



Evolution
MINING

APPENDIX C

Geochemistry Assessment

**COWAL GOLD OPERATIONS
MINE LIFE MODIFICATION**

Environmental Assessment
2016



Resource
Strategies



**COWAL GOLD OPERATIONS MINE LIFE MODIFICATION
ENVIRONMENTAL GEOCHEMISTRY ASSESSMENT
OF WASTE ROCK AND TAILINGS**

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Attachment A:	Previous Test Results from Drill-Holes E46D3173, 1535DD051 and 1535DD066
Attachment B:	Current Waste Rock and Ore Sample Test Results

1.0 Introduction

Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of the Cowal Gold Operations (CGO) located approximately 38 kilometres north-east of West Wyalong in New South Wales (NSW) (Figure 1). Mining operations at the CGO are approved to 31 December 2024 and are carried out in accordance with Development Consent DA 14/98 (as modified). Evolution proposes to modify Development Consent DA 14/98 under section 75W of the NSW *Environmental Planning and Assessment Act, 1979* to facilitate the continuation of open pit mining and processing operations at the CGO for an additional 8 years (i.e. to the end of 2032) (herein referred to as the Modification).

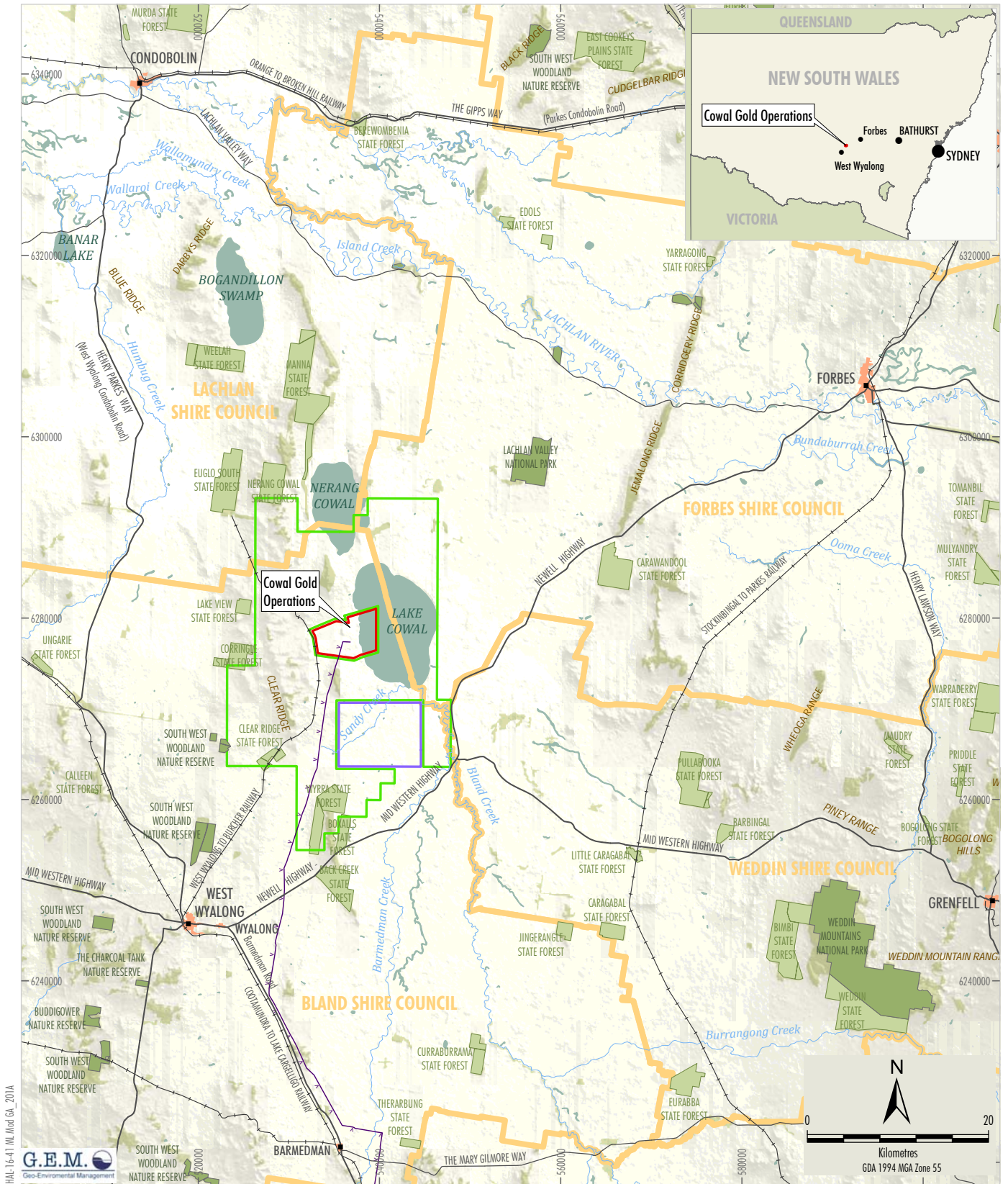
1.1 Background

The main activities associated with development of the Modification would include:

