Knight Piésold CONSULTING

MEMORANDUM

To:	Savannah Resources	**Date:**	15 September 2020
Attn:	Dale Ferguson	**Our Ref:**	PE20-01212
		KP File Ref.:	PE501-00080/06-A ejt M20011
cc:		**From:**	Dave Morgan

RE: MINA DO BARROSO – TAILINGS GEOCHEMICAL ASSESSMENT REV 1

1. INTRODUCTION

A tailings sample produced from metallurgical work for the Mina Do Barroso project was submitted for geochemical analysis at Intertek Genalysis (Perth), with the results supplied to Knight Piésold (KP). The sample was received as a filter cake from Nagrom and was labelled "GRA Flotation Tailings Comp" produced from the G12 sighter flotation run on a Grandao ore composite sample.

The sample is understood to be similar to the tailings previously tested in December 2019, although a different reagent regime has been used in the production of the sample which avoids the need for sulfuric acid.

This memorandum summarises the results of the testwork conducted by Intertek Genalysis. Details of the testwork methods and interpretation principles are provided in Appendix A, with laboratory test certificates for the analytical testing provided in Appendix B.

2. TAILINGS GEOCHEMICAL CHARACTERISTICS

2.1 INTRODUCTION

The testwork results are presented and discussed in the following sections. It should be noted that this assessment of the tailings geochemistry does not include specific assessment of residual proprietary process chemicals and reagents which may be present within the tailings. Given that the reagents used vary throughout metallurgical testwork programmes, it is recommended that consideration of the reagents is conducted during the pilot plant testwork phase as part of the detailed engineering. This may involve obtaining and reviewing the material safety data sheets (MSDSs) which state each product's identify and ingredients, health and physical hazards, safe handling and storage procedures and disposal considerations.

2.2 ACID BASE ACCOUNTING

The acid base accounting testwork was reported by the laboratory using Australian conventions and terminology, i.e. acid neutralising capacity (ANC), maximum potential acidity (MPA) and net acid producing potential (NAPP) reported in units of kg H_2SO_4/t and ANC/MPA ratio (no units). However, in order to comply with EU standards (specifically EN15875:2011) these values have been reported as converted to neutralisation potential (NP), acid potential (AP) and net neutralisation potential (NPR) in units of kg $CaCO_3$/t and neutralisation potential ratio (NPR, no units). This is

summarised in Table 2.1, with specific details on the testing procedures provided in Appendix A.

It should also be noted that net acid generation testing has been conducted which is reported in units of kg H_2SO_4/t. This is not a test which is included under EU standards for characterising sulfidic waste and, as such, there is no corresponding term for this measurement.

Table 2.1: Acid Base Accounting Terminology

Australian Term	Units	EU Term	Units
ANC	kg H_2SO_4/t	NP	kg $CaCO_3$/t
MPA	kg H_2SO_4/t	AP	kg $CaCO_3$/t
NAPP	kg H_2SO_4/t	NNP	kg $CaCO_3$/t
ANC/MPA Ratio	N/A	NPR (NP/AP Ratio)	N/A
NAG	kg H_2SO_4/t	N/A	N/A

The results of the analysis are summarised in Tables 2.2 and 2.3 and indicate that sulfur was not identified above the analytical detection limit of 0.01%. As such, the sample was essentially devoid of sulfur and has a negligible AP. However, for the purposes of this study is it conservatively assumed that the sulfide content is 0.01% with a corresponding AP of 0.3 kg $CaCO_3$/t.

The NP of the sample was determined along with estimates of the carbonate content. The two results can be used as a check against one another and to identify the contribution of NP from carbonates and other non-carbonate minerals. The sample recorded a low NP of 9 kg $CaCO_3$/t, with the carbonate content indicated to be negligible. As such, the NP is likely entirely derived from non-carbonate minerals, which may be less reactive and only available to buffer acid under low pH conditions.

Based on the AP and NP results the sample recorded a NNP of 9 kg $CaCO_3$/t and NPR of 29, both of which indicate excess NP.

2.3 NET ACID GENERATION

The net acid generation (NAG) test aids in interpretation of acid formation potential classifications. It also identifies whether the sulfides and neutralising minerals contained in the sample are readily available to produce or consume acid.

The results of the NAG test are given in Table 2.3 and indicate that under extreme oxidising conditions, the tailings did not produce any measurable acid, with the final pH of the NAG solution recorded at pH 8.1. These results correlate well with the acid base accounting results.

2.4 ACID FORMATION POTENTIAL

KP prefers to determine the acid formation potential of the sample based on the NNP and NAG test. On this basis, the positive NNP and NAG pH of 8.1 result in a Non Acid Forming (NAF) classification as there is no perceived risk of this tailings sample generating acid. The acid formation potential according to this method is shown in Figure 2.1.

There is no formal procedure for classifying the acid forming potential under EN 15875:2011, however, Article 1 of the Commission Decision 2009/359/EC completes the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries, whereby waste shall be considered as being inert where the waste has a maximum content of sulfide sulfur of 0.1 %, or the waste has a maximum content of sulfide sulfur of 1 % and the NPR is greater than 3. This criteria is also provided within Decreto-Lei No. 10/2010, Anexo I,(1)(b). On this basis, the sample meets the acid base accounting criteria for inert waste.

Table 2.2: Acid Base Accounting Results

Sample	Sulfur Species			NP	Carbon Species				Paste pH
	Sulfur	Sulfate	Sulfide		Carbon	Acid Insoluble Carbon	Calcite Equivalent	$CaCO_3$-NP	
	%	%	%	kg $CaCO_3$/t	%	%	% $CaCO_3$	kg $CaCO_3$/t	
Flotation Tailings	0.01	0.01	0.01	9	0.02	0.02	0.00	0	8.2

Table 2.3: Acid Base Accounting Calculations and NAG Test Results

Sample	Calculations			NAG Results			Acid Forming Potential
	AP	NPR	NNP	NAG (7.0)	NAG (4.5)	NAG pH	
	kg $CaCO_3$/t		kg $CaCO_3$/t	kg H_2SO_4/t	kg H_2SO_4/t		
Flotation Tailings	0.3	29	9	0	0	8.1	Non Acid Forming (NAF)

Note: Values in the tables have been rounded.

2.5 MULTI-ELEMENT RESULTS

In order to assess the tailings metal(loid) concentrations in relation to the criteria for inert waste set out under in Article 1 of the Commission Decision 2009/359/EC and Decreto-Lei No. 10/2010, Anexo I,(1)(b), the results have been assessed against the following criteria for comparison purposes:

- Element enrichments based on average crustal abundance concentrations.
- Agência Portuguesa do Ambiente (APA) reference values for soil.
- Baseline soil sampling results.
- Results from the drilling and assay database.

The findings of these comparisons are provided in the following sections.

2.5.1 Element Enrichments

Whole rock multi-element analysis of the tailings solids was conducted to assess element enrichments within the solid fraction of the tailings. Multi-element analysis results were compared to the average crustal abundance (ACA) to calculate the geochemical abundance indices (GAIs). The GAI quantifies an assay result for a particular element in terms of ACA. The assay results, ACAs and GAIs are provided in Table 2.4 and indicate that the sample had a very low number of element enrichments, with the enrichment level varying from slight to significant. Beryllium and molybdenum were found to be significantly enriched, with tin classed as slightly enriched. It is also noted that these results indicate a substantial reduction in metal(loid) enrichment compared to the previous tailings sample tested in December 2019.

2.5.2 APA Reference Values for Soil

The results of the multi-element analysis have also been compared to Agência Portuguesa do Ambiente (APA) reference values for soil, specifically Table C values which are for applicable for sites with shallow soils, which are defined as sites where the layer of soil on the rocky substrate is equal to or less than 2 m across at least one third of the site. The values provided in Table C are subdivided for various land uses; agricultural, urban and industrial/commercial. As such, the values for industrial/commercial land use are considered to be the most applicable. Although reference values are subdivided based on whether the groundwater is being used, the values do not differ for industrial/commercial land use. In addition, the reference values for certain metal(loid)s are different depending on the soil grain size. In the absence of detailed information, the lower values for these metal(loid)s have been applied. However, review of the results indicates that the values for soils with different grain sizes would not affect the outcome of the assessment, with beryllium, chromium and molybdenum exceeding the soil reference guidelines regardless of soil texture.

