.21
0022 Grab 3 (SXT_MET_043)	0.029		234	140.3		0.25
0023 Grab 4 (SXT_MET_044)	0.014		210	108.1		1.34

CHECKS						
0001 (SXT_MET_033)						
0002 (SXT_MET_032)						
0003 (SXT_MET_035)	0.024		7	2.9		0.23
0004 (SXT_MET_030)		X			X	
0005 Grab 4 (SXT_MET_044)						
0006 (SXT_MET_024)						

STANDARDS						
0001 KLEN73988						
0002 OREAS 130						
0003 ANC-4						
0004 NAG Std 3						
0005 OREAS 630			47			
0006 OREAS 25a	1.511			119.8		X
0007 TMDW		9.932				

ELEMENTS	Y	Zn	Zn	Zn	Zr
UNITS	ppm	ppm	ppm	mg/l	ppm
DETECTION LIMIT	0.01	1	0.2	0.01	0.05
DIGEST	AR005/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MS	MS	MS	OE	MS
SAMPLE NUMBERS					
0001 (SXT_MET_021)	5.54	106	93.0	X	3.79
0002 (SXT_MET_022)					
0003 (SXT_MET_023)	8.30	39	31.4	X	6.26
0004 (SXT_MET_024)					
0005 (SXT_MET_026)					
0006 (SXT_MET_027)					
0007 (SXT_MET_028)	3.61	85	76.6	X	2.05
0008 (SXT_MET_029)					
0009 (SXT_MET_030)	6.18	97	86.1	X	2.96
0010 (SXT_MET_031)					
0011 (SXT_MET_032)					
0012 (SXT_MET_033)					
0013 (SXT_MET_034)					
0014 (SXT_MET_035)	9.59	134	116.8		4.45
0015 (SXT_MET_036)					
0016 (SXT_MET_037)					
0017 (SXT_MET_038)					
0018 (SXT_MET_039)	7.79	78	65.2	X	6.92
0019 (SXT_MET_040)					
0020 Grab 1 (SXT_MET_041)	6.51	115	105.6		6.84
0021 Grab 2 (SXT_MET_042)	5.94	89	82.1		7.96
0022 Grab 3 (SXT_MET_043)	7.50	98	87.2		5.29
0023 Grab 4 (SXT_MET_044)	6.31	74	67.8		6.03

CHECKS					
0001 (SXT_MET_033)					
0002 (SXT_MET_032)					
0003 (SXT_MET_035)	9.48	136	115.1		4.18
0004 (SXT_MET_030)				X	
0005 Grab 4 (SXT_MET_044)					
0006 (SXT_MET_024)					

STANDARDS					
0001 KLEN73988					
0002 OREAS 130					
0003 ANC-4					
0004 NAG Std 3					
0005 OREAS 630		5338			
0006 OREAS 25a	4.44		30.7		18.54
0007 TMDW					

ELEMENTS	Au	Au-Rp1	Ag	Ag	Ag	Al
UNITS	ppb	ppm	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.1	0.005	0.05	0.02	0.01	50
DIGEST	AR005/	FA25/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X		X	X		X
0004 Control Blank					X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Al	Al	ANC	As	As	As
UNITS	%	mg/l	kgH2SO4/t	ppm	ppm	ug/l
DETECTION LIMIT	0.005	0.01	1	0.5	0.05	0.1
DIGEST	AR005/	ASLP5/	ANCx/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	OE	VOL	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank			X			
0002 Control Blank						
0003 Control Blank	X			X	0.62	
0004 Control Blank		X				X
0005 Control Blank						
0006 Control Blank						

ELEMENTS	B	B	Ba	Ba	Ba	Be
UNITS	ppm	mg/l	ppm	ppm	ug/l	ppm
DETECTION LIMIT	5	0.01	0.1	0.05	0.05	0.05
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X		X	X		X
0004 Control Blank		X			X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Be	Be	Bi	Bi	Bi	C
UNITS	ppm	ug/l	ppm	ppm	ug/l	%
DETECTION LIMIT	0.02	0.1	0.01	0.02	0.005	0.01
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	
ANALYTICAL FINISH	MS	MS	MS	MS	MS	/CSA
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						X
0002 Control Blank						
0003 Control Blank	X		X	X		
0004 Control Blank		X			X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	CO3	C-Acinsol	C-CO3	Ca	Ca	Ca
UNITS	mgCaCO3/L	%	%	ppm	%	mg/l
DETECTION LIMIT	5	0.01	0.01	50	0.005	0.01
DIGEST	ASLP5/	C71/		4A/	AR005/	ASLP5/
ANALYTICAL FINISH	VOL	CSA	/CALC	MS	MS	OE
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277		0.12				

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank				X	0.035	
0004 Control Blank	X					X
0005 Control Blank						
0006 Control Blank		X				

ELEMENTS	Cd	Cd	Cd	Ce	Cl	Co
UNITS	ppm	ppm	ug/l	ppm	mg/l	ppm
DETECTION LIMIT	0.02	0.005	0.02	0.002	2	0.1
DIGEST	4A/	AR005/	ASLP5/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	MS	MS	MS	VOL	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X		0.002		X
0004 Control Blank			X		X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Co	Co	ColourChange	Cr	Cr	Cr
UNITS	ppm	ug/l	NONE	ppm	ppm	mg/l
DETECTION LIMIT	0.01	0.1	0	1	0.2	0.01
DIGEST	AR005/	ASLP5/	ANCx/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	QUAL	MS	MS	OE
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X			X	X	
0004 Control Blank		X				X
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Cs	Cu	Cu	Cu	EC	EC
UNITS	ppm	ppm	ppm	mg/l	uS/cm	uS/cm
DETECTION LIMIT	0.01	0.5	0.05	0.01	10	10
DIGEST	AR005/	4A/	AR005/	ASLP5/	Ws5/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	OE	MTR	MTR
STANDARDS						
0008 PD-1						
0009 PD-1					324	
0010 OREAS 277						
BLANKS						
0001 Control Blank					X	
0002 Control Blank						
0003 Control Blank	X	X	X			
0004 Control Blank				X		X
0005 Control Blank						
0006 Control Blank						

ELEMENTS	F	Fe	Fe	Fe	Final-pH	Fizz-Rate
UNITS	mg/L	ppm	%	mg/l	NONE	NONE
DETECTION LIMIT	0.01	50	0.001	0.01	0.1	0
DIGEST	ASLP5/	4A/	AR005/	ASLP5/	ANCx/	ANCx/
ANALYTICAL FINISH	SIE	MS	MS	OE	MTR	QUAL
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank					1.0	
0002 Control Blank						
0003 Control Blank		X	0.003			
0004 Control Blank	X			X		
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Ga	Ge	HCO3	Hf	Hg	Hg
UNITS	ppm	ppm	mgCaCO3/L	ppm	ppm	ug/l
DETECTION LIMIT	0.1	0.05	5	0.01	0.01	0.1
DIGEST	AR005/	AR005/	ASLP5/	AR005/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	VOL	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X		X	X	
0004 Control Blank			X			X
0005 Control Blank						
0006 Control Blank						

ELEMENTS	In	K	K	K	La	Li
UNITS	ppm	ppm	%	mg/l	ppm	ppm
DETECTION LIMIT	0.01	20	0.001	0.1	0.002	0.1
DIGEST	AR005/	4A/	AR005/	ASLP5/	AR005/	4A/
ANALYTICAL FINISH	MS	MS	MS	OE	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	246	0.001		0.003	0.1
0004 Control Blank				X		
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Li	Li	Mg	Mg	Mg	Mn
UNITS	ppm	ug/l	ppm	%	mg/l	ppm
DETECTION LIMIT	0.05	0.05	20	0.001	0.01	1
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	MS	MS	MS	OE	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X		X	X		X
0004 Control Blank		X			0.01	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Mn	Mn	Mo	Mo	Mo	Na
UNITS	ppm	mg/l	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.2	0.001	0.1	0.02	0.05	20
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	4A/
ANALYTICAL FINISH	MS	OE	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X		X	X		X
0004 Control Blank		X			X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Na	Na	NAG	NAGpH	NAG(4.5)	Nb
UNITS	%	mg/l	kgH2SO4/t	NONE	kgH2SO4/t	ppm
DETECTION LIMIT	0.001	0.1	1	0.1	1	0.05
DIGEST	AR005/	ASLP5/	NAGx/	NAGx/	NAGx/	AR005/
ANALYTICAL FINISH	MS	OE	VOL	MTR	VOL	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank			6	4.9	X	
0003 Control Blank	X					X
0004 Control Blank		X				
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Ni	Ni	Ni	OH	P	Pb
UNITS	ppm	ppm	mg/l	mgCaCO3/L	ppm	ppm
DETECTION LIMIT	0.5	0.1	0.01	5	10	0.5
DIGEST	4A/	AR005/	ASLP5/	ASLP5/	AR005/	4A/
ANALYTICAL FINISH	MS	MS	OE	VOL	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X			X	X
0004 Control Blank			X	X		
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Pb	Pb	Pd	NAG(7.0)	pH	pH
UNITS	ppm	ug/l	ppb	kgH2SO4/t	NONE	NONE
DETECTION LIMIT	0.2	0.5	1	1	0.1	0.1
DIGEST	AR005/	ASLP5/	AR005/	NAGx/	Ws5/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	VOL	MTR	MTR
STANDARDS						
0008 PD-1						
0009 PD-1					8.8	
0010 OREAS 277						

BLANKS						
0001 Control Blank					5.4	
0002 Control Blank				6		
0003 Control Blank	X		X			
0004 Control Blank		X				5.9
0005 Control Blank						
0006 Control Blank						

ELEMENTS	pH Drop	Pt	Rb	Rb	Rb	Re
UNITS	NONE	ppb	ppm	ppm	ug/l	ppm
DETECTION LIMIT	0.1	1	0.05	0.02	0.02	0.001
DIGEST	ANCx/	AR005/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MTR	MS	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank		X	X	X		X
0004 Control Blank					X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	S	S	S	S	S-SO4	SO4
UNITS	%	%	%	mg/l	%	%
DETECTION LIMIT	0.01	0.02	0.05	0.05	0.01	0.03
DIGEST		SCR/	AR005/	ASLP5/	S71/	
ANALYTICAL FINISH	/CSA	VOL	MS	OE	OE	/CALC
STANDARDS						
0008 PD-1					4.23	
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank	X					X
0002 Control Blank						
0003 Control Blank			X			
0004 Control Blank				X		
0005 Control Blank					X	
0006 Control Blank						