- increasing the final depth of the open pit by 70 metres (m) to enable mining of additional ore and an increase in total gold production (Figure 2);
- extending the life of the approved CGO by up to 8 years, to 31 December 2032;
- upgrades to the existing leach circuit within the processing plant to improve gold recovery;
- increasing the total life of mine ore production/volume of tailings and mined waste rock;
- maximising tailings storage capacity of the existing tailings storage facilities (TSFs) via additional lifts and converting the area between the existing TSFs into a new storage area;
- incorporation of a rock fill buttress cover on the outer slopes of the TSF embankments to provide long term stability; and
- an increase to the TSF embankment lift fleet.

The Modification would involve no change to the following key components of the existing CGO:

- mining tenement;
- lake isolation system;
- existing/approved surface development extent of the CGO;
- water management system and design objectives;



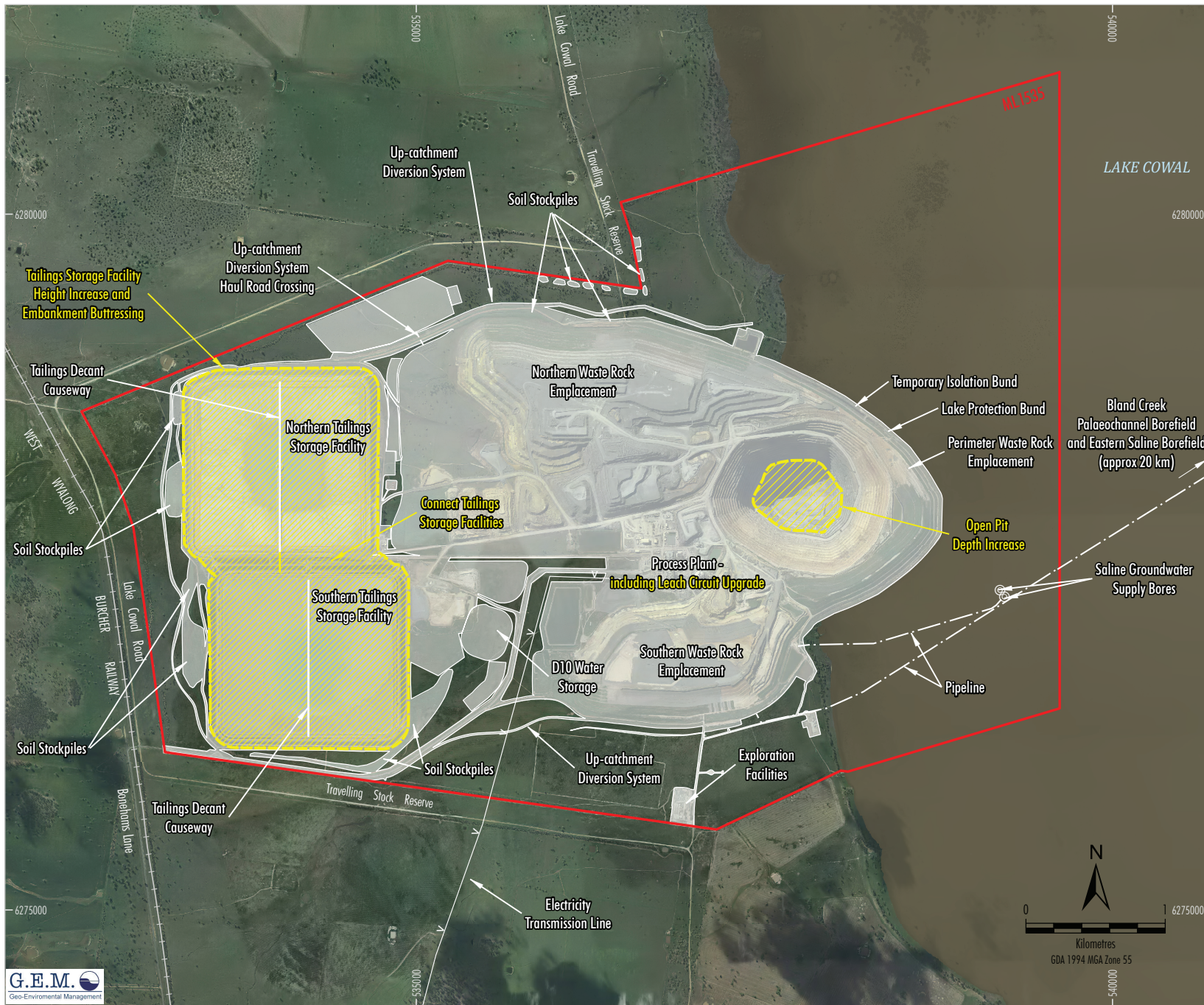
- LEGEND**
- Mining Lease Boundary (ML 1535)
 - Exploration Licence (EL 1590)
 - Exploration Licence (EL 7750)
 - National Park & Nature Reserve
 - State Forest
 - Local Government Area Boundary
 - Electricity Transmission Line
 - Railway