The summarised results compared to the assessment criteria are presented in Table 2.5.

2.5.3 Baseline Soil Data

Comparison of the tailings assay results to baseline soil testing for the project area indicates that the concentrations of several metal(loid)s in the tailings are greater than those recorded in the soil when compared to both average and maximum values. Summarised results compared to baseline soil data are presented in Table 2.6.

2.5.4 Drilling and Assay Database

Background metal(loid) concentrations in pegmatite and schist lithologies has also been reviewed, which is based on assay data from the project drilling database. The data has been subdivided as surface samples and those at depth. Only ten metal(loid)s were analysed in the assay database, but comparison with the tailings test results from this study indicate that several metal(loid) concentrations in the tailings are greater than the average and maximum values from the surface assay samples and average values from the drilling database. Summarised results compared to the assay database are presented in tables 2.7 to 2.10.

Table 2.4: Tailings Assay Results, ACA and GAIs

Element	Unit	Tailings Assay Results	ACA	GAI
Ag	ppm	0.10	0.07	0
Al	ppm	63788	82000	0
As	ppm	6	1.5	1
B	ppm	50	10	1
Ba	ppm	20	500	0
Be	ppm	37	2.6	3
Bi	ppm	0.23	0.048	1
C	ppm	200	480	0
Ca	ppm	1694	41000	0
Cd	ppm	0.20	0.11	0
Cl	ppm	200	130	0
Co	ppm	5.1	20	0
Cr	ppm	338	100	1
Cu	ppm	128	50	0
F	ppm	190	950	0
Fe	ppm	8550	41000	0
Hg	ppm	0.01	0.05	0
K	ppm	18691	21000	0
Mg	ppm	385	23000	0
Mn	ppm	1009	950	0
Mo	ppm	56	1.5	4
Na	ppm	31829	23000	0
Ni	ppm	247	80	1
P	ppm	1893	1000	0
Pb	ppm	24	14	0
S	ppm	100	260	0
Sb	ppm	0.18	0.2	0
Se	ppm	0.02	0.05	0
Sn	ppm	15	2.2	2
Sr	ppm	58	370	0
Th	ppm	1.4	12	0
U	ppm	13	2.4	1
V	ppm	7	160	0
Zn	ppm	129	75	0

Legend:

Not Enriched	0 – 1
Slightly Enriched	2
Significantly Enriched	3 – 4
Highly Enriched	5 – 6

Table 2.5: Tailings Assay Results and APA Soil Reference Values

Element	Tailings Assay Results (ppm)	APA Guidelines (Table C) Industrial/ Commercial Land Use (ppm)
Antimony	0.02	40
Arsenic	6	18
Barium	20	670
Beryllium	**37**	8
Cadmium	0.2	1.9
Lead	24	120
Cobalt	5	80
Copper	128	230
Chromium	**338**	160
Mercury	0.01	3.9
Molybdenum	**56**	40
Nickel	247	270
Silver	0.1	40
Selenium	0.02	5.5
Thallium	N/D	3.3
Uranium	12.7	33
Vanadium	7	86
Zinc	129	340

Notes:

Values in red bold indicate where a guideline value has been exceeded.

N/D is Not Determined.

Table 2.6: Tailings Assay Results and Average Baseline Soil Values

Element	Unit	Tailings Assay Results	Average Soil Baseline	Maximum Soil Baseline
Ag	ppm	0.10	0.50	0.50
Al	ppm	**63788**	27365	60000
As	ppm	6	23	115
B	ppm	**50**	1.0	1.0
Ba	ppm	20	36	88
Be	ppm	**37**	1.2	2.8
Bi	ppm	0.23	1.0	1.0
C	ppm	200	N/D	N/D
Ca	ppm	**1694**	546	4940
Cd	ppm	0.20	0.4	0.4
Cl	ppm	200	N/D	N/D
Co	ppm	5.1	9.2	29.5
Cr	ppm	**338**	29	60
Cu	ppm	**128**	22	43
F	ppm	190	N/D	N/D
Fe	ppm	8550	39376	67000
Hg	ppm	0.01	0.34	4.94
K	ppm	**18691**	3101	6170
Mg	ppm	385	3448	10500
Mn	ppm	**1009**	185	430
Mo	ppm	**56**	0.41	0.59
Na	ppm	**31829**	77	270
Ni	ppm	**247**	19	51
P	ppm	**1893**	326	552
Pb	ppm	**24**	20	45
S	ppm	100	357	4120
Sb	ppm	0.18	0.50	0.50
Se	ppm	0.02	2.0	2.0
Sn	ppm	**15**	2.0	7.2
Sr	ppm	**58**	6.6	50.9
Th	ppm	1.4	N/D	N/D
U	ppm	13	N/D	N/D
V	ppm	7	31	61
Zn	ppm	**129**	49	93

Notes:

Values in red bold indicate where an average baseline value has been exceeded.

Values shaded yellow indicate where a maximum baseline value has been exceeded.

N/D is Not Determined.

Table 2.7: Tailings Assay Results and Average Drilling Assays

Element	Unit	Tailings Assay Results	All Pegmatite Samples (RC and DD) Average Value	All Schist Samples (RC and DD) Average Value
Ag	ppm	0.10	2.7	2.3
As	ppm	6	24	105
Be	ppm	37	112	20
Bi	ppm	0.23	0.69	0.56
Cu	ppm	**128**	2.4	22
Fe	ppm	**8550**	8300	38400
Ni	ppm	**247**	14	35
Sb	ppm	**0.18**	0.12	0.15
Se	ppm	0.02	2.6	2.7
Sn	ppm	15	70	47

Notes:
Values in red bold indicate where average pegmatite value has been exceeded.
Values shaded yellow indicate where average schist value has been exceeded.

Table 2.8: Tailings Assay Results and Average Drilling Assays (Surface Samples)

Element	Unit	Tailings Assay Results	All Pegmatite Samples (RC and DD) Average Value	All Schist Samples (RC and DD) Average Value
Ag	ppm	0.10	2.65	2.26
As	ppm	6	23.88	104.53
Be	ppm	37	111.87	19.99
Bi	ppm	0.23	0.69	0.56
Cu	ppm	**128**	2.4	21.91
Fe	ppm	**8550**	8300	38400
Ni	ppm	**247**	13.8	34.98
Sb	ppm	**0.18**	0.12	0.15
Se	ppm	0.02	2.61	2.69
Sn	ppm	15	70.3	47.08

Notes:
Values in red bold indicate where average pegmatite value has been exceeded.
Values shaded yellow indicate where average schist value has been exceeded.

Table 2.9: Tailings Assay Results and Maximum Drilling Assays

Element	Unit	Tailings Assay Results	All Pegmatite Samples (RC and DD) Maximum Value	All Schist Samples (RC and DD) Maximum Value
Ag	ppm	0.10	10	13
As	ppm	6	503	599
Be	ppm	37	310	250
Bi	ppm	0.23	10	1.9
Cu	ppm	128	30	40
Fe	ppm	8550	20300	60000
Ni	ppm	247	50	30
Sb	ppm	0.18	1.8	1.4
Se	ppm	0.02	23	14
Sn	ppm	15	502	690

Notes:
No exceedances.

Table 2.10: Tailings Assay Results and Maximum Drilling Assays (Surface Samples)

Element	Unit	Tailings Assay Results	All Pegmatite Samples (RC and DD) Maximum Value	All Schist Samples (RC and DD) Maximum Value
Ag	ppm	0.10	10	13
As	ppm	6	503	599
Be	ppm	37	310	250
Bi	ppm	0.23	10	1.9
Cu	ppm	**128**	30	40
Fe	ppm	8550	20300	60000
Ni	ppm	**247**	50	30
Sb	ppm	0.18	1.8	1.4
Se	ppm	0.02	23	14
Sn	ppm	15	502	690

Notes:
Values in red bold indicate where maximum pegmatite value has been exceeded.
Values shaded yellow indicate where maximum schist value has been exceeded.