ELEMENTS	Sb	Sb	Sb	Sc	Se	Se
UNITS	ppm	ppm	ug/l	ppm	ppm	ppm
DETECTION LIMIT	0.05	0.02	0.01	0.02	0.5	0.05
DIGEST	4A/	AR005/	ASLP5/	AR005/	4A/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X		X	X	X
0004 Control Blank			X			
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Se	Sn	Sn	Sn	Sr	Ta
UNITS	ug/l	ppm	ppm	ug/l	ppm	ppm
DETECTION LIMIT	0.5	0.1	0.05	0.1	0.05	0.01
DIGEST	ASLP5/	4A/	AR005/	ASLP5/	AR005/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank		X	X		0.08	X
0004 Control Blank	X			X		
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Te	Te	Te	Th	Th	Th
UNITS	ppm	ppm	ug/l	ppm	ppm	ug/l
DETECTION LIMIT	0.2	0.02	0.1	0.01	0.005	0.005
DIGEST	4A/	AR005/	ASLP5/	4A/	AR005/	ASLP5/
ANALYTICAL FINISH	MS	MS	MS	MS	MS	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						
BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X		X	X	
0004 Control Blank			X			X
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Ti	Tl	Tl	Tl	TotAlk	U
UNITS	ppm	ppm	ppm	ug/l	mgCaCO3/L	ppm
DETECTION LIMIT	5	0.02	0.01	0.01	5	0.01
DIGEST	AR005/	4A/	AR005/	ASLP5/		4A/
ANALYTICAL FINISH	MS	MS	MS	MS	/CALC	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X	X	X			X
0004 Control Blank				X	X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	U	U	V	V	V	W
UNITS	ppm	ug/l	ppm	ppm	mg/l	ppm
DETECTION LIMIT	0.005	0.005	1	0.5	0.01	0.02
DIGEST	AR005/	ASLP5/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MS	MS	MS	MS	OE	MS
STANDARDS						
0008 PD-1						
0009 PD-1						
0010 OREAS 277						

BLANKS						
0001 Control Blank						
0002 Control Blank						
0003 Control Blank	X		X	X		X
0004 Control Blank		X			X	
0005 Control Blank						
0006 Control Blank						

ELEMENTS	Y	Zn	Zn	Zn	Zr
UNITS	ppm	ppm	ppm	mg/l	ppm
DETECTION LIMIT	0.01	1	0.2	0.01	0.05
DIGEST	AR005/	4A/	AR005/	ASLP5/	AR005/
ANALYTICAL FINISH	MS	MS	MS	OE	MS
STANDARDS					
0008 PD-1					
0009 PD-1					
0010 OREAS 277					

BLANKS					
0001 Control Blank					
0002 Control Blank					
0003 Control Blank	X	3	X		X
0004 Control Blank				X	
0005 Control Blank					
0006 Control Blank					

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
/CALC **20/05/20 15:32**	Intertek Genalysis Perth **3244 3237** No digestion or other pre-treatment undertaken. Results Determined by calculation from other reported data.	
/CSA **20/05/20 15:38**	Intertek Genalysis Perth **3244 3237** Induction Furnace Analysed by Infrared Spectrometry	**ENV_W061, CSA : ENV_W061**
4A/MS **08/05/20 02:50**	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**
ANCx/MTR **08/05/20 00:06**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed with Electronic Meter Measurement	
ANCx/QUAL **08/05/20 00:06**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Qualitative Inspection	
ANCx/VOL **08/05/20 00:06**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Volumetric Technique.	
AR005/MS **07/05/20 22:03**	Intertek Genalysis Adelaide **3244 18645** 0.5 gram mini Aqua-Regia digest. Analysed by Inductively Coupled Plasma Mass Spectrometry.	
ASLP5/MS **07/05/20 09:44**	Intertek Genalysis Perth **3244 3237** Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Inductively Coupled Plasma Mass Spectrometry.	

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
ASLP5/MTR **07/05/20 09:44**	Intertek Genalysis Perth **3244 3237** Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed with Electronic Meter Measurement	
ASLP5/OE **07/05/20 09:44**	Intertek Genalysis Perth **3244 3237** Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	
ASLP5/SIE **07/05/20 09:44**	Intertek Genalysis Perth **3244 3237** Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Specific Ion Electrode.	
ASLP5/VOL **07/05/20 09:44**	Intertek Genalysis Perth **3244 3237** Australian Standard Leachates Protocol for Wastes, Sediments & Contaminated Soils. Analysed by Volumetric Technique.	
C71/CSA **07/05/20 17:32**	Intertek Genalysis Perth **3244 3237** Digestion by hot acid(s) and Induction Furnace Analysed by Infrared Spectrometry	
NAGx/MTR **08/05/20 02:34**	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed with Electronic Meter Measurement	
NAGx/VOL **08/05/20 02:34**	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed by Volumetric Technique.	
S71/OE **07/05/20 22:01**	Intertek Genalysis Perth **3244 3237** Digestion to eliminate sulphides. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
SCR/VOL **07/05/20 09:45**	Intertek Genalysis Perth **3244 3237** Chromium Reducible Suplhur Analysed by Volumetric Technique.	
Ws5/MTR **07/05/20 09:24**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:5. Analysed with Electronic Meter Measurement	
WT01 **20/05/20 15:38**	Intertek Genalysis Perth **3244 3237** Reporting weights of samples	

Metallurgical Testwork

conducted upon

Fimiston South (Waste Rock Analysis) Gold Ore Composites

for

Kalgoorlie Consolidated Gold Mines Pty Ltd

Report No. A20380

January 2020

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FIGURES

APPENDICES

SUMMARY

In late July 2018, ALS Metallurgy Services was requested by Ms Vicki Cull, representing Kalgoorlie Consolidated Gold Mines Pty Limited (KCGM), to conduct a defined program of metallurgical testwork on 12 waste rock (drill-core) samples, originating from the Fimiston (South – Waste Rock Analysis) Gold Operation in Kalgoorlie, Western Australia.

Salient findings of the testwork program are as follows:

• Head Assays

Sub-samples of all 12 Fimiston South Waste Rock samples were submitted for head assays. Key head assay results are tabulated below.

FIMISTON (SOUTH – WASTE ROCK ANALYSIS) GOLD OPERATION: COMPOSITE HEAD ASSAYS								
Sample ID	Au (g/t)	Au (avg) (g/t)	Ag (g/t)	As (ppm)	$C_{ORGANIC}$ (%)	$S_{SULPHIDE}$ (%)	Sb (ppm)	Te (ppm)
#1	<0.02/0.02	0.02	<0.3	50	0.06	<0.02	3.3	<0.2
#2	<0.02/<0.02	<0.02	0.3	30	0.06	0.12	1.1	<0.2
#3	0.30/0.36	0.33	0.6	130	2.22	2.96	18.2	1.6
#4	<0.02/0.02	0.02	<0.3	140	0.39	1.24	10.0	0.2
#5	<0.02/0.02	<0.02	<0.3	20	0.06	<0.02	1.9	<0.2
#6	0.24/0.29	0.27	0.3	170	0.03	0.50	6.9	0.2
#7	1.20/2.14	1.67	0.3	200	0.03	0.86	3.4	0.4
#8	<0.02/<0.02	<0.02	<0.3	70	0.03	0.18	0.9	<0.2
#9	<0.02/<0.02	<0.02	<0.3	130	0.03	0.16	3.5	<0.2
#10	<0.02/<0.02	<0.02	<0.3	80	0.06	0.42	3.0	<0.2
#11	<0.02/<0.02	<0.02	<0.3	40	0.03	0.32	2.1	<0.2
#12	<0.02/<0.02	<0.02	<0.3	30	<0.03	0.08	1.3	<0.2

For the Fimiston South Waste Rock Samples #1 to #12, the average gold grades were 0.02, <0.02, 0.33, 0.02, <0.02, 0.27, 1.67, <0.02, <0.02, <0.02, <0.02, and <0.02 g/t Au, respectively.

• Acid Mine Drainage (AMD) Prediction Analysis

AMD prediction analysis was conducted on all 12 Fimiston South Waste Rock composites. The results are summarised in the following table.

FIMISTON (SOUTH – WASTE ROCK ANALYSIS) GOLD OPERATION: AMD PREDICTION ANALYSIS							
Sample ID	S_{TOTAL} (%)	ANC	NAG	TAPP	NAPP	NAG pH	NAG Conductivity (mS/cm)
		H_2SO_4 (kg/t)					
#1	0.02	179	-3	1	-178	11.33	0.868
#2	0.18	264	-3	5	-259	10.80	0.429
#3	3.30	129	-3	101	-28	8.67	1.228
#4	1.36	152	-3	41	-111	8.92	0.601
#5	0.06	281	-3	2	-279	11.12	0.653
#6	0.58	227	-3	18	-209	9.36	0.274
#7	0.90	262	-3	27	-235	9.36	0.266
#8	0.20	149	-3	6	-143	11.27	0.866
#9	0.16	281	-3	5	-276	9.69	0.241
#10	0.44	183	-3	13	-170	9.51	0.245
#11	0.32	244	-3	10	-234	9.49	0.221
#12	0.12	232	-3	4	-228	11.21	0.793

The AMD results for all 12 Fimiston South Waste Rock samples indicate that none appear likely to become net acid-producers.

• Mineralogical Analysis by XRD

Sub-samples of all 12 Fimiston South Waste Rock samples were submitted for semi-quantitative (XRD) mineralogical analysis. Summary results are tabulated below.

FIMISTON (SOUTH – WASTE ROCK SAMPLES) GOLD OPERATION: MINERALOGICAL ANALYSIS BY XRD												
Mineral or Mineral Group	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8	Sample #9	Sample #10	Sample #11	Sample #12
Magnetite	0	3	0	0	0	0	0	3	0	0	4	2
Ilmenite	0	0	0	0	0	2	2	0	0	0	2	1
Pyrite	0	0	3	2	0	1	2	0	1	2	1	1
Pyrrhotite	0	0	4	2	0	0	0	0	0	0	0	0
Clay Mineral	2	2	<1	<1	3	<1	1	1	<1	<1	<1	1
Kaolinite	1	<1	<1	0	1	0	<1	1	0	0	<1	1
Chlorite	25	32	3	3	29	1	14	17	2	4	15	25
Annite - Biotite - Phlogopite	2	1	2	3	1	1	1	5	1	0	1	0
Muscovite	<1	2	17	13	2	9	7	1	3	1	3	0
Paragonite	0	0	0	0	1	0	1	0	6	6	1	0
Calcic Amphibole	30	0	0	0	0	0	0	20	0	0	0	9
Clinopyroxene	1	0	0	0	0	0	0	2	0	6	0	1
Epidote	8	0	0	0	0	0	0	8	0	0	0	5
Plagioclase	7	12	4	6	10	21	11	24	2	1	18	23
K-Feldspar &/or Rutile	1	1	1	1	0	0	0	2	0	0	1	0
Quartz	18	31	54	54	29	36	34	13	41	47	31	22
Dolomite - Ankerite	0	2	8	7	7	10	19	0	29	20	18	<1
Calcite	4	13	<1	0	15	0	0	3	0	0	0	7
Siderite - Magnesite	1	1	4	7	0	18	8	0	13	11	5	0
Rutile	0	0	0	0	2	0	2	0	4	2	0	2

- ## External Environmental Testwork

Environmental testwork was conducted externally and the reports are included in Appendix V.

1. INTRODUCTION

In late July 2019, ALS Metallurgy Services was requested by Ms Vicki Cull, representing Kalgoorlie Consolidated Gold Mines Pty Limited (KCGM), to conduct a defined program of metallurgical testwork on 12 waste rock (drill-core) samples, originating from the Fimiston (South – Waste Rock Analysis) Gold Operation in Kalgoorlie, Western Australia.

The proposed project comprised the following testwork:

- Sample preparation
- Head analysis
- Acid mine drainage (AMD) prediction analysis
- Mineralogical analysis by XRD
- External chromium reducible sulphur, DI water leachate, and NAG liquor analyses.

The test program is presented as flow diagrams in Figures 1 and 2.

The testwork was controlled by Ms Vicki Cull, on behalf of KCGM, with Mr Wayne Harding supervising the program on behalf of ALS Metallurgy Services. Testwork results were communicated to the client immediately when available, which enabled the program to progress on a fully informed basis.

The purpose of this report is to describe samples and testwork procedures used in this program, together with a presentation of results and some commentary.

HAMID SHERIFF
Group General Manager – Metallurgy Services

W. A. Harding
WAYNE HARDING
Principal Metallurgist

KARSTEN WINTER
Mineralogy Manager – Metallurgy

2. SAMPLES AND SAMPLE PREPARATION

In mid-September 2019 ALS Metallurgy received a consignment of waste rock (drill-core) samples from the KCGM Fimiston (South) Gold Operation in Kalgoorlie, Western Australia.

Sample details are included in Appendix I and are presented in the table below.

FIMISTON (SOUTH - WASTE ROCK ANALYSIS) GOLD OPERATION: SAMPLE DETAILS			
Sample/Bag ID	Drill-Hole Interval (m)	As-Received Mass (kg)	Test Sample ID
SCGD027G - Bags 1-2	195-204	22.90	**#1**
SCGD027G - Bags 1-3	821-830	31.75	**#2**
SCGD027G - Bags 1-4	1064-1073	45.15	**#3**
SCGD028E - Bags 1-3	1031-1040	37.60	**#4**
SCGD028G - Bags 1-3	351-360	33.40	**#5**
SCGD028G - Bags 1-4	721-730	40.85	**#6**
SCGD029A - Bags 1-4	768-777	55.60	**#7**
SCGD029G - Bags 1-3	920-930	41.25	**#8**
SCGD029J - Bags 1-3	231-240	38.65	**#9**
SCGD030A - Bags 1-4	660-670	40.80	**#10**
SCGD030A - Bags 1-3	917-926	40.00	**#11**
SCGD030F - Bags 1-3	970-980	38.60	**#12**

The sample preparation procedures are illustrated in Figures 1 and 2, and are briefly summarised below:

(1) Each sample was control-crushed to <3.35 mm, homogenised, and split into the following charges:

- 1 x 200 g for head assays
- 1 x 100 g for semi-quantitative XRD analysis
- 1 x 200 g for AMD prediction analysis
- 1 x 1 kg, (various selected samples) pulverised to P_{80}: 75 µm, then separated into the following charges for dispatch to ALS Environmental in Wangara, Perth:
    - 1 x 50 g for chromium reducible sulphur analysis
    - 1 x 500 g for DI water leachate analysis
    - 1 x 100 g for NAG testwork and analysis of NAG liquor.

(2) Reserve.

3. TESTWORK WATER

Perth tap water was used throughout the test program.

4. ANALYTICAL PROCEDURES

Assay samples generated during the course of the test program were submitted to the ALS Metallurgy analytical laboratory in Perth for analysis.

In addition, environmental determinations were conducted at the ALS Environmental laboratory in Wangara, Perth.

The following analytical techniques were used at ALS Metallurgy:

Gold in ores:	Fire assay/ICP-MS
C_{TOTAL}, $C_{ORGANIC}$:	CS2000 analysis
S_{TOTAL}, $S_{SULPHIDE}$:	CS2000 analysis
Multi-element scan of solids:	Acid digestion with ICP-OES
Ag, As, Hg, Sb, and Te:	Mixed acid/ICP finish

Details of the ALS Environmental analytical techniques are included in Appendix V.

5. HEAD ANALYSIS

Sub-samples of all 12 Fimiston South Waste Rock samples were submitted for head assays (Figure 1). Full head assay details are included in Appendix II, whilst a summary is tabulated below.

FIMISTON (SOUTH – WASTE ROCK ANALYSIS) GOLD OPERATION: COMPOSITE HEAD ASSAYS								
Sample ID	Au (g/t)	Au (avg) (g/t)	Ag (g/t)	As (ppm)	$C_{ORGANIC}$ (%)	$S_{SULPHIDE}$ (%)	Sb (ppm)	Te (ppm)
#1	<0.02/0.02	0.02	<0.3	50	0.06	<0.02	3.3	<0.2
#2	<0.02/<0.02	<0.02	0.3	30	0.06	0.12	1.1	<0.2
#3	0.30/0.36	0.33	0.6	130	2.22	2.96	18.2	1.6
#4	<0.02/0.02	0.02	<0.3	140	0.39	1.24	10.0	0.2
#5	<0.02/0.02	<0.02	<0.3	20	0.06	<0.02	1.9	<0.2
#6	0.24/0.29	0.27	0.3	170	0.03	0.50	6.9	0.2
#7	1.20/2.14	1.67	0.3	200	0.03	0.86	3.4	0.4
#8	<0.02/<0.02	<0.02	<0.3	70	0.03	0.18	0.9	<0.2
#9	<0.02/<0.02	<0.02	<0.3	130	0.03	0.16	3.5	<0.2
#10	<0.02/<0.02	<0.02	<0.3	80	0.06	0.42	3.0	<0.2
#11	<0.02/<0.02	<0.02	<0.3	40	0.03	0.32	2.1	<0.2
#12	<0.02/<0.02	<0.02	<0.3	30	<0.03	0.08	1.3	<0.2

Comments on the above data are as follows:

- For the Fimiston South Waste Rock samples #1 to #12, the average gold grades were 0.02, <0.02, 0.33, 0.02, <0.02, 0.27, 1.67, <0.02, <0.02, <0.02, <0.02, and < 0.02 g/t Au, respectively.
- For the Fimiston South Waste Rock Samples #1, #2, and #5 to #12, carbon speciation assays indicate low levels of organic carbon decreasing the likelihood of preg-robbing of gold in solution during cyanidation. However, samples #3 and #4 exhibit elevated organic carbon levels, which may increase the likelihood of preg-robbing of gold in solution. Also for all 12 samples, base metals are present in low concentrations decreasing the possibility of excess cyanide consumption through preferential complexing with these metals.
- Arsenic assays for all 12 samples indicate low levels, decreasing the possibility of sulphide mineral such as arsenopyrite being present within the samples, which in turn decreases the likelihood of refractory gold deportment. Mercury levels are low for all samples.
- All 12 Fimiston South Waste Rock samples contain low grades of antimony. If present as sulphides, antimony can solubilise at high pH and potentially form passivating oxide layers on the gold surfaces, which can have a detrimental effect on gold cyanidation. Tellurium assays are also low for these 12 samples, decreasing the likely presence of refractory telluride minerals which have the potential to be gold-bearing.

6. ACID MINE DRAINAGE (AMD) PREDICTION ANALYSIS

AMD prediction analysis was conducted on all 12 Fimiston South Waste Rock composites (Figure 1).

6.1 Procedure

The analysis consisted of determining the following parameters:

- TAPP: Theoretical Acid Production Potential. Total sulphur content was measured and converted into equivalent sulphuric acid (kg acid/tonne of ore).
- ANC: Acid Neutralising Capacity. Depends on acid consuming minerals (i.e. carbonates) within the ore.
- NAPP: Net Acid Production Potential. Equal to TAPP minus ANC.
- NAG: Net Acid Generation. This is a measurement of the actual acid produced by the ore under oxidising conditions. The ore is oxidised by the addition of hydrogen peroxide with heat.

6.2 Results

A detailed tabulation of the AMD analysis is presented in Appendix III, whilst a summary is presented in the following table.

FIMISTON (SOUTH – WASTE ROCK ANALYSIS) GOLD OPERATION: AMD PREDICTION ANALYSIS							
Sample ID	S_{TOTAL} (%)	ANC	NAG	TAPP	NAPP	NAG pH	NAG Conductivity (mS/cm)
		H_2SO_4 (kg/t)					
#1	0.02	179	-3	1	-178	11.33	0.868
#2	0.18	264	-3	5	-259	10.80	0.429
#3	3.30	129	-3	101	-28	8.67	1.228
#4	1.36	152	-3	41	-111	8.92	0.601
#5	0.06	281	-3	2	-279	11.12	0.653
#6	0.58	227	-3	18	-209	9.36	0.274
#7	0.90	262	-3	27	-235	9.36	0.266
#8	0.20	149	-3	6	-143	11.27	0.866
#9	0.16	281	-3	5	-276	9.69	0.241
#10	0.44	183	-3	13	-170	9.51	0.245
#11	0.32	244	-3	10	-234	9.49	0.221
#12	0.12	232	-3	4	-228	11.21	0.793

The AMD results for all 12 Fimiston South Waste Rock samples indicate that none appear likely to become net acid-producers.

7. MINERALOGICAL ANALYSIS BY XRD

Sub-samples of all 12 Fimiston South Waste Rock samples were submitted for semi-quantitative (XRD) mineralogical analysis at the ALS mineralogy facility in Balcatta, Perth (Figures 2 and 4). The analyses were carried out in conjunction with the detailed head assays to assist in mineral identification.

The XRD summary results are tabulated below, whilst full details are found in Appendix IV.

FIMISTON (SOUTH – WASTE ROCK SAMPLES) GOLD OPERATION: MINERALOGICAL ANALYSIS BY XRD

Mineral or Mineral Group	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8	Sample #9	Sample #10	Sample #11	Sample #12
Magnetite	0	3	0	0	0	0	0	3	0	0	4	2
Ilmenite	0	0	0	0	0	2	2	0	0	0	2	1
Pyrite	0	0	3	2	0	1	2	0	1	2	1	1
Pyrrhotite	0	0	4	2	0	0	0	0	0	0	0	0
Clay Mineral	2	2	<1	<1	3	<1	1	1	<1	<1	<1	1
Kaolinite	1	<1	<1	0	1	0	<1	1	0	0	<1	1
Chlorite	25	32	3	3	29	1	14	17	2	4	15	25
Annite - Biotite - Phlogopite	2	1	2	3	1	1	1	5	1	0	1	0
Muscovite	<1	2	17	13	2	9	7	1	3	1	3	0
Paragonite	0	0	0	0	1	0	1	0	6	6	1	0
Calcic Amphibole	30	0	0	0	0	0	0	20	0	0	0	9
Clinopyroxene	1	0	0	0	0	0	0	2	0	6	0	1
Epidote	8	0	0	0	0	0	0	8	0	0	0	5

Continued/...

FIMISTON (SOUTH – WASTE ROCK SAMPLES) GOLD OPERATION: MINERALOGICAL ANALYSIS BY XRD (Cont'd)												
Mineral or Mineral Group	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8	Sample #9	Sample #10	Sample #11	Sample #12
Plagioclase	7	12	4	6	10	21	11	24	2	1	18	23
K-Feldspar &/or Rutile	1	1	1	1	0	0	0	2	0	0	1	0
Quartz	18	31	54	54	29	36	34	13	41	47	31	22
Dolomite - Ankerite	0	2	8	7	7	10	19	0	29	20	18	< 1
Calcite	4	13	<1	0	15	0	0	3	0	0	0	7
Siderite - Magnesite	1	1	4	7	0	18	8	0	13	11	5	0
Rutile	0	0	0	0	2	0	2	0	4	2	0	2

Summary comments on the above data are as follows:

- Clay mineral seems to be smectite and vermiculite.
- Dolomite - ankerite might be present in samples 1 and 8.
- A trace amount of apatite might be present in Sample 6.

8. ENVIRONMENTAL ANALYSIS

Environmental testwork was conducted externally at ALS Environmental on selected Fimiston South Waste Rock samples for chromium reducible sulphur, DI water leachate, and NAG Liquor analyses.