2.6 DISTILLED WATER EXTRACT ANALYSIS

Extract testing was conducted to provide an indication of readily soluble metals and metalloids in the tailings solids as a filtrate sample was not provided to KP. The method used follows the same principles as that set out in EN14429:2015 for the natural pH solution (as per Section 9.4), except the extract solution is prepared as a water:solids ratio of 3:1 rather than 10:1 and agitated for 24 hours rather than 48. Further details of the test method used in this assignment are provided in Appendix A. During subsequent design stages when tailings testing is repeated, either a sample of

filtrate will be analysed or extract testing will be conducted on the tailings solids in accordance with EN14429:2015.

The results of the extract testing have been compared to a range of reference water quality values to allow for initial evaluation of the leachate water chemistry. These reference values are outlined below with additional details provided in Appendix A. It is not implied by production of the reference water quality values that the project will be required to meet these reference levels or that these reference levels should be used as the regulatory framework.

2.6.1 Release and Surface Water Guidelines

The results of the extract testing have been compared to IFC guidelines for mining effluents, Portuguese emission limit values for wastewater discharge and European surface water guidelines. A range of guidelines have been adopted to enable assessment of a wider range of parameters, with further details of the guidelines and references provided in Appendix A.

The results of the comparison are summarised in Table 2.11 and indicate the extract to be of a reasonable quality, meeting the IFC release guidelines and Portuguese emission standards. However, the laboratory was only able to achieve a detection limit for mercury of 0.0001 mg/L (0.1 µg/L), compared to the EU surface water guideline of 0.00007 mg/L (0.07 µg/L). Although mercury was not detected above 0.0001 mg/L it is not possible to determine whether it is present above the EU surface water threshold of 0.00007 mg/L. However, given that the concentration of mercury in the tailings solids was not detected above the detection limit of 0.01 ppm, which represents 20% of the average crustal abundance and approximately 0.25% of the APA guideline for mercury, it follows that mercury is unlikely to be present in the leachate solution at environmentally significant levels. All other metals and metalloids were confirmed as being below the EU surface water thresholds.

2.6.2 EU Drinking Water Guidelines

The extract sample has also been compared to EU drinking water guidelines, supplemented with WHO guidelines for barium and uranium to allow a fuller assessment. Further details of the guidelines and references provided in Appendix A.

The sample was found be of a reasonable quality with only slight exceedances of the guidelines for arsenic and fluoride (chemical parameters), together with a slight exceedance of manganese (indicator parameter). It is not currently known whether the project will be required to meet drinking water standards.

The results of the analyses compared to drinking water guidelines are shown in Table 2.12, with the implications for tailings management provided in Section 3.

Table 2.11: Extract Comparison to Surface Water and Release Guidelines

Parameter	IFC Mining Release (mg/L)	Portuguese Emissions (mg/L)	EU Surface Water (mg/L)	Assay Results (mg/L)
pH	6 to 9	6 to 9	N/G	8.2
TDS	N/G	N/G	N/G	30
EC	N/G	N/G	N/G	97
Aluminium	N/G	10	N/G	0.24
Antimony	N/G	N/G	N/G	0.012
Arsenic	0.1	1	N/G	0.05
Barium	N/G	N/G	N/G	0.002
Boron	N/G	N/G	N/G	0.04
Cadmium	0.05	0.2	0.00045 - 0.0015 [1]	0.00002
Calcium	N/G	N/G	N/G	2.1
Chloride	N/G	N/G	N/G	12
Chromium	N/G	2	N/G	0.01
Cobalt	N/G	N/G	N/G	0.0001
Copper	0.3	1	N/G	0.03
Fluoride	N/G	N/G	N/G	0.60
Iron	2	2	N/G	0.07
Lead	0.2	1	0.0072	0.001
Magnesium	N/G	N/G	N/G	1.0
Manganese	N/G	2	N/G	0.03
Mercury	0.002	0.05	0.00007 [2]	0.0001
Molybdenum	N/G	N/G	N/G	0.006
Nickel	0.5	2	0.02	0.01
Phosphorus	N/G	10	N/G	1.5
Selenium	N/G	N/G	N/G	0.001
Silver	N/G	N/G	N/G	0.0004
Sodium	N/G	N/G	N/G	13
Sulfate	N/G	2000	N/G	7
Tin	N/G	N/G	N/G	0.001
Uranium	N/G	N/G	N/G	0.0009
Vanadium	N/G	N/G	N/G	0.01
Zinc	N/G	N/G	N/G	0.01

Notes:

N/G = No guideline.

Exceedances of guideline values shown in red bold (no exceedances).

[1] Varies according to water hardness.

[2] Mercury was not detected, but as the limit of detection exceeds the surface water guideline it is not possible to determine the whether the metal is present at levels exceeding or below the surface water threshold.

Table 2.12: Extract Comparison to Drinking Water Guidelines

Parameter	Drinking Water Guideline (mg/L)	Assay Results (mg/L)
pH	6.5-9.5	8.2
TDS	N/G	30
EC	2500	97
Aluminium	0.2	**0.24**
Antimony	0.005	**0.012**
Arsenic	0.01	**0.05**
Barium	0.7 [1]	0.002
Boron	1	0.04
Cadmium	0.005	0.00002
Calcium	N/G	2.1
Chloride	250	12
Chromium	0.05	0.01
Cobalt	N/G	0.0001
Copper	2	0.03
Fluoride	1.5	0.60
Iron	0.2	0.07
Lead	0.01	0.001
Magnesium	N/G	1.0
Manganese	0.05 [2]	0.03
Mercury	0.001	0.0001
Molybdenum	N/G	0.006
Nickel	0.02	0.01
Phosphorus	N/G	1.5
Selenium	0.01	0.001
Silver	N/G	0.0004
Sodium	200	13
Sulfate	250	7
Tin	N/G	0.001
Uranium	0.03 [1]	0.0009
Vanadium	N/G	0.01
Zinc	N/G	0.01

Notes:

N/G = No guideline.

Values in red bold exceed EU drinking water guideline.

[1] Value taken from WHO guidelines in the absence of an EU threshold.

[2] Threshold for manganese is an indicator parameter rather than health based.

3. SUMMARY OF RESULTS AND IMPLICATIONS FOR TAILINGS MANAGEMENT

3.1 ACID FORMING POTENTIAL

The tailings sample is considered to be Non Acid Forming (NAF) based on the negligible sulfur content, positive NNP value and circum neutral NAG pH result. Based on these results, there is no perceived risk of the tailings sample generating acid.

The sample also met the definition for inert waste, as per Article 1 of the Commission Decision 2009/359/EC which completes the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries, whereby waste shall be considered as being inert where the waste has a maximum content of sulfide sulfur of 0.1 %, or the waste has a maximum content of sulfide sulfur of 1 % and the NPR is greater than 3. The same criteria is provided within Decreto-Lei No. 10/2010, Anexo I,(1)(b).

3.2 MULTI-ELEMENT ENRICHMENT

The sample had a very low number of element enrichments, with the enrichment level varying from slight to significant. Beryllium and molybdenum were found to be significantly enriched, with tin classed as slightly enriched. It is also noted that these results indicate a substantial reduction in metal(loid) enrichment compared to the previous tailings sample tested in December 2019.

Comparison of the multi-element analysis results with Agência Portuguesa do Ambiente (APA) reference values for soil, specifically Table C values which are for applicable for sites with shallow soils and an industrial/commercial land use indicated beryllium, chromium and molybdenum concentrations within the tailings to exceed the soil reference guidelines.

Comparison of the tailings metal(loid) concentrations with the soil baseline data and the drilling assay database indicate that the concentrations of several metal(loid)s in the tailings are greater than the average and maximum background conditions. However, overall the concentrations can be considered typical of mineralised deposits and any potential issues can be managed with appropriate engineering controls (refer to Section 3.4).

3.3 EXTRACT WATER QUALITY

The distilled water extract sample was found to be of a reasonable quality when compared to IFC guidelines for mining effluents, Portuguese emission standards and EU surface water guidelines, meeting the various criteria. This indicates that the metal(loids) identified in the tailings solids are not readily soluble under the circum neutral pH conditions which are expected to prevail in the TSF and, as such, leachate concentrations emanating from the tailings are not expected to be problematic based on the reference water quality values applied in this study.