The analytical results, procedures, and quality control information are included in Appendix V.

FIGURES

FIGURE 1 : METALLURGICAL TEST PROGRAM FLOWSHEET - FIMISTON SOUTH WASTE ROCK SAMPLE ANALYSIS

A20380 KALGOORLIE CONSOLIDATED GOLD MINES LTD

RECEIVE THE FOLLOWING WASTE ROCK SAMPLES:

1. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 195-204m SAMPLE # 1 - 22.90kg
2. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 821-830m SAMPLE # 2 - 31.75kg
3. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 1064-1073m SAMPLE # 3 - 45.15kg
4. KCGM FIMISTON SOUTH WASTE ROCK SCGD028E 1031-1040m SAMPLE # 4 - 37.60kg
5. KCGM FIMISTON SOUTH WASTE ROCK SCGD028G 351-360m SAMPLE # 5 - 33.40kg
6. KCGM FIMISTON SOUTH WASTE ROCK SCGD028G 721-730m SAMPLE # 6 - 40.85kg
7. KCGM FIMISTON SOUTH WASTE ROCK SCGD029A768-777m SAMPLE # 7 - 55.60kg
8. KCGM FIMISTON SOUTH WASTE ROCK SCGD029G 920-930m SAMPLE # 8 - 41.25kg
9. KCGM FIMISTON SOUTH WASTE ROCK SCGD029J 231-240m SAMPLE # 9 - 38.65kg
10. KCGM FIMISTON SOUTH WASTE ROCK SCGD030A 660-670m SAMPLE # 10 - 40.80kg
11. KCGM FIMISTON SOUTH WASTE ROCK SCGD030A 917-926m SAMPLE # 11 - 40.00kg
12. KCGM FIMISTON SOUTH WASTE ROCK SCGD030F 970-980m SAMPLE # 12 - 38.60kg

FOR EACH WASTE ROCK SAMPLE - CONDUCT THE FOLLOWING:

CONDUCT FULL SAMPLE INVENTORY / DRY SAMPLES - SEND INVENTORY TO CLIENT

CONTROL CRUSH TO < 3.35mm

HOMOGENISE / SPLIT SUITABLE SUB-SAMPLES

1 x 200g

HEAD ASSAY

FOR:
Au [DUPL],
Ag (LDL), As,
C_{TOTAL}
$C_{ORGANIC}$
CO_3^{2-}
S_{TOTAL}
$S_{SULPHIDE}$
Hg, Sb, Te @
Low Detection Limit
ICP SCAN

1 x 100g

XRD MINERALOGICAL ANALYSIS

IDENTIFY ALL
MAIN MINERALS
PRESENT

1 x 200g

ACID MINE DRAINAGE (AMD) ANALYSIS

(Total S, ANC, NAG, TAPP,
NAPP, NAG pH, NAG Cond)

RESERVE

HAZARD ID
Sample Contains no Known Hazardous Material
Caution with fine dust

NOTE : USE PERTH TAP WATER FOR ALL TESTWORK

FIGURE 2 : METALLURGICAL TEST PROGRAM FLOWSHEET - FIMISTON SOUTH WASTE ROCK SAMPLE ANALYSIS

A20380 KALGOORLIE CONSOLIDATED GOLD MINES LTD

RECEIVE THE FOLLOWING WASTE ROCK SAMPLES:

1. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 195-204m SAMPLE # 1 - 1.0kg
2. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 821-830m SAMPLE # 2 - 1.0kg
3. KCGM FIMISTON SOUTH WASTE ROCK SCGD027G 1064-1073m SAMPLE # 3 - 1.0kg
4. KCGM FIMISTON SOUTH WASTE ROCK SCGD028E 1031-1040m SAMPLE # 4 - 1.0kg
5. KCGM FIMISTON SOUTH WASTE ROCK SCGD028G 351-360m SAMPLE # 5 - 1.0kg
6. KCGM FIMISTON SOUTH WASTE ROCK SCGD028G 721-730m SAMPLE # 6 - 1.0kg
7. KCGM FIMISTON SOUTH WASTE ROCK SCGD029A768-777m SAMPLE # 7 - 1.0kg
8. KCGM FIMISTON SOUTH WASTE ROCK SCGD029G 920-930m SAMPLE # 8 - 1.0kg
9. KCGM FIMISTON SOUTH WASTE ROCK SCGD029J 231-240m SAMPLE # 9 - 1.0kg
10. KCGM FIMISTON SOUTH WASTE ROCK SCGD030A 660-670m SAMPLE # 10 - 1.0kg
11. KCGM FIMISTON SOUTH WASTE ROCK SCGD030A 917-926m SAMPLE # 11 - 1.0kg
12. KCGM FIMISTON SOUTH WASTE ROCK SCGD030F 970-980m SAMPLE # 12 - 1.0kg

FOR THE SELECTED WASTE ROCK SAMPLES (CLIENT TO ADVISE) - CONDUCT THE FOLLOWING:

RECEIVE -3.35mm CRUSHED & SPLIT SAMPLES - FROM FIGURE 1

RETRIEVE & PREPARE A 1.0kg SUB-SAMPLE OF EACH WASTE ROCK SAMPLE FOR DISPATCH TO ALS ENVIRONMENTAL

PULVERISE SAMPLE @ ALS METALLURGY - PRIOR TO DISPATCH FOR THE FOLLOWING ANALYSIS

1 x 50g

FOR THE FOLLOWING SELECTED SAMPLES:

3. FIMISTON SOUTH WASTE ROCK SAMPLE # 3
4. FIMISTON SOUTH WASTE ROCK SAMPLE # 4

CONDUCT:
CHROMIUM REDUCIBLE SULPHUR ANALYSIS

1 x 500g

FOR THE FOLLOWING SELECTED SAMPLES:

1. FIMISTON SOUTH WASTE ROCK SAMPLE # 1
2. FIMISTON SOUTH WASTE ROCK SAMPLE # 2
3. FIMISTON SOUTH WASTE ROCK SAMPLE # 3
4. FIMISTON SOUTH WASTE ROCK SAMPLE # 4
5. FIMISTON SOUTH WASTE ROCK SAMPLE # 5
6. FIMISTON SOUTH WASTE ROCK SAMPLE # 6
7. FIMISTON SOUTH WASTE ROCK SAMPLE # 7
8. FIMISTON SOUTH WASTE ROCK SAMPLE # 8
9. FIMISTON SOUTH WASTE ROCK SAMPLE # 9
10. FIMISTON SOUTH WASTE ROCK SAMPLE # 10
11. FIMISTON SOUTH WASTE ROCK SAMPLE # 11
12. FIMISTON SOUTH WASTE ROCK SAMPLE # 12

CONDUCT:
DI WATER LEACHATE ANALYSIS

1 x 100g

FOR THE FOLLOWING SELECTED SAMPLES:

3. FIMISTON SOUTH WASTE ROCK SAMPLE # 3
4. FIMISTON SOUTH WASTE ROCK SAMPLE # 4
7. FIMISTON SOUTH WASTE ROCK SAMPLE # 7
8. FIMISTON SOUTH WASTE ROCK SAMPLE # 8
9. FIMISTON SOUTH WASTE ROCK SAMPLE # 9
10. FIMISTON SOUTH WASTE ROCK SAMPLE # 10

CONDUCT:
NAG TESTING WITH ANALYSIS ON NAG LIQUOR

RESERVE

HAZARD ID
Sample Contains no Known Hazardous Material
Caution with fine dust

NOTE : USE PERTH TAP WATER FOR ALL TESTWORK

APPENDICES

APPENDIX I

Sample Details

A20380 KCGM FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

AS RECEIVED FIMISTON SOUTH WASTE ROCK GOLD ORE SAMPLE WEIGHTS:

Sample Identity	Drill Core Hole Interval (m)	As Received Sample Weight (kg)
SCGD027G - BAGS 1-2	195-204	**22.90**
SCGD027G - BAGS 1-3	821-830	**31.75**
SCGD027G - BAGS 1-4	1064-1073	**45.15**
SCGD028E - BAGS 1-3	1031-1040	**37.60**
SCGD028G - BAGS 1-3	351-360	**33.40**
SCGD028G - BAGS 1-4	721-730	**40.85**
SCGD029A - BAGS 1-4	768-777	**55.60**
SCGD029G - BAGS 1-3	920-930	**41.25**
SCGD029J - BAGS 1-3	231-240	**38.65**
SCGD030A - BAGS 1-4	660-670	**40.80**
SCGD030A - BAGS 1-3	917-926	**40.00**
SCGD030F - BAGS 1-3	970-980	**38.60**
TOTAL:		466.55

APPENDIX II

Head Assays

A20380 : FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

FIMISTON SOUTH WASTE ROCK SAMPLE - HEAD ASSAYS

ANALYTE	UNIT	FIMISTON SOUTH WASTE ROCK SCGD027G 195-204m SAMPLE # 1	FIMISTON SOUTH WASTE ROCK SCGD027G 821-830m SAMPLE # 2	FIMISTON SOUTH WASTE ROCK SCGD027G 1064-1073m SAMPLE # 3	FIMISTON SOUTH WASTE ROCK SCGD028E 1031-1040m SAMPLE # 4	FIMISTON SOUTH WASTE ROCK SCGD028G 351-360m SAMPLE # 5	FIMISTON SOUTH WASTE ROCK SCGD028G 721-730m SAMPLE # 6
Au_1	g/t	< 0.02	< 0.02	0.30	< 0.02	< 0.02	0.24
Au_2	g/t	0.02	< 0.02	0.36	0.02	< 0.02	0.29
Au (Average)	g/t	0.02	< 0.02	0.33	0.02	< 0.02	0.27
Ag	g/t	< 0.3	0.3	0.6	< 0.3	< 0.3	0.3
Al	%	7.60	6.52	6.28	7.28	7.28	5.16
As	ppm	50	30	130	140	20	170
Ba	ppm	70	85	490	640	45	110
Be	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Bi	ppm	< 10	< 10	< 10	< 10	< 10	< 10
C total	%	0.63	1.98	4.17	2.61	2.52	3.78
C organic	%	0.06	0.06	2.22	0.39	0.06	0.03
C carbonate	%	2.85	9.60	9.75	11.10	12.30	18.75
Ca	%	7.20	5.80	1.90	2.10	6.70	2.90
Cd	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Co	ppm	55	45	55	25	40	40
Cr	ppm	110	20	50	60	50	10
Cu	ppm	168	64	410	346	122	< 2
Fe	%	9.46	10.6	6.16	4.98	8.48	11.3
Hg	ppm	0.7	< 0.1	1.8	0.4	0.2	0.3
K	%	0.1600	0.3300	2.62	3.01	0.5600	1.71
Li	ppm	35	70	15	15	55	15
Mg	%	5.08	2.76	1.88	2.44	3.12	1.32
Mn	ppm	1500	1700	400	500	1400	1800
Mo	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Na	%	1.15	1.45	0.4280	0.6100	1.43	1.51
Ni	ppm	185	25	65	35	40	< 5
P	ppm	600	700	300	500	600	1300
Pb	ppm	20	< 5	< 5	35	10	< 5
S total	%	0.02	0.18	3.30	1.36	0.06	0.58
S sulphide	%	< 0.02	0.12	2.96	1.24	< 0.02	0.50
Sb	ppm	3.3	1.1	18.2	10.0	1.9	6.9
SiO2	%	46.8	47.4	60.0	58.4	45.0	49.4
Sr	ppm	118	88	244	246	88	72
Te	ppm	< 0.2	< 0.2	1.6	0.2	< 0.2	0.2
Ti	ppm	5400	9600	2200	3000	60000	11400
V	ppm	224	330	58	82	250	4
Y	ppm	< 100	< 100	< 100	< 100	< 100	< 100
Zn	ppm	116	100	636	324	108	88