However, the sample was found to slightly exceed the EU drinking water guidelines for arsenic, fluoride and manganese. Overall, the metal(loid) concentrations were lower than the previous tailings sample test in December 2019.

The engineering controls implemented on the basis of these results are outlined in Section 3.4.

3.4 TAILINGS MANAGEMENT DESIGN

The geochemical properties of the tailings are generally considered to be low risk and should be able to be adequately managed through the implementation of appropriate engineering design, as outlined below.

The tailings produced will be placed concurrently with Run of Mine waste as part of an Integrated Waste Landform (IWL). Continuous cover and encapsulation of the tailings will be achieved as part of standard waste dump operating procedures. This cover system should be resistant to erosion and incorporate a growth medium to encourage revegetation. The requirement for the cover system to reduce infiltration will depend on the environmental discharge limits specified for the project, which may take into consideration baseline surface water and groundwater quality. However, the results from this assessment indicate that the elevated metal(loid) concentrations recorded in the tailings samples do not appear to be readily mobile. As such, leachate concentrations emanating from the tailings are not expected to be problematic based on the reference water quality values applied in this study. It is noted that the current IWL design incorporates surface water drainage and capping measures to reduce infiltration into the waste and seepage collection systems at the downstream toe from which leachate will be pumped to a water polishing / treatment system prior to reuse or discharge during operations. Therefore, the intent is for the water discharged from the IWL to meet the project discharge limits.

On the basis of these results, a key requirement of the IWL facility design will be to prevent the loss of tailings solids through adequate sediment control structures. These structures will intercept the main drainage lines and direct water around mining areas using low embankments, low bunds and diversion channels. It is intended that all disturbed areas are diverted into these systems to enable sediment control and water quality polishing prior to release downstream or recycle back to the process plant for treatment (to provide water of quality suitable for processing or for direct release back to the Rio Covas). Post closure, after removal of contained sediments (placed in mine waste storages) and once rehabilitation areas have stabilised, these structures will be removed to restore drainage lines to the original configuration as far as practical. The requirement to completely remove structures post closure will be reviewed towards the end of the mine life as part of the overall closure strategy.

Further geochemical analysis should be conducted to confirm the current results during the pilot plant testwork phase conducted as part of the detailed engineering. This testing will include analysis of the filtrate if available or, alternatively, leaching testwork in accordance with EN 14429:2015. Testing may also include humidity cell testing to examine the metal leaching rates and seepage quality in response to weathering, which are likely to be lower than those recorded in the distilled water extract test. This is because the distilled water extract test comprises agitating a pulverized sub-sample of tailings in water for 24 hours to encourage release of readily soluble metals/metalloids. By contrast, the humidity cell testing involves placement of 2 kg of (non-pulverised) tailings in a cell, where the sample is then exposed to heat and wetting/drying cycles to simulate and accelerate weathering, with a weekly flush of distilled water. This water is then analysed to determine the leachate quality in response to weathering, which is usually considered to provide a more accurate reflection of the seepage quality which is likely to occur when the tailings are placed within the IWL. However, as humidity cell testing usually runs for a period of 6 to 12 months, this will need to be considered in the detailed engineering design schedule.

We trust this memorandum report meets your current requirements, however, please do not hesitate to contact us should have any queries.

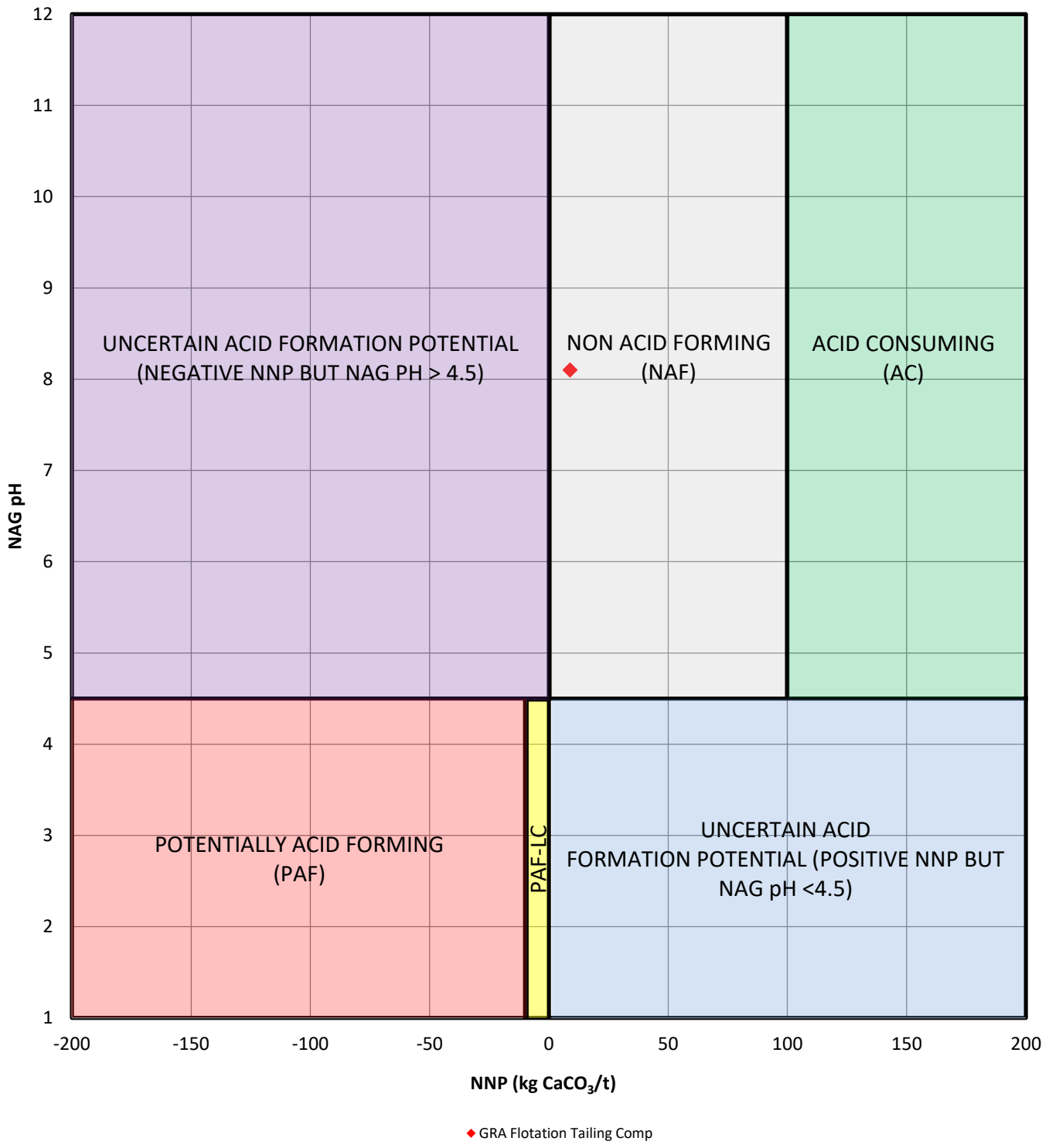
Yours faithfully
KNIGHT PIÉSOLD PTY LTD

ED TUPLIN
Senior Project Engineer

BRETT STEVENSON
Principal Engineer

FIGURE

Acid Formation Potential



Acid Formation Potential	NNP (kg $CaCO_3$ / t)	NAG pH
Potentially Acid Forming (PAF)	< -10	<4.5
Potentially Acid Forming - Low Capacity (PAF - LC)	0 to -10	<4.5
Non Acid Forming (NAF)	Positive	≥4.5
Acid Consuming (AC)	>100	≥4.5
Uncertain	Negative	≥4.5
	Positive	<4.5

APPENDIX A

Testwork Methods and Interpretation Principles

A. TESTWORK METHODS

A.1 ACID BASE ACCOUNTING

Acid base accounting (ABA) assesses a sample's potential to form acid from the oxidation of sulfides and the ability to neutralise acid by the dissolution of minerals, especially carbonates, contained in the sample. The test work methods used were based on the ABA methodology defined in the Mine Environment Neutral Drainage (MEND) Acid Rock Drainage Prediction Manual (Ref. 1) and Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (Ref. 2), as detailed below.

Total carbon and total inorganic carbon were determined by LECO induction furnace, with infrared detection. Sulfate sulfur was determined by HCl digest with ICP detection. Neutralisation Potential (NP) was determined by digestion in a standard solution of HCl, followed by back titration with NaOH to determine the amount of acid consumed. The technique used was based on Sobek et al (Ref. 3), however, a siderite correction step has been added to the method, after Stewart et al (Ref. 4).

The results of the ABA test work are used to calculate the Acid Potential (AP) which is a measure of the maximum amount of sulfuric acid which can be produced from the total oxidation of all sulfides within the sample, assuming all sulfide is present as pyrite.

The Net Neutralisation Potential (NNP) is the balance between the AP and the NP. A positive NNP indicates that there is an excess neutralising capacity and a negative NNP indicates there is excess potential acidity.

A.2 NET ACID GENERATION

Net Acid Generation (NAG) test work is a direct measure of the sample's ability to produce acid through sulfide oxidation. The addition of hydrogen peroxide to samples causes rapid oxidation of the contained sulfides to produce sulfuric acid.

The procedure employed is based upon the Static NAG Test (Ref. 5 and 6). The static NAG test involves the addition of 250 mL of 15% hydrogen peroxide to 2.5 g of pulverised sample. The sample is allowed to react overnight prior to heating for a period of three hours. Once the sample has cooled the pH of the sample is measured prior to titration back to pH 4.5 and 7 to determine the acidity produced by the oxidation reactions.

A.3 ACID FORMING POTENTIAL

The acid formation potential of a sample is calculated based on the acid base accounting, i.e. the balance between a sample's ability to produce acid from the oxidation of sulfide minerals (AP) and the sample's ability to neutralise acid by the dissolution of alkaline minerals contained within the sample (NP).

Historically a safety margin was applied to ratio between the NP and AP to allow for variability in the rates of acid production and neutralisation processes and the potential for geographic separation of the acid producing and acid neutralising phases. This safety margin was generally set by industry at 2 in North America and 3 in Australia.

With recent advances in the understanding and acceptance of the NAG test there has been a move away from this method of classifying materials based solely on the NP and AP as these calculated parameters do not take into consideration the true availability of acid producing and acid neutralising phases.

Knight Piésold prefers to utilise the results of the acid base accounting in combination with the NAG testing results to classify the acid formation potential of materials. Knight Piésold's classification system is summarised in Table A.1. It is based on the Australian Government publication; Managing Acidic and Metalliferous Drainage (Ref. 4) and is

broadly similar to the classification system contained within the AMIRA ARD Test Handbook (Ref. 5), which is advocated by the Global Acid Rock Drainage Guidelines (Ref. 6).

Table A.1: Acid Formation Potential Classification System

Acid Formation Potential Class	NNP (kg $CaCO_3$ /t)	NAG pH
Potentially Acid Forming (PAF)	< -10	<4.5
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to -10	<4.5
Non Acid Forming (NAF)	Positive	≥4.5
Acid Consuming (AC)	>100	≥4.5
Uncertain (UC)	Negative	≥4.5
	Positive	<4.5

A.4 MULTI-ELEMENT ANALYSIS OF SOLIDS

A.4.1 Geochemical Enrichments

Multi-element analysis of the tailings solids was conducted to assess element enrichments within the sample. The four acid digestion method used results in near total digestion of the sample to assess the whole rock geochemistry.

Multi-element analysis results were compared to average crustal abundances to calculate the geochemical abundance indices. The Geochemical Abundance Index (GAI) quantifies an assay result for a particular element in terms of average crustal abundance.

The GAI is calculated from the following formula:

$$\mathbf{GAI = Log_2 (C_n / (1.5 \times B_n))}$$

Where:
Cn = measured concentration of element in sample
Bn = average crustal abundance (Bowen, Ref. 10)

The GAI is expressed on a scale of 0 to 6, with 0 indicating that the element concentration is less than or similar to average crustal abundance, and a GAI of 6 indicating an element concentration of more than 96 times the average crustal abundance. The enrichment ranges for GAIs are as follows:

- GAI = 0 represents <3 times crustal abundance.
- GAI = 1 represents 3 to 6 times crustal abundance.
- GAI = 2 represents 6 to 12 times crustal abundance.
- GAI = 3 represents 12 to 24 times crustal abundance.
- GAI = 4 represents 24 to 48 times crustal abundance.
- GAI = 5 represents 48 to 96 times crustal abundance.
- GAI = 6 represents more than 96 times crustal abundance.

Knight Piésold has assigned an arbitrary scale to the GAI, with indices of 0 and 1 being classified as “not enriched”, an index of 2 being classed as “slightly enriched”, indices of 3 and 4 being classed as “significantly enriched” and indices of 5 and 6 being classified as “highly enriched”.

A.4.1 Soil Quality Screening

The multi-element analysis results were also compared to Agência Portuguesa do Ambiente (APA) reference values (Ref. 11) for preliminary assessment of possible closure

requirements, such as construction of engineered cover systems or limiting land use / access.

The establishment of these soil quality screening values is to allow for evaluation only and it is not implied by production of these values that the project will be required to meet these reference levels or that these reference levels should be used as the regulatory framework.

A.5 LEACHATE WATER QUALITY

Distilled water extract testing of the tailings solids has been conducted to identify any readily soluble metals and metalloids.

The procedure specified is based on the Shake Flask Method as described in the Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (Ref. 2), as described below.

Initially 50 grams of each sample was mixed with 150 mL of deionized water. The mixtures were then bottle rolled for 24 hours. The pH and the conductivity of the solutions were measured and the bottles left to stand for a minimum of three hours. The solution was then siphoned off and filtered through a 0.45 µm membrane before preservation of the solution by acid addition prior to analysis. The analysis was by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) depending on the element being analysed and the detection limits required.

The results have been compared to a set of reference water quality standards, which are discussed in Section A.6.

A.6 REFERENCE WATER QUALITY STANDARDS

To allow assessment of the results of the extract analysis, two sets of reference values have been established as follows:

- Reference Set 1 – IFC guidelines for release of water from mining operations (Ref. 12), Portuguese emission standards for wastewater (Ref. 13) and EU surface water guidelines (Ref. 14). These reference values are summarised in Table A.2.

- Reference Set 2 – EU drinking water standards (Ref. 15), supplemented with WHO guidelines (Ref. 16) to allow a fuller assessment. These reference values are presented in Table A.3.

The establishment of these reference water quality values is to allow for evaluation only and it is not implied by production of the reference water quality values that the project will be required to meet these reference levels or that these reference levels should be used as the regulatory framework.

Table A.2: Reference Guidelines for Release and Surface Water

Parameter	Unit	IFC Release	Portuguese Emissions	EU Surface Water
pH	S.U.	6 to 9	6 to 9	N/G
TDS	mg/kg	N/G	N/G	N/G
EC	µS/cm	N/G	N/G	N/G
Aluminum	mg/L	N/G	10	N/G
Antimony	mg/L	N/G	N/G	N/G
Arsenic	mg/L	0.1	1	N/G
Barium	mg/L	N/G	N/G	N/G
Boron	mg/L	N/G	N/G	N/G
Cadmium	mg/L	0.05	0.2	0.00045 - 0.0015[1]
Calcium	mg/L	N/G	N/G	N/G
Chloride	mg/L	N/G	N/G	N/G
Chromium	mg/L	N/G	2	N/G
Cobalt	mg/L	N/G	N/G	N/G
Copper	mg/L	0.3	1	N/G
Fluoride	mg/L	N/G	N/G	N/G
Iron	mg/L	2	2	N/G
Lead	mg/L	0.2	1	0.0072
Magnesium	mg/L	N/G	N/G	N/G
Manganese	mg/L	N/G	2	N/G
Mercury	mg/L	0.002	0.05	0.00007
Molybdenum	mg/L	N/G	N/G	N/G
Nickel	mg/L	0.5	2	0.02
Phosphorus	mg/L	N/G	10	N/G
Selenium	mg/L	N/G	N/G	N/G
Silver	mg/L	N/G	N/G	N/G
Sodium	mg/L	N/G	N/G	N/G
Sulfate	mg/L	N/G	2000	N/G
Tin	mg/L	N/G	N/G	N/G
Uranium	mg/L	N/G	N/G	N/G
Vanadium	mg/L	N/G	N/G	N/G
Zinc	mg/L	N/G	N/G	N/G

Notes:

N/G – No guideline

[1] Varies according to water hardness.