A20380 : FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

FIMISTON SOUTH WASTE ROCK SAMPLE - HEAD ASSAYS

ANALYTE	UNIT	FIMISTON SOUTH WASTE ROCK SCGD029A768-777m SAMPLE # 7	FIMISTON SOUTH WASTE ROCK SCGD029G 920-930m SAMPLE # 8	FIMISTON SOUTH WASTE ROCK SCGD029J 231-240m SAMPLE # 9	FIMISTON SOUTH WASTE ROCK SCGD030A 660-670m SAMPLE # 10	FIMISTON SOUTH WASTE ROCK SCGD030A 917-926m SAMPLE # 11	FIMISTON SOUTH WASTE ROCK SCGD030F 970-980m SAMPLE # 12
Au_1	g/t	1.20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Au_2	g/t	2.14	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Au (Average)	g/t	1.67	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ag	g/t	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Al	%	5.60	7.84	6.92	7.56	5.16	7.16
As	ppm	200	70	130	80	40	30
Ba	ppm	115	70	255	150	140	20
Be	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Bi	ppm	< 10	< 10	< 10	< 10	< 10	< 10
C total	%	4.05	0.54	5.07	3.72	4.20	1.29
C organic	%	0.03	0.03	0.03	0.06	0.03	< 0.03
C carbonate	%	20.10	2.55	25.20	18.30	20.85	6.38
Ca	%	4.70	5.90	6.00	4.60	5.30	6.10
Cd	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Co	ppm	80	55	45	55	70	50
Cr	ppm	< 10	20	150	170	< 10	30
Cu	ppm	34	106	60	78	22	120
Fe	%	12.7	9.36	9.24	8.56	13.7	9.38
Hg	ppm	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
K	%	1.06	0.2700	0.8800	0.5700	0.5600	0.0500
Li	ppm	55	30	20	40	70	50
Mg	%	1.96	3.40	1.68	1.28	2.28	3.44
Mn	ppm	2000	1500	2400	1800	2100	1500
Mo	ppm	< 5	< 5	< 5	< 5	< 5	< 5
Na	%	1.34	2.45	1.33	1.45	1.50	2.26
Ni	ppm	< 5	40	85	100	5	40
P	ppm	600	600	1000	900	500	400
Pb	ppm	< 5	< 5	10	5	10	20
S total	%	0.90	0.20	0.16	0.44	0.32	0.12
S sulphide	%	0.86	0.18	0.16	0.42	0.32	0.08
Sb	ppm	3.4	0.9	3.5	3.0	2.1	1.3
SiO2	%	41.8	49.0	44.2	47.2	41.4	47.0
Sr	ppm	146	162	192	146	102	106
Te	ppm	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Ti	ppm	13800	7600	9600	8600	15200	7400
V	ppm	514	332	252	250	214	300
Y	ppm	< 100	< 100	< 100	< 100	< 100	< 100
Zn	ppm	110	76	102	112	108	118

APPENDIX III

Acid Mine Drainage Prediction Analysis

Details and Results

A20380 : FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

FIMISTON SOUTH WASTE ROCK SAMPLE - ACID MINE DRAINAGE (AMD) TESTWORK

ANALYTE	UNIT	FIMISTON SOUTH WASTE ROCK SCGD027G 195-204m SAMPLE # 1	FIMISTON SOUTH WASTE ROCK SCGD027G 821-830m SAMPLE # 2	FIMISTON SOUTH WASTE ROCK SCGD027G 1064-1073m SAMPLE # 3	FIMISTON SOUTH WASTE ROCK SCGD028E 1031-1040m SAMPLE # 4
S total	%	0.02	0.18	3.30	1.36
ANC	(kg/t H_2SO_4)	179	264	129	152
NAG	(kg/t H_2SO_4)	-3	-3	-3	-3
TAPP	(kg/t H_2SO_4)	1	5	101	41
NAPP	(kg/t H_2SO_4)	-178	-259	-28	-111
NAG pH		11.33	10.80	8.67	8.92
NAG Conductivity	ms/cm	0.868	0.429	1.228	0.601

(1) **TAPP**: **Theoretical Acid Production Potential**. Total sulphur content is measured and converted into equivalent sulphuric acid (kg acid tonne of ore).
(2) **ANC**: **Acid Neutralising Capacity**. Depends on acid consuming minerals (i.e. Carbonates) within the ore.
(3) **NAPP**: **Nett Acid Production Potential**. Equal to TAPP minus ANC.
(4) **NAG**: **Actual acid production**.

A20380 : FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

FIMISTON SOUTH WASTE ROCK SAMPLE - ACID MINE DRAINAGE (AMD) TESTWORK

ANALYTE	UNIT	FIMISTON SOUTH WASTE ROCK SCGD028G 351-360m SAMPLE # 5	FIMISTON SOUTH WASTE ROCK SCGD028G 721-730m SAMPLE # 6	FIMISTON SOUTH WASTE ROCK SCGD029A768-777m SAMPLE # 7	FIMISTON SOUTH WASTE ROCK SCGD029G 920-930m SAMPLE # 8
S total	%	0.06	0.58	0.90	0.20
ANC	(kg/t H_2SO_4)	281	227	262	149
NAG	(kg/t H_2SO_4)	-3	-3	-3	-3
TAPP	(kg/t H_2SO_4)	2	18	27	6
NAPP	(kg/t H_2SO_4)	-279	-209	-235	-143
NAG pH		11.12	9.36	9.36	11.27
NAG Conductivity	ms/cm	0.653	0.274	0.266	0.866

(1) **TAPP**: **Theoretical Acid Production Potential**. Total sulphur content is measured and converted into equivalent sulphuric acid (kg acid tonne of ore).
(2) **ANC**: **Acid Neutralising Capacity**. Depends on acid consuming minerals (i.e. Carbonates) within the ore.
(3) **NAPP**: **Nett Acid Production Potential**. Equal to TAPP minus ANC.
(4) **NAG**: **Actual acid production**.

A20380 : FIMISTON SOUTH WASTE ROCK SAMPLE TESTWORK PROGRAM

KALGOORLIE CONSOLIDATED GOLD MINES LTD

FIMISTON SOUTH WASTE ROCK SAMPLE - ACID MINE DRAINAGE (AMD) TESTWORK

ANALYTE	UNIT	FIMISTON SOUTH WASTE ROCK SCGD029J 231-240m SAMPLE # 9	FIMISTON SOUTH WASTE ROCK SCGD030A 660-670m SAMPLE # 10	FIMISTON SOUTH WASTE ROCK SCGD030A 917-926m SAMPLE # 11	FIMISTON SOUTH WASTE ROCK SCGD030F 970-980m SAMPLE # 12
S total	%	0.16	0.44	0.32	0.12
ANC	(kg/t H_2SO_4)	281	183	244	232
NAG	(kg/t H_2SO_4)	-3	-3	-3	-3
TAPP	(kg/t H_2SO_4)	5	13	10	4
NAPP	(kg/t H_2SO_4)	-276	-170	-234	-228
NAG pH		9.69	9.51	9.49	11.21
NAG Conductivity	ms/cm	0.241	0.245	0.221	0.793

(1) **TAPP**: **Theoretical Acid Production Potential**. Total sulphur content is measured and converted into equivalent sulphuric acid (kg acid tonne of ore).
(2) **ANC**: **Acid Neutralising Capacity**. Depends on acid consuming minerals (i.e. Carbonates) within the ore.
(3) **NAPP**: **Nett Acid Production Potential**. Equal to TAPP minus ANC.
(4) **NAG**: **Actual acid production**.

APPENDIX IV

Mineralogical Analyses by XRD

Tabulated Report MIN4039

A20380 (MIN4039)
KCGM

SAMPLES RECEIVED

Twelve samples were submitted to ALS Metallurgy for semi-quantitative XRD analysis.

Sample 1	WASTE ROCK SAMPLE # 1	Sample 7	WASTE ROCK SAMPLE # 7
Sample 2	WASTE ROCK SAMPLE # 2	Sample 8	WASTE ROCK SAMPLE # 8
Sample 3	WASTE ROCK SAMPLE # 3	Sample 9	WASTE ROCK SAMPLE # 9
Sample 4	WASTE ROCK SAMPLE # 4	Sample 10	WASTE ROCK SAMPLE # 10
Sample 5	WASTE ROCK SAMPLE # 5	Sample 11	WASTE ROCK SAMPLE # 11
Sample 6	WASTE ROCK SAMPLE # 6	Sample 12	WASTE ROCK SAMPLE # 12

SAMPLE PREPARATION

Each sample was pressed into a back-packed sample holder to minimize preferred orientation of the particles. Powder X-ray diffraction (XRD) was used to analyse each sample and a combination of matrix flushing and reference intensity ratio (RIR) derived constants was used in the quantification of the minerals identified in each sample.

ANALYTICAL PROCEDURES

The XRD traces were collected under the following instrument conditions:

XRD	Panalytical Empyrean
Radiation	Co Kα 1.789
Generator	40 kV 40 mA
Angular Range	5° to 77° 2θ
Time/Step	120 s
Step Size	0.0131° 2θ
Divergence Slit	0.5 °
Anti-Scatter Slit	7.5 mm
Slit Type	Fixed
Detector	PIXcel in linear mode
Rotation Speed	60 rpm

SAMPLES SUBMITTED BY

Wayne Harding (ALS Metallurgy)

ANALYSIS UNDERTAKEN BY

Rosalind Crossley (ALS Metallurgy Mineralogy)

REPORTED BY

Rosalind Crossley and Swati Deol (ALS Metallurgy Mineralogy)

REPORT DATE

24 October 2019

RESULTS

The quantitative results shown in the table below have been normalised to 100 %, and the values shown represent the relative proportion of the crystalline material in the sample. Totals greater or smaller than 100 % are due to rounding errors.

Results in the table preceded by an asterisk indicate normally a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it might also indicate an uncertainty in regard of the phase itself, or both.

Mineral or mineral group	Sample 1 WASTE ROCK SAMPLE # 1	Sample 2 WASTE ROCK SAMPLE # 2	Sample 3 WASTE ROCK SAMPLE # 3	Sample 4 WASTE ROCK SAMPLE # 4	Sample 5 WASTE ROCK SAMPLE # 5	Sample 6 WASTE ROCK SAMPLE # 6
	Mass %					
Magnetite	0	3	0	0	0	0
Ilmenite	0	0	0	0	0	2
Pyrite	0	0	3	2	0	1
Pyrrhotite	0	0	4	2	0	0
Clay mineral	2	2	< 1	< 1	3	< 1
Kaolinite	1	< 1	< 1	0	1	0
Chlorite	25	32	3	3	29	1
Annite - biotite - phlogopite	2	1	2	3	1	1
Muscovite	< 1	2	17	13	2	9
Paragonite	0	0	0	0	1	0
Calcic amphibole	30	0	0	0	0	0
Clinopyroxene	1	0	0	0	0	0
Epidote	8	0	0	0	0	0
Plagioclase	7	12	4	6	10	21
K-feldspar and/or rutile	1	1	1	1	0	0
Quartz	18	31	54	54	29	36
Dolomite - ankerite	0	2	8	7	7	10
Calcite	4	13	< 1	0	15	0
Siderite - magnesite	1	1	4	7	0	18
Rutile	0	0	0	0	2	0

RESULTS

The quantitative results shown in the table below have been normalised to 100 %, and the values shown represent the relative proportion of the crystalline material in the sample. Totals greater or smaller than 100 % are due to rounding errors.

Results in the table preceded by an asterisk indicate normally a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it might also indicate an uncertainty in regard of the phase itself, or both.

Mineral or mineral group	Sample 7 WASTE ROCK SAMPLE # 7	Sample 8 WASTE ROCK SAMPLE # 8	Sample 9 WASTE ROCK SAMPLE # 9	Sample 10 WASTE ROCK SAMPLE # 10	Sample 11 WASTE ROCK SAMPLE # 11	Sample 12 WASTE ROCK SAMPLE # 12
	Mass %					
Magnetite	0	3	0	0	4	2
Ilmenite	2	0	0	0	2	1
Pyrite	2	0	1	2	1	1
Pyrrhotite	0	0	0	0	0	0
Clay mineral	1	1	< 1	< 1	< 1	1
Kaolinite	< 1	1	0	0	< 1	1
Chlorite	14	17	2	4	15	25
Annite - biotite - phlogopite	1	5	1	0	1	0
Muscovite	7	1	3	1	3	0
Paragonite	1	0	6	6	1	0
Calcic amphibole	0	20	0	0	0	9
Clinopyroxene	0	2	0	6	0	1
Epidote	0	8	0	0	0	5
Plagioclase	11	24	2	1	18	23
K-feldspar and/or rutile	0	2	0	0	1	0
Quartz	34	13	41	47	31	22
Dolomite - ankerite	19	0	29	20	18	< 1
Calcite	0	3	0	0	0	7
Siderite - magnesite	8	0	13	11	5	0
Rutile	2	0	4	2	0	2

COMMENTS

Clay mineral seems to be smectite and vermiculite.

Dolomite - ankerite might be present in samples 1 and 8.

A trace amount of apatite might be present in sample 6.

Magnetite might be present in samples where it is not reported.

Some amorphous material is likely present.

APPENDIX V

ALS Environmental Analysis Report

CERTIFICATE OF ANALYSIS

Work Order	: **EP1912515**	Page	: 1 of 16
Client	: **ALS METALLURGY**	Laboratory	: Environmental Division Perth
Contact	: WAYNE HARDING	Contact	: Customer Services EP
Address	: 6 MACADAM PLACE BALCATTA WA 6021	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 03 6431 6333	Telephone	: +61-8-9406 1301
Project	: A20380	Date Samples Received	: 27-Nov-2019 10:00
Order number	: 123501	Date Analysis Commenced	: 29-Nov-2019
C-O-C number	: ----	Issue Date	: 11-Dec-2019 21:27
Sampler	: ----		
Site	: ----		
Quote number	: EP/989/19		
No. of samples received	: 18		
No. of samples analysed	: 18		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: DI WATER LEACHATE
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	FIMISTON SOUTH WASTE ROCK SAMPLE #1	FIMISTON SOUTH WASTE ROCK SAMPLE #2	FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #5
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
				EP1912515-001	EP1912515-002	EP1912515-003	EP1912515-004	EP1912515-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.36	7.61	7.97	7.52	7.43
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1540	1590	1480	1510	1130
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	10	16	9	9	10
Total Alkalinity as CaCO3	----	1	mg/L	10	16	9	9	10
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	1	2	11	8	9
Silicon as SiO2	14464-46-1	0.1	mg/L	3.3	1.0	3.3	3.9	2.1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	2	14	11	26
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	2	2	15	11	2
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	6	10	10	10	14
Magnesium	7439-95-4	1	mg/L	2	4	6	7	6
Sodium	7440-23-5	1	mg/L	4	3	4	4	7
Potassium	7440-09-7	1	mg/L	3	3	20	31	6
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	1.46	1.82	0.68	1.00	1.36
Antimony	7440-36-0	0.001	mg/L	0.013	0.003	0.148	0.088	0.006
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	0.018	0.031	0.002
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.056	0.013	0.004	0.005	0.002
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.002	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	<0.001	0.003	0.006	0.003	0.002

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**
(Matrix: **WATER**)

			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #1	FIMISTON SOUTH WASTE ROCK SAMPLE #2	FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #5
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912515-001	EP1912515-002	EP1912515-003	EP1912515-004	EP1912515-005
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.003**	**0.002**	**0.002**	**0.003**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	**0.014**	**0.004**	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.011**	**0.049**	**0.084**	**0.083**	**0.059**
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: DI WATER LEACHATE
(Matrix: WATER)

			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #6	FIMISTON SOUTH WASTE ROCK SAMPLE #7	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9	FIMISTON SOUTH WASTE ROCK SAMPLE #10
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912515-006	EP1912515-007	EP1912515-008	EP1912515-009	EP1912515-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.02	7.46	9.26	7.18	7.96
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	407	1600	383	755	376
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	5	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	7	7	9	4	14
Total Alkalinity as CaCO3	----	1	mg/L	7	7	14	4	14
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	3	4	1	2	2
Silicon as SiO2	14464-46-1	0.1	mg/L	2.7	2.8	3.3	4.3	3.4
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	4	2	2	2
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4	6	4	6	3
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	20	23	6	15	13
Magnesium	7439-95-4	1	mg/L	8	12	2	4	4
Sodium	7440-23-5	1	mg/L	5	12	6	30	29
Potassium	7440-09-7	1	mg/L	25	14	5	5	3
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.83	0.68	1.82	0.96	1.21
Antimony	7440-36-0	0.001	mg/L	0.035	0.007	0.002	0.029	0.015
Arsenic	7440-38-2	0.001	mg/L	0.002	0.003	0.005	0.189	0.022
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.002	0.002	0.002	0.002	<0.001
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.002	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	0.013	0.018	<0.001	0.005	0.011

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #6	FIMISTON SOUTH WASTE ROCK SAMPLE #7	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9	FIMISTON SOUTH WASTE ROCK SAMPLE #10
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912515-006	EP1912515-007	EP1912515-008	EP1912515-009	EP1912515-010
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.018**	**0.021**	**0.001**	**0.010**	**0.011**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.039**	**0.072**	**0.010**	**0.035**	**0.020**
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #11	FIMISTON SOUTH WASTE ROCK SAMPLE #12	----	----	----
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1912515-011	EP1912515-012	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.53**	**7.54**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**362**	**1360**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**26**	**8**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**27**	**8**	----	----	----
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**2**	**1**	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**1.7**	**1.6**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	**1**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**4**	**2**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**21**	**7**	----	----	----
Magnesium	7439-95-4	1	mg/L	**15**	**3**	----	----	----
Sodium	7440-23-5	1	mg/L	**9**	**4**	----	----	----
Potassium	7440-09-7	1	mg/L	**8**	<1	----	----	----
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.60**	**1.87**	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.004**	**0.003**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.002**	----	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.024**	**0.002**	----	----	----

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**
(Matrix: **WATER**)

			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #11	FIMISTON SOUTH WASTE ROCK SAMPLE #12	----	----	----
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1912515-011	EP1912515-012	--------	--------	--------
				Result	Result	----	----	----
EG020W: Water Leachable Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.017**	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.050**	**0.019**	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	----	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	----	----	----
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----

Analytical Results

Sub-Matrix: LIQUOR
(Matrix: WATER)

Client sample ID				FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #7	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9
Client sampling date / time				21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912515-013	EP1912515-014	EP1912515-015	EP1912515-016	EP1912515-017
				Result	Result	Result	Result	Result
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	254	79	21	7	3
Silicon as SiO2	14464-46-1	0.1	mg/L	41.4	96.0	182	355	51.2
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	148	50	15	41	14
Magnesium	7439-95-4	1	mg/L	100	26	16	<1	12
Sodium	7440-23-5	1	mg/L	29	16	17	16	22
Potassium	7440-09-7	1	mg/L	9	12	5	7	2
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	41.5	30.1	50.6	98.9	16.0
Antimony	7440-36-0	0.001	mg/L	0.077	0.024	0.006	0.002	0.004
Arsenic	7440-38-2	0.001	mg/L	1.16	1.23	0.476	0.196	0.202
Beryllium	7440-41-7	0.001	mg/L	0.003	0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.451	0.369	0.090	0.229	0.113
Bismuth	7440-69-9	0.001	mg/L	0.004	0.003	<0.001	0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0165	0.0030	0.0005	0.0003	0.0004
Chromium	7440-47-3	0.001	mg/L	0.097	0.051	0.005	0.048	0.067
Copper	7440-50-8	0.001	mg/L	4.42	4.00	0.146	0.511	0.125
Cobalt	7440-48-4	0.001	mg/L	0.643	0.097	0.204	0.119	0.072
Nickel	7440-02-0	0.001	mg/L	0.713	0.479	0.020	0.119	0.152
Lead	7439-92-1	0.001	mg/L	0.180	0.130	0.010	0.007	0.008
Zinc	7440-66-6	0.005	mg/L	7.26	4.10	0.461	0.269	0.214
Lithium	7439-93-2	0.001	mg/L	0.061	0.028	0.165	0.122	0.012
Manganese	7439-96-5	0.001	mg/L	3.65	4.24	5.77	3.42	3.82
Molybdenum	7439-98-7	0.001	mg/L	0.036	0.013	0.003	0.005	0.003
Silver	7440-22-4	0.001	mg/L	0.003	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	1.99	1.12	0.448	0.080	0.144
Tellurium	22541-49-7	0.005	mg/L	0.019	<0.005	<0.005	<0.005	<0.005
Titanium	7440-32-6	0.01	mg/L	0.08	0.09	0.16	11.2	0.16
Vanadium	7440-62-2	0.01	mg/L	0.08	0.07	0.46	0.52	0.11
Ytterbium	7440-64-4	0.001	mg/L	0.002	0.001	0.001	0.002	<0.001
Iron	7439-89-6	0.05	mg/L	505	135	254	166	121
Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: LIQUOR (Matrix: WATER)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #7	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912515-013	EP1912515-014	EP1912515-015	EP1912515-016	EP1912515-017
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: LIQUOR (Matrix: WATER)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #10	----	----	----	----
			Client sampling date / time	21-Nov-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EP1912515-018	--------	--------	--------	--------
				Result	----	----	----	----
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**22**	----	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**128**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**16**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**11**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**22**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**2**	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**48.1**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.004**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.590**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.185**	----	----	----	----
Bismuth	7440-69-9	0.001	mg/L	**0.002**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0014**	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.190**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.638**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.378**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.685**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.024**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.950**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.057**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**8.77**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.005**	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.390**	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	----	----	----	----
Titanium	7440-32-6	0.01	mg/L	**0.09**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**0.30**	----	----	----	----
Ytterbium	7440-64-4	0.001	mg/L	**0.002**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**328**	----	----	----	----
Gold	7440-57-5	0.001	mg/L	<0.001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: **LIQUOR**
(Matrix: **WATER**)