Table A.3: Drinking Water Guidelines

Parameter	Unit	Guideline
pH	S.U.	6.5-9.5
TDS	mg/kg	N/G
EC	µS/cm	2500
Aluminium	mg/L	0.2
Antimony	mg/L	0.005
Arsenic	mg/L	0.01
Barium	mg/L	0.7 [1]
Boron	mg/L	1
Cadmium	mg/L	0.005
Calcium	mg/L	N/G
Chloride	mg/L	250
Chromium	mg/L	0.05
Cobalt	mg/L	N/G
Copper	mg/L	2
Fluoride	mg/L	1.5
Iron	mg/L	0.2
Lead	mg/L	0.01
Magnesium	mg/L	N/G
Manganese	mg/L	0.05
Mercury	mg/L	0.001
Molybdenum	mg/L	N/G
Nickel	mg/L	0.02
Phosphorus	mg/L	N/G
Selenium	mg/L	0.01
Silver	mg/L	N/G
Sodium	mg/L	200
Sulfate	mg/L	250
Tin	mg/L	N/G
Uranium	mg/L	0.03 [1]
Vanadium	mg/L	N/G
Zinc	mg/L	N/G

Notes:

N/G = No guideline.

[1] Value taken from WHO guidelines in the absence of an EU threshold.

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2. British Columbia Ministry of Energy and Mines (August 1998). Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia.
3. Sobek, A.A., Schuller, W.A., Freeman, J.R. and Smith, R.M. (1978). Field and laboratory methods applicable to overburden and mine soils, EPA 600/2-78-054.
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16. World Health Organisation (2011). Guidelines for Drinking-water Quality. Fourth Edition.

APPENDIX B

Laboratory Reports

MINERALS
TEST REPORT

CLIENT

KNIGHT PIESOLD PTY LIMITED
PO Box 6837
EAST PERTH, W.A. 6892
AUSTRALIA

JOB INFORMATION

JOB CODE	: 752.0/2001796
NO. SAMPLES	: 1
NO. ELEMENTS	: 47
CLIENT ORDER NO.	: PE501-00080/04 (Job 1 of 1)
SAMPLE SUBMISSION NO.	: PE501-00080/04
PROJECT	: MINA DO BARROSO
SAMPLE TYPE	: Solid
DATE RECEIVED	: 03/02/2020
DATE TESTED	: 11/02/2020 - 21/02/2020
DATE REPORTED	: 21/02/2020
DATE PRINTED	: 21/02/2020

REPORT NOTES

TESTED BY

Intertek
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100
Email: min.aus.per@intertek.com

APPROVED SIGNATURE FOR

Craig RITCHIE
Operations Manager - Perth

This report relates specifically to the sample(s) tested that were drawn and/or provided by the client or their nominated third party to Intertek. The reported result(s) provide no warranty or verification on the sample(s) representing any specific goods and/or shipment. This report was prepared solely for the use of the client named in this report. Intertek accepts no responsibility for any loss, damage or liability suffered by a third party as a result of any reliance upon or use of this report. The results provided are not intended for commercial settlement purposes.
Except where explicitly agreed in writing, all work and services performed by Intertek is subject to our standard Terms and Conditions which can be obtained at our website: intertek.com/terms/

SIGNIFICANT FIGURES

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

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

SAMPLE STORAGE

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

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

LEGEND	X	= Less than Detection Limit		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	Ag	Al	ANC	As	B	Ba
UNITS	ppm	ppm	kgH2SO4/t	ppm	ppm	ppm
DETECTION LIMIT	0.1	50	1	1	50	0.1
DIGEST	4AB/	4AB/	ANCx/	4AB/	FP1/	4AB/
ANALYTICAL FINISH	MS	OE	VOL	MS	OE	MS
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	0.1	6.33%	9	6	<50	20.2
CHECKS						
0001 GRA Flotation Tailing Comp	0.1	6.42%		6		19.3
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp					<50	
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp			8			
0006 GRA Flotation Tailing Comp						
0007 GRA Flotation Tailing Comp						
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925	2.5	7.49%		9		431.9
0002 OREAS 97.01						
0003 AMIS0373					<50	
0004 AMIS0343						
0005 DS-1						
0006 ANC-3			97			
0007 NAG Std 3						
0008 GWS-3						
0009 0.5%NaCl-1						
0010 PD-1						
0011 TOC-1b						
BLANKS						
0001 Control Blank	<0.1	<50		<1		0.2
0002 Control Blank						
0003 Control Blank						
0004 Control Blank					<50	
0005 Control Blank						
0006 Control Blank			<1			
0007 Control Blank						
0008 Control Blank						
0009 Control Blank						
0010 Control Blank						
0011 Control Blank						

ELEMENTS	Be	Bi	C	C-Acinsol	C-CO3	Ca
UNITS	ppm	ppm	%	%	%	ppm
DETECTION LIMIT	0.1	0.01	0.01	0.01	0.01	50
DIGEST	4AB/	4AB/		C71/		4AB/
ANALYTICAL FINISH	MS	MS	/CSA	CSA	/CALC	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	36.9	0.24	0.02	0.02	<0.01	1750
CHECKS						
0001 GRA Flotation Tailing Comp	36.1	0.22	0.02			1637
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp						
0006 GRA Flotation Tailing Comp						
0007 GRA Flotation Tailing Comp						
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp				0.02		
STANDARDS						
0001 OREAS 925	2.3	32.93				4659
0002 OREAS 97.01						
0003 AMIS0373						
0004 AMIS0343						
0005 DS-1			3.07			
0006 ANC-3						
0007 NAG Std 3						
0008 GWS-3						
0009 0.5%NaCl-1						
0010 PD-1						
0011 TOC-1b				1.24		
BLANKS						
0001 Control Blank	<0.1	<0.01	<0.01			<50
0002 Control Blank						
0003 Control Blank						
0004 Control Blank						
0005 Control Blank						
0006 Control Blank						
0007 Control Blank						
0008 Control Blank						
0009 Control Blank						
0010 Control Blank						
0011 Control Blank				<0.01		

ELEMENTS	Cd	Cl	Co	lourChange	Cr	Cu
UNITS	ppm	%	ppm	NONE	ppm	ppm
DETECTION LIMIT	0.1	0.02	0.1	0	5	1
DIGEST	4AB/	CL1/	4AB/	ANCx/	4AB/	4AB/
ANALYTICAL FINISH	MS	COL	MS	QUAL	OE	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	0.2	<0.02	5.1	Yes	327	134
CHECKS						
0001 GRA Flotation Tailing Comp	0.2		5.0		348	121
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp				Yes		
0006 GRA Flotation Tailing Comp						
0007 GRA Flotation Tailing Comp						
0008 GRA Flotation Tailing Comp		<0.02				
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925	0.6		24.3		69	6103
0002 OREAS 97.01						
0003 AMIS0373						
0004 AMIS0343						
0005 DS-1						
0006 ANC-3						
0007 NAG Std 3						
0008 GWS-3						
0009 0.5%NaCl-1		0.30				
0010 PD-1						
0011 TOC-1b						
BLANKS						
0001 Control Blank	<0.1		<0.1		5	2
0002 Control Blank						
0003 Control Blank						
0004 Control Blank						
0005 Control Blank						
0006 Control Blank						
0007 Control Blank						
0008 Control Blank						
0009 Control Blank		<0.02				
0010 Control Blank						
0011 Control Blank						