			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #10	----	----	----	----
			Client sampling date / time	21-Nov-2019 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EP1912515-018**	--------	--------	--------	--------
				Result	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #1	FIMISTON SOUTH WASTE ROCK SAMPLE #2	FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #5
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	*CAS Number*	*LOR*	*Unit*	EP1912515-001	EP1912515-002	EP1912515-003	EP1912515-004	EP1912515-005
				Result	Result	Result	Result	Result
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.8**	**8.7**	**8.6**	**8.6**	**8.6**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #6	FIMISTON SOUTH WASTE ROCK SAMPLE #7	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9	FIMISTON SOUTH WASTE ROCK SAMPLE #10
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	**EP1912515-006**	**EP1912515-007**	**EP1912515-008**	**EP1912515-009**	**EP1912515-010**
				Result	Result	Result	Result	Result
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.5**	**8.5**	**9.1**	**8.7**	**8.7**

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	FIMISTON SOUTH WASTE ROCK SAMPLE #11	FIMISTON SOUTH WASTE ROCK SAMPLE #12	FIMISTON SOUTH WASTE ROCK SAMPLE #3	FIMISTON SOUTH WASTE ROCK SAMPLE #4	FIMISTON SOUTH WASTE ROCK SAMPLE #7
Client sampling date / time				21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00
				EP1912515-011	EP1912515-012	EP1912515-013	EP1912515-014	EP1912515-015
				Result	Result	Result	Result	Result
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	----	----	**5.7**	**8.6**	**8.8**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	----	----	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	----	----	**1.9**	<0.1	<0.1
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	----	**9.4**	**9.4**	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	<2	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	<0.02	<0.02	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	----	----	**3.14**	**1.23**	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	----	**1960**	**765**	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	**8.68**	**12.1**	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	**1730**	**2420**	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	**2.78**	**3.88**	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	**1.5**	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	**1.29**	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	**803**	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	**60**	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	**3.14**	**1.23**	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	**1960**	**765**	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	**147**	**57**	----
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.5**	**9.0**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	FIMISTON SOUTH WASTE ROCK SAMPLE #8	FIMISTON SOUTH WASTE ROCK SAMPLE #9	FIMISTON SOUTH WASTE ROCK SAMPLE #10	----	----
			Client sampling date / time	21-Nov-2019 00:00	21-Nov-2019 00:00	21-Nov-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EP1912515-016	EP1912515-017	EP1912515-018	--------	--------
				Result	Result	Result	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.5**	**8.9**	**8.9**	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	----	----

QUALITY CONTROL REPORT

Work Order	: **EP1912515**	Page	: 1 of 11
Client	: **ALS METALLURGY**	Laboratory	: Environmental Division Perth
Contact	: WAYNE HARDING	Contact	: Customer Services EP
Address	: 6 MACADAM PLACE BALCATTA WA 6021	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 03 6431 6333	Telephone	: +61-8-9406 1301
Project	: A20380	Date Samples Received	: 27-Nov-2019
Order number	: 123501	Date Analysis Commenced	: 29-Nov-2019
C-O-C number	: ----	Issue Date	: 11-Dec-2019
Sampler	: ----		
Site	: ----		
Quote number	: EP/989/19		
No. of samples received	: 18		
No. of samples analysed	: 18		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA011: Net Acid Generation (QC Lot: 2737813)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.9	1.9	0.00	0% - 50%
EA033-A: Actual Acidity (QC Lot: 2737814)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.00	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.4	9.4	0.00	0% - 20%
EA033-B: Potential Acidity (QC Lot: 2737814)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	3.14	2.92	7.16	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	1960	1820	7.16	0% - 20%
EA033-C: Acid Neutralising Capacity (QC Lot: 2737814)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	8.68	8.71	0.345	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	2.78	2.79	0.359	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	1730	1740	0.299	0% - 20%
EA033-E: Acid Base Accounting (QC Lot: 2737814)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA033: Net Acidity (sulfur units)	----	0.02	% S	1.29	1.06	19.6	0% - 20%
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	3.14	2.92	7.26	0% - 20%
		EA033: Liming Rate	----	1	kg CaCO3/t	60	50	18.2	0% - 20%

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-E: Acid Base Accounting (QC Lot: 2737814) - continued									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	147	137	7.04	0% - 20%
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	803	664	19.0	0% - 20%
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	1960	1820	7.14	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2749220)									
EP1912515-002	FIMISTON SOUTH WASTE ROCK SAMPLE #2	EA005-P: pH Value	----	0.01	pH Unit	7.61	7.59	0.263	0% - 20%
EP1912515-012	FIMISTON SOUTH WASTE ROCK SAMPLE #12	EA005-P: pH Value	----	0.01	pH Unit	7.54	7.54	0.00	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2749218)									
EP1912515-002	FIMISTON SOUTH WASTE ROCK SAMPLE #2	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1590	1580	0.333	0% - 20%
EP1912515-012	FIMISTON SOUTH WASTE ROCK SAMPLE #12	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1360	1350	0.222	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2749219)									
EP1912515-002	FIMISTON SOUTH WASTE ROCK SAMPLE #2	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	16	16	0.00	0% - 50%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	16	16	0.00	0% - 50%
EP1912515-012	FIMISTON SOUTH WASTE ROCK SAMPLE #12	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	8	8	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	8	8	0.00	No Limit
ED040T: Total Major Anions (QC Lot: 2748391)									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED040T: Sulfur as S	63705-05-5	1	mg/L	1	<1	0.00	No Limit
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	ED040T: Sulfur as S	63705-05-5	1	mg/L	2	2	0.00	No Limit
ED040T: Total Major Anions (QC Lot: 2748432)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	ED040T: Sulfur as S	63705-05-5	1	mg/L	254	277	8.64	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2747985)									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	2	0.00	No Limit
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	2	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
ED045G: Chloride by Discrete Analyser (QC Lot: 2747986)									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED045G: Chloride	16887-00-6	1	mg/L	2	2	0.00	No Limit
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	ED045G: Chloride	16887-00-6	1	mg/L	4	4	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 2748365)									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED093F: Calcium	7440-70-2	1	mg/L	6	6	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	4	4	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	ED093F: Calcium	7440-70-2	1	mg/L	21	21	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	15	15	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	9	9	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	8	8	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2748428)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0165	0.0171	3.25	0% - 20%
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	0.077	0.078	1.71	0% - 20%
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	1.16	1.24	6.17	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	0.003	0.002	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.451	0.459	1.76	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.097	0.098	0.00	0% - 20%
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.643	0.668	3.74	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	4.42	4.45	0.696	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.180	0.185	2.54	0% - 20%
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.061	0.059	3.76	0% - 20%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	3.65	3.70	1.22	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.036	0.037	0.00	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.713	0.723	1.38	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	7.26	7.28	0.383	0% - 20%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	41.5	43.2	4.21	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	0.08	0.08	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	505	519	2.62	0% - 20%
EP1912903-006	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.008	0.009	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.044	0.045	0.00	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.002	0.001	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2748428) - continued									
EP1912903-006	Anonymous	EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.350	0.363	3.51	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	0.002	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.011	0.010	0.00	0% - 50%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.136	0.133	1.81	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.237	0.246	3.47	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.017	0.018	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.03	0.04	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.91	0.91	0.00	0% - 50%
EG020T: Total Metals by ICP-MS (QC Lot: 2748429)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EG020B-T: Bismuth	7440-69-9	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020B-T: Silver	7440-22-4	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	1.99	1.97	1.03	0% - 20%
		EG020B-T: Tellurium	22541-49-7	0.005	mg/L	0.019	0.020	0.00	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	0.08	0.08	0.00	No Limit
EP1912903-006	Anonymous	EG020B-T: Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	3.76	3.83	1.88	0% - 20%
		EG020B-T: Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2748430)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EG020D-T: Ytterbium	7440-64-4	0.001	mg/L	0.002	0.002	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2748431)									
EP1912515-013	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EG020E-T: Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746656)									
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	EG020B-W: Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-W: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-W: Strontium	7440-24-6	0.001	mg/L	0.050	0.051	0.00	0% - 20%
		EG020B-W: Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020B-W: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020B-W: Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-W: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-W: Strontium	7440-24-6	0.001	mg/L	0.011	0.011	0.00	0% - 50%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746656) - continued									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020B-W: Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020B-W: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746657)									
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	EG020D-W: Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020D-W: Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746658)									
EP1912515-008	FIMISTON SOUTH WASTE ROCK SAMPLE #8	EG020E-W: Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020E-W: Gold	7440-57-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746659)									
EP1912515-011	FIMISTON SOUTH WASTE ROCK SAMPLE #11	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Antimony	7440-36-0	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.006	0.004	45.8	No Limit
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Lithium	7439-93-2	0.001	mg/L	0.024	0.024	0.00	0% - 20%
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.017	0.020	15.4	0% - 50%
		EG020A-W: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	0.60	0.60	0.00	0% - 20%
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Antimony	7440-36-0	0.001	mg/L	0.013	0.013	0.00	0% - 50%
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.056	0.053	5.88	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.002	0.003	0.00	No Limit
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2746659) - continued									
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Lithium	7439-93-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	1.46	1.50	2.57	0% - 20%
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2748435)									
EP1912515-015	FIMISTON SOUTH WASTE ROCK SAMPLE #7	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035W: Water Leachable Mercury by FIMS (QC Lot: 2746661)									
EP1912515-003	FIMISTON SOUTH WASTE ROCK SAMPLE #3	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1912515-012	FIMISTON SOUTH WASTE ROCK SAMPLE #12	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EA011: Net Acid Generation (QCLot: 2737813)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	24.084 kg H2SO4/t	97.0	85.1	112
EA033-A: Actual Acidity (QCLot: 2737814)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	24.27 mole H+ / t	93.4	79.4	110
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2737814)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.202 % S	96.0	84.6	110
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 2737814)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	4.9 % CaCO3	103	98.1	108
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 2737814)								
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EA005P: pH by PC Titrator (QCLot: 2749220)								
EA005-P: pH Value	----	----	pH Unit	---- ----	4 pH Unit 7 pH Unit	100 100	98.5 98.5	102 102
EA010P: Conductivity by PC Titrator (QCLot: 2749218)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	95.2	92.1	105
ED037P: Alkalinity by PC Titrator (QCLot: 2749219)								
ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	----	----	----	----
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1 <1	20 mg/L 200 mg/L	117 104	81.2 90.0	126 110
ED040T: Total Major Anions (QCLot: 2748391)								
ED040T: Sulfur as S	63705-05-5	1	mg/L	<1	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
ED040T: Total Major Anions (QCLot: 2748432)								
ED040T: Sulfur as S	63705-05-5	1	mg/L	<1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2747985)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	93.1	87.7	113
				<1	100 mg/L	95.6	87.7	113
ED045G: Chloride by Discrete Analyser (QCLot: 2747986)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	97.1	87.9	114
				<1	1000 mg/L	97.8	87.9	114
ED093F: Dissolved Major Cations (QCLot: 2748365)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	104	85.9	113
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	106	88.0	110
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	106	87.3	118
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	103	89.7	108
EG020T: Total Metals by ICP-MS (QCLot: 2748428)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	89.7	117
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	0.02 mg/L	104	82.9	120
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	118	89.6	118
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	110	85.4	120
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	106	88.0	117
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	105	89.2	116
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	87.8	114
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	104	89.0	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	100	85.8	115
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	88.4	111
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	104	79.1	120
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	100	88.5	115
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	107	89.7	120
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	103	87.4	116
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	104	89.5	116
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	117	88.1	120
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	109	87.1	120
EG020T: Total Metals by ICP-MS (QCLot: 2748429)								
EG020B-T: Bismuth	7440-69-9	0.001	mg/L	<0.001	0.1 mg/L	105	87.4	114
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.02 mg/L	120	66.8	120
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	103	89.5	119
EG020B-T: Tellurium	22541-49-7	0.005	mg/L	<0.005	0.1 mg/L	106	85.9	120
EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	108	85.0	120
EG020T: Total Metals by ICP-MS (QCLot: 2748430)								
EG020D-T: Ytterbium	7440-64-4	0.001	mg/L	<0.001	0.01 mg/L	101	80.0	120