ELEMENTS	EC	F	Fe	Final-pH	Fizz-Rate	Hg
UNITS	uS/cm	ppm	%	NONE	NONE	ppm
DETECTION LIMIT	10	50	0.01	0.1	0	0.01
DIGEST	Paste/	FC7/	4AB/	ANCx/	ANCx/	HG1/
ANALYTICAL FINISH	MTR	SIE	OE	MTR	QUAL	CV
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	134	189	0.98	1.7	0.0000000	<0.01
CHECKS						
0001 GRA Flotation Tailing Comp			0.73			
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp		190				
0005 GRA Flotation Tailing Comp				1.7	0.0000000	
0006 GRA Flotation Tailing Comp						
0007 GRA Flotation Tailing Comp	130					
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925			7.04			
0002 OREAS 97.01						
0003 AMIS0373						
0004 AMIS0343		2178				
0005 DS-1						
0006 ANC-3				1.8		
0007 NAG Std 3						
0008 GWS-3	319					
0009 0.5%NaCl-1						
0010 PD-1						
0011 TOC-1b						
BLANKS						
0001 Control Blank			<0.01			
0002 Control Blank						
0003 Control Blank						<0.01
0004 Control Blank						
0005 Control Blank		<50				
0006 Control Blank				1.6		
0007 Control Blank						
0008 Control Blank	<10					
0009 Control Blank						
0010 Control Blank						
0011 Control Blank						

ELEMENTS	K	Mg	Mn	Mo	Na	NAG
UNITS	ppm	ppm	ppm	ppm	ppm	kgH2SO4/t
DETECTION LIMIT	20	20	1	0.1	20	1
DIGEST	4AB/	4AB/	4AB/	4AB/	4AB/	NAGx/
ANALYTICAL FINISH	OE	OE	OE	MS	OE	VOL
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	1.86%	369	998	56.3	3.09%	<1
CHECKS						
0001 GRA Flotation Tailing Comp	1.88%	400	1019	55.4	3.28%	
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp						
0006 GRA Flotation Tailing Comp						<1
0007 GRA Flotation Tailing Comp						
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925	2.51%	1.79%	1012	1.0	2807	
0002 OREAS 97.01						
0003 AMIS0373						
0004 AMIS0343						
0005 DS-1						
0006 ANC-3						
0007 NAG Std 3						23
0008 GWS-3						
0009 0.5%NaCl-1						
0010 PD-1						
0011 TOC-1b						
BLANKS						
0001 Control Blank	<20	<20	<1	0.9	<20	
0002 Control Blank						
0003 Control Blank						
0004 Control Blank						
0005 Control Blank						
0006 Control Blank						
0007 Control Blank						5
0008 Control Blank						
0009 Control Blank						
0010 Control Blank						
0011 Control Blank						

ELEMENTS	NAGpH	NAG(4.5)	Ni	P	Pb	pH
UNITS	NONE	kgH2SO4/t	ppm	ppm	ppm	NONE
DETECTION LIMIT	0.1	1	1	50	2	0.1
DIGEST	NAGx/	NAGx/	4AB/	4AB/	4AB/	Paste/
ANALYTICAL FINISH	MTR	VOL	OE	OE	MS	MTR
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	8.1	<1	242	1865	24	8.2
CHECKS						
0001 GRA Flotation Tailing Comp			251	1920	24	
0002 GRA Flotation Tailing Comp						
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp						
0006 GRA Flotation Tailing Comp	8.1	<1				
0007 GRA Flotation Tailing Comp						8.3
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp						
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925			35	600	119	
0002 OREAS 97.01						
0003 AMIS0373						
0004 AMIS0343						
0005 DS-1						
0006 ANC-3						
0007 NAG Std 3	2.6	20				
0008 GWS-3						9.0
0009 0.5%NaCl-1						
0010 PD-1						
0011 TOC-1b						
BLANKS						
0001 Control Blank			<1	<50	<2	
0002 Control Blank						
0003 Control Blank						
0004 Control Blank						
0005 Control Blank						
0006 Control Blank						
0007 Control Blank	5.0	<1				
0008 Control Blank						5.5
0009 Control Blank						
0010 Control Blank						
0011 Control Blank						

ELEMENTS	pH Drop	S	S-SO4	Sb	Se	Sn
UNITS	NONE	%	%	ppm	ppm	ppm
DETECTION LIMIT	0.1	0.01	0.01	0.05	0.01	0.1
DIGEST	ANCx/		S71/	4AB/	SE1/	4AB/
ANALYTICAL FINISH	MTR	/CSA	OE	MS	MS	MS
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	3.8	<0.01	<0.01	0.18	0.02	15.1
CHECKS						
0001 GRA Flotation Tailing Comp		<0.01		0.18		15.2
0002 GRA Flotation Tailing Comp					0.02	
0003 GRA Flotation Tailing Comp						
0004 GRA Flotation Tailing Comp						
0005 GRA Flotation Tailing Comp	3.8					
0006 GRA Flotation Tailing Comp						
0007 GRA Flotation Tailing Comp						
0008 GRA Flotation Tailing Comp						
0009 GRA Flotation Tailing Comp			<0.01			
0010 GRA Flotation Tailing Comp						
STANDARDS						
0001 OREAS 925				1.44		16.2
0002 OREAS 97.01					0.62	
0003 AMIS0373						
0004 AMIS0343						
0005 DS-1		2.69				
0006 ANC-3						
0007 NAG Std 3						
0008 GWS-3						
0009 0.5%NaCl-1						
0010 PD-1			4.22			
0011 TOC-1b						
BLANKS						
0001 Control Blank		<0.01		<0.05		0.1
0002 Control Blank					<0.01	
0003 Control Blank						
0004 Control Blank						
0005 Control Blank						
0006 Control Blank						
0007 Control Blank						
0008 Control Blank						
0009 Control Blank						
0010 Control Blank			<0.01			
0011 Control Blank						

ELEMENTS	Sr	Th	U	V	Zn
UNITS	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	0.05	0.01	0.01	2	1
DIGEST	4AB/	4AB/	4AB/	4AB/	4AB/
ANALYTICAL FINISH	MS	MS	MS	OE	OE
SAMPLE NUMBERS					
0001 GRA Flotation Tailing Comp	58.30	1.40	12.47	8	147
CHECKS					
0001 GRA Flotation Tailing Comp	58.14	1.44	12.85	5	110
0002 GRA Flotation Tailing Comp					
0003 GRA Flotation Tailing Comp					
0004 GRA Flotation Tailing Comp					
0005 GRA Flotation Tailing Comp					
0006 GRA Flotation Tailing Comp					
0007 GRA Flotation Tailing Comp					
0008 GRA Flotation Tailing Comp					
0009 GRA Flotation Tailing Comp					
0010 GRA Flotation Tailing Comp					
STANDARDS					
0001 OREAS 925	37.36	16.07	3.02	94	448
0002 OREAS 97.01					
0003 AMIS0373					
0004 AMIS0343					
0005 DS-1					
0006 ANC-3					
0007 NAG Std 3					
0008 GWS-3					
0009 0.5%NaCl-1					
0010 PD-1					
0011 TOC-1b					
BLANKS					
0001 Control Blank	0.10	<0.01	<0.01	<2	6
0002 Control Blank					
0003 Control Blank					
0004 Control Blank					
0005 Control Blank					
0006 Control Blank					
0007 Control Blank					
0008 Control Blank					
0009 Control Blank					
0010 Control Blank					
0011 Control Blank					

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
/CALC **14/02/20 15:56**	Intertek Genalysis Perth **3244 3237** No digestion or other pre-treatment undertaken. Results Determined by calculation from other reported data.	
/CSA **21/02/20 16:11**	Intertek Genalysis Perth **3244 3237** Induction Furnace Analysed by Infrared Spectrometry	**ENV_W061, CSA : ENV_W061**
4AB/MS **11/02/20 08:06**	Intertek Genalysis Perth **3244 3237** Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Mass Spectrometry.	**4AB/ : MPL_W001, MS : ICP_W003**
4AB/OE **11/02/20 08:06**	Intertek Genalysis Perth **3244 3237** Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	**4AB/ : MPL_W001, OE : ICP_W004**
ANCx/MTR **12/02/20 08:01**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed with Electronic Meter Measurement	
ANCx/QUAL **12/02/20 08:01**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Qualitative Inspection	
ANCx/VOL **12/02/20 08:01**	Intertek Genalysis Perth **3244 3237** Acid Neutralizing Capacity Digestion Procedure. Analysed by Volumetric Technique.	
C71/CSA **10/02/20 08:29**	Intertek Genalysis Perth **3244 3237** Digestion by hot acid(s) and Induction Furnace Analysed by Infrared Spectrometry	