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2748431)								
EG020E-T: Gold	7440-57-5	0.001	mg/L	<0.001	0.01 mg/L	114	80.0	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2746656)								
EG020B-W: Bismuth	7440-69-9	0.001	mg/L	<0.001	0.1 mg/L	98.8	84.6	115
EG020B-W: Silver	7440-22-4	0.001	mg/L	<0.001	0.02 mg/L	118	70.0	120
EG020B-W: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	103	91.1	115
EG020B-W: Tellurium	22541-49-7	0.005	mg/L	<0.005	0.1 mg/L	116	87.2	120
EG020B-W: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	115	82.0	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2746657)								
EG020D-W: Yttrium	7440-65-5	0.001	mg/L	<0.001	0.01 mg/L	113	80.0	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2746658)								
EG020E-W: Gold	7440-57-5	0.001	mg/L	<0.001	0.01 mg/L	104	80.0	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2746659)								
EG020A-W: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	90.0	115
EG020A-W: Antimony	7440-36-0	0.001	mg/L	<0.001	0.02 mg/L	117	78.0	120
EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	106	88.8	117
EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	98.7	83.6	120
EG020A-W: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	102	88.4	116
EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	105	89.5	114
EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	88.4	111
EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	87.1	115
EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.0	84.4	113
EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.2	86.7	111
EG020A-W: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	92.0	80.5	120
EG020A-W: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	103	88.4	114
EG020A-W: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	111	88.6	120
EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	86.5	114
EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	106	88.5	114
EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	110	83.5	120
EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	99.5	87.9	117
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2748435)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	101	85.1	115
EG035W: Water Leachable Mercury by FIMS (QCLot: 2746661)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.6	88.7	113

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2747985)							
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	102	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 2747986)							
EP1912515-001	FIMISTON SOUTH WASTE ROCK SAMPLE #1	ED045G: Chloride	16887-00-6	1000 mg/L	95.0	70.0	130
EG020T: Total Metals by ICP-MS (QCLot: 2748428)							
EP1912515-014	FIMISTON SOUTH WASTE ROCK SAMPLE #4	EG020A-T: Arsenic	7440-38-2	1 mg/L	112	70.0	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	107	70.0	130
		EG020A-T: Barium	7440-39-3	1 mg/L	123	70.0	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	114	70.0	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	103	70.0	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	113	70.0	130
		EG020A-T: Copper	7440-50-8	1 mg/L	# Not Determined	70.0	130
		EG020A-T: Lead	7439-92-1	1 mg/L	112	70.0	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	# Not Determined	70.0	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	111	70.0	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	106	70.0	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	# Not Determined	70.0	130
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2746659)							
EP1912515-002	FIMISTON SOUTH WASTE ROCK SAMPLE #2	EG020A-W: Arsenic	7440-38-2	1 mg/L	115	70.0	130
		EG020A-W: Beryllium	7440-41-7	1 mg/L	121	70.0	130
		EG020A-W: Barium	7440-39-3	1 mg/L	116	70.0	130
		EG020A-W: Cadmium	7440-43-9	0.25 mg/L	121	70.0	130
		EG020A-W: Chromium	7440-47-3	1 mg/L	108	70.0	130
		EG020A-W: Cobalt	7440-48-4	1 mg/L	108	70.0	130
		EG020A-W: Copper	7440-50-8	1 mg/L	105	70.0	130
		EG020A-W: Lead	7439-92-1	1 mg/L	108	70.0	130
		EG020A-W: Manganese	7439-96-5	1 mg/L	108	70.0	130
		EG020A-W: Nickel	7440-02-0	1 mg/L	112	70.0	130
		EG020A-W: Vanadium	7440-62-2	1 mg/L	108	70.0	130
		EG020A-W: Zinc	7440-66-6	1 mg/L	123	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2748435)							
EP1912515-016	FIMISTON SOUTH WASTE ROCK SAMPLE #8	EG035T: Mercury	7439-97-6	0.01 mg/L	106	70.0	130
EG035W: Water Leachable Mercury by FIMS (QCLot: 2746661)							
EP1912515-004	FIMISTON SOUTH WASTE ROCK SAMPLE #4	EG035W: Mercury	7439-97-6	0.01 mg/L	108	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1912515**	Page	: 1 of 11
Client	: **ALS METALLURGY**	Laboratory	: Environmental Division Perth
Contact	: WAYNE HARDING	Telephone	: +61-8-9406 1301
Project	: A20380	Date Samples Received	: 27-Nov-2019
Site	: ----	Issue Date	: 11-Dec-2019
Sampler	: ----	No. of samples received	: 18
Order number	: 123501	No. of samples analysed	: 18

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020T: Total Metals by ICP-MS	EP1912515--014	FIMISTON SOUTH WASTE R(	**Copper**	7440-50-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020T: Total Metals by ICP-MS	EP1912515--014	FIMISTON SOUTH WASTE R(	**Manganese**	7439-96-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020T: Total Metals by ICP-MS	EP1912515--014	FIMISTON SOUTH WASTE R(	**Zinc**	7440-66-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	----	----	----	06-Dec-2019	29-Nov-2019	**7**
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural						
FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	----	----	----	09-Dec-2019	06-Dec-2019	**3**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA011: Net Acid Generation							
80* dried soil (EA011) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**02-Dec-2019**	30-May-2020	✓
EA033-A: Actual Acidity							
80* dried soil (EA033) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**05-Dec-2019**	01-Mar-2020	✓
EA033-B: Potential Acidity							
80* dried soil (EA033) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**05-Dec-2019**	01-Mar-2020	✓
EA033-C: Acid Neutralising Capacity							
80* dried soil (EA033) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**05-Dec-2019**	01-Mar-2020	✓
EA033-D: Retained Acidity							
80* dried soil (EA033) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**05-Dec-2019**	01-Mar-2020	✓
EA033-E: Acid Base Accounting							
80* dried soil (EA033) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4	**21-Nov-2019**	**02-Dec-2019**	20-Nov-2020	✓	**05-Dec-2019**	01-Mar-2020	✓
EN60: Bottle Leaching Procedure							
Non-Volatile Leach: 14 day HT(e.g. SV organics) (EN60-Dla) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**21-Nov-2019**	**29-Nov-2019**	05-Dec-2019	✓	**----**	----	----

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**06-Dec-2019**	29-Nov-2019	×

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**06-Dec-2019**	27-Dec-2019	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**06-Dec-2019**	13-Dec-2019	✓
ED040T: Total Major Anions							
Clear Plastic Bottle - Nitric Acid; Unfiltered (ED040T) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10	**05-Dec-2019**	**06-Dec-2019**	02-Jan-2020	✓	**06-Dec-2019**	02-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Unfiltered (ED040T) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**06-Dec-2019**	27-Dec-2019	✓	**06-Dec-2019**	27-Dec-2019	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**06-Dec-2019**	27-Dec-2019	✓

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**06-Dec-2019**	27-Dec-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10	**05-Dec-2019**	**----**	----	----	**09-Dec-2019**	12-Dec-2019	✓
Clear Plastic Bottle - Natural (ED093F) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**09-Dec-2019**	06-Dec-2019	✘
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020E-T) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10	**05-Dec-2019**	**06-Dec-2019**	02-Jun-2020	✓	**06-Dec-2019**	02-Jun-2020	✓
EG020W: Water Leachable Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020E-W) FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**05-Dec-2019**	27-May-2020	✓	**05-Dec-2019**	27-May-2020	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10	**05-Dec-2019**	**----**	----	----	**06-Dec-2019**	02-Jan-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation
EG035W: Water Leachable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035W)							
FIMISTON SOUTH WASTE ROCK SAMPLE #1, FIMISTON SOUTH WASTE ROCK SAMPLE #2, FIMISTON SOUTH WASTE ROCK SAMPLE #3, FIMISTON SOUTH WASTE ROCK SAMPLE #4, FIMISTON SOUTH WASTE ROCK SAMPLE #5, FIMISTON SOUTH WASTE ROCK SAMPLE #6, FIMISTON SOUTH WASTE ROCK SAMPLE #7, FIMISTON SOUTH WASTE ROCK SAMPLE #8, FIMISTON SOUTH WASTE ROCK SAMPLE #9, FIMISTON SOUTH WASTE ROCK SAMPLE #10, FIMISTON SOUTH WASTE ROCK SAMPLE #11, FIMISTON SOUTH WASTE ROCK SAMPLE #12	**29-Nov-2019**	**----**	----	----	**05-Dec-2019**	27-Dec-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Total	ED040T	3	18	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite D	EG020D-T	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite E	EG020E-T	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Mercury by FIMS	EG035W	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite B	EG020B-W	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite C	EG020D-W	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite E	EG020E-W	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	*Count QC*	*Count Regular*	*Rate (%) Actual*	*Rate (%) Expected*	*Evaluation*	*Quality Control Specification*
Laboratory Control Samples (LCS) - Continued							
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite D	EG020D-T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite E	EG020E-T	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Mercury by FIMS	EG035W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite B	EG020B-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite C	EG020D-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite E	EG020E-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Total	ED040T	2	18	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite D	EG020D-T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite E	EG020E-T	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Mercury by FIMS	EG035W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite B	EG020B-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite C	EG020D-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite E	EG020E-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Mercury by FIMS	EG035W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	SOIL	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	SOIL	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Net Acid Generation	EA011	SOIL	In house: Referenced to Miller (1998) Titremetric procedure determines net acidity in a soil following peroxide oxidation. Titrations to both pH 4.5 and pH 7 are reported.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Alkalinity by PC Titrator	ED037-P	SOIL	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Major Anions - Total	ED040T	SOIL	In house: Referenced to APHA 3120 Samples are digested by USEPA 3005 prior to analysis. Sulfur and/or Silicon content is determined by ICP/AES and reported as Sulfate and/or Silica after conversion by gravimetric factor.
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	SOIL	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	SOIL	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals by ICP-MS - Suite A	EG020A-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, AS 4439.3, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Water Leachable Metals by ICP-MS - Suite B	EG020B-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite D	EG020D-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Water Leachable Metals by ICP-MS - Suite C	EG020D-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite E	EG020E-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Water Leachable Metals by ICP-MS - Suite E	EG020E-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Water Leachable Mercury by FIMS	EG035W	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the TCLP solution. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	SOIL	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals in DI Water Leachate	EN25W	SOIL	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Leach Preparation	EN35	SOIL	In house: Preparation of Soil / Liquid leaches as per client instructions.
Deionised Water Leach	EN60-DIa	SOIL	In house QWI-EN/60 referenced to AS4439.3 Preparation of Leachates