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
CL1/COL **12/02/20 05:47**	Intertek Genalysis Perth **3244 3237** Carbonate leach specific for Chlorine. Analysed by UV-Visible Spectrometry.	**ENV_W014, COL : ENV_W014**
FC7/SIE **11/02/20 10:48**	Intertek Genalysis Perth **3244 3237** Alkaline fusion (Nickel crucible) specific for Fluorine. Analysed by Specific Ion Electrode.	**ENV_W012, SIE : ENV_W012**
FP1/OE **11/02/20 08:14**	Intertek Genalysis Adelaide **3244 18645** Sodium peroxide fusion (Zirconia crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	**FP1/ : MPL_W011, OE : ICP_W004**
HG1/CV **11/02/20 09:09**	Intertek Genalysis Perth **3244 3237** Low temperature Perchloric acid digest specific for Mercury. Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.	
HG1/MS **11/02/20 09:09**	Intertek Genalysis Perth **3244 3237** Low temperature Perchloric acid digest specific for Mercury. Analysed by Inductively Coupled Plasma Mass Spectrometry.	**HG1/ : MPL_W008, MS : ICP_W003**
NAGx/MTR **12/02/20 07:50**	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed with Electronic Meter Measurement	
NAGx/VOL **12/02/20 07:50**	Intertek Genalysis Perth **3244 3237** Net Acid Generation Extraction of samples with H2O2 Analysed by Volumetric Technique.	
Paste/MTR **11/02/20 13:55**	Intertek Genalysis Perth **3244 3237** Water Extraction using a specific sample:water ratio. Analysed with Electronic Meter Measurement	

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
S71/OE **12/02/20 06:51**	Intertek Genalysis Perth **3244 3237** Digestion to eliminate sulphides. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	
SE1/MS **12/02/20 06:56**	Intertek Genalysis Perth **3244 3237** Aqua-Regia digest followed by Precipitation and Concentration. Specific for Selenium. Analysed by Inductively Coupled Plasma Mass Spectrometry.	
WT01 **21/02/20 16:11**	Intertek Genalysis Perth **3244 3237** Reporting weights of samples	

MINERALS
TEST REPORT

CLIENT

KNIGHT PIESOLD PTY LIMITED
PO Box 6837
EAST PERTH, W.A. 6892
AUSTRALIA

JOB INFORMATION

JOB CODE	: 752.0/2002278
NO. SAMPLES	: 1
NO. ELEMENTS	: 36
CLIENT ORDER NO.	: BR-20007 (Job 1 of 1)
SAMPLE SUBMISSION NO.	: PE501-00080/04
PROJECT	: MINA DO BARROSO
SAMPLE TYPE	: Ex-Pulp
DATE RECEIVED	: 03/02/2020
DATE TESTED	: 19/02/2020
DATE REPORTED	: 07/09/2020
DATE PRINTED	: 07/09/2020

REPORT NOTES

1. Amended Report: to include additional elements not previously reported.

TESTED BY

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APPROVED SIGNATURE FOR

Craig RITCHIE
Operations Manager - Perth

This report relates specifically to the sample(s) tested that were drawn and/or provided by the client or their nominated third party to Intertek. The reported result(s) provide no warranty or verification on the sample(s) representing any specific goods and/or shipment. This report was prepared solely for the use of the client named in this report. Intertek accepts no responsibility for any loss, damage or liability suffered by a third party as a result of any reliance upon or use of this report. The results provided are not intended for commercial settlement purposes.
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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 will be stored at a daily rate until clients written advice regarding return, collection or disposal is received. If storage information is not supplied on the submission, or arranged with the laboratory in writing the default will be to store the samples with the applicable charges. Storage is charged at $4.00 per m3 per day, expenses related to the return or disposal of samples will be charged at cost. Current disposal cost is charged at $150.00 per m3.

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

LEGEND	X	= Less than Detection Limit		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	Ag	Al	As	B	Ba	Be
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l
DETECTION LIMIT	0.01	0.01	0.1	0.01	0.05	0.1
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	MS	OE	MS	OE	MS	MS
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	<0.01	0.18	11.2	0.11	0.32	<0.1
CHECKS						
0001 GRA Flotation Tailing Comp	<0.01	0.20	10.2	0.10	1.27	<0.1
STANDARDS						
0001 GWS-3						
BLANKS						
0001 Control Blank	<0.01	<0.01	<0.1	<0.01	0.05	<0.1

ELEMENTS	Bi	Ca	Cd	Cl	Co	Cr
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	mg/l
DETECTION LIMIT	0.005	0.01	0.02	1	0.1	0.01
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	MS	OE	MS	COL	MS	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	<0.005	1.01	<0.02	9	<0.1	<0.01
CHECKS						
0001 GRA Flotation Tailing Comp	<0.005	1.10	<0.02	9	<0.1	<0.01
STANDARDS						
0001 GWS-3				28		
BLANKS						
0001 Control Blank	<0.005	<0.01	<0.02	<1	<0.1	<0.01

ELEMENTS	Cu	EC	F	Fe	Hg	K
UNITS	mg/l	uS/cm	mg/l	mg/l	ug/l	mg/l
DETECTION LIMIT	0.01	10	0.1	0.01	0.1	0.1
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	OE	MTR	SIE	OE	MS	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	0.04	90	2.0	<0.01	<0.1	2.7
CHECKS						
0001 GRA Flotation Tailing Comp	0.04	90	2.1	<0.01	<0.1	2.6
STANDARDS						
0001 GWS-3		319	0.6			
BLANKS						
0001 Control Blank	<0.01	<10	<0.1	<0.01	<0.1	0.1

ELEMENTS	Mg	Mn	Mo	Na	Ni	P
UNITS	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
DETECTION LIMIT	0.01	0.001	0.05	0.1	0.01	0.05
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	OE	OE	MS	OE	OE	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	0.46	0.057	12.64	12.5	<0.01	1.33
CHECKS						
0001 GRA Flotation Tailing Comp	0.47	0.056	12.17	12.5	<0.01	1.22
STANDARDS						
0001 GWS-3						
BLANKS						
0001 Control Blank	<0.01	<0.001	<0.05	<0.1	<0.01	<0.05

ELEMENTS	Pb	pH	S	Sb	Se	Sn
UNITS	ug/l	NONE	mg/l	ug/l	ug/l	ug/l
DETECTION LIMIT	0.5	0.1	0.05	0.01	0.5	0.1
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	MS	MTR	OE	MS	MS	MS
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	<0.5	8.4	2.18	0.54	<0.5	0.1
CHECKS						
0001 GRA Flotation Tailing Comp	<0.5	8.4	2.05	0.54	<0.5	0.1
STANDARDS						
0001 GWS-3		9.0				
BLANKS						
0001 Control Blank	<0.5	5.5	<0.05	<0.01	<0.5	<0.1

ELEMENTS	Sr	TDSEva	Th	U	V	Zn
UNITS	ug/l	mg/Kg	ug/l	ug/l	mg/l	mg/l
DETECTION LIMIT	0.02	20	0.005	0.005	0.01	0.01
DIGEST	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/	Ws3/
ANALYTICAL FINISH	MS	GR	MS	MS	OE	OE
SAMPLE NUMBERS						
0001 GRA Flotation Tailing Comp	8.72	73	<0.005	3.715	<0.01	<0.01
CHECKS						
0001 GRA Flotation Tailing Comp	8.23	55	<0.005	3.723	<0.01	<0.01
STANDARDS						
0001 GWS-3						
BLANKS						
0001 Control Blank	0.06	36	<0.005	<0.005	<0.01	<0.01

METHOD CODE DESCRIPTION

Method Code Date Tested	Analysing Laboratory NATA Laboratory Accreditation	NATA Scope of Accreditation
Ws3/COL **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed by UV-Visible Spectrometry.	*
Ws3/GR **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed by Gravimetric Technique	*
Ws3/MS **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed by Inductively Coupled Plasma Mass Spectrometry.	*
Ws3/MTR **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed with Electronic Meter Measurement	*
Ws3/OE **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.	*
Ws3/SIE **10/02/20 08:36**	Intertek Genalysis Perth **3244 3237** Water Extraction using a sample:water ratio of 1:3. Analysed by Specific Ion Electrode.	*
WT01	Intertek Genalysis Perth **3244 3237** Reporting weights of samples	*

* Denotes not on Scope of Accreditation