Source: Geoscience Australia (2006); NSW Department of Industry (2016)



CGO MINE LIFE MODIFICATION
Regional Location

Figure 1



- LEGEND**
- Mining Lease Boundary (ML 1535)
 - Approximate Extent of Approved Surface Development
 - Modification Components

Source: Evolution - Orthophoto (August 2016)



**CGO MINE LIFE MODIFICATION
Modification General Arrangement**

Figure 2

- mining methods;
- ore processing rate;
- waste rock emplacement disturbance areas;
- cyanide (CN) destruction method;
- approved CN concentration limits in the aqueous component of the tailings slurry;
- water supply sources;
- approved daily or annual extraction limits of the Bland Creek Palaeochannel Borefield;
- site access road;
- power supply;
- exploration activities;
- average or peak annual employment;
- hours of operation; or
- TSF embankment construction hours of 7 am to 6 pm.

Geo-Environmental Management Pty Ltd (GEM) was commissioned by Evolution to conduct a geochemistry assessment of the additional waste rock and tailings that would be produced as a result of the Modification, and identify any potential geochemical impacts. This report builds on the previous investigations conducted for the CGO and assesses the geochemical characteristics of the primary ore types from the expanded pit area in order to identify any potential geochemical implications for the proposed Modification, and provide the required recommendations for managing the waste emplacements, tailings storage facilities and the open pit.

1.2 Study Objectives

The objectives of this study are to:

- Assess any changes in the geochemistry of the waste rock and low-grade ore from the Modification area compared to the previous assessment characteristics, including the acid forming characteristics, multi-element composition, element enrichment and solubility, and salinity and sodicity.
- Assess any changes in the geochemistry of the tailings based on ore samples from the Modification area compared to the characteristics from the previous assessments, including the acid forming characteristics, multi-element composition, element enrichment and solubility based on the geochemical characteristics of representative ore types within the proposed new mining areas.
- Identify any waste rock materials from the Modification area that are considered to be geochemically suitable for potential use as rehabilitation media based on the acid forming characteristics, salinity and sodicity, and element enrichment and solubility characteristics of these materials.
- Evaluate any predicted changes to the pit void water quality based on the geochemical characteristics of mine rock from the Modified pit area.
- Prepare a draft waste rock and tailings geochemistry assessment report that provides:
 - an overview of the results and findings of the geochemical test work conducted to-date;
 - an evaluation of any potential salinity, sodicity, or acid and metalliferous drainage risks associated with the Modification, and the implications for managing the waste rock emplacements, tailings storage facilities, open pit and general mining operations based on current mining practices; and
 - recommendations for any changes to the current management strategies at the CGO and any identified future testing requirements.
- Prepare a final report incorporating any comments on the draft report/s provided by Evolution.

2.0 Previous Geochemical Investigations

Initial geochemical investigations were conducted by Environmental Geochemistry International Pty Ltd (EGi) prior to commencing mining operations at the approved CGO. These investigations were commissioned by North Limited and reported in the Cowal Gold Project Environmental Impact Statement (EIS) (North Limited, 1998). Subsequent geochemical investigations were commissioned by Barrick (Cowal) Limited (Barrick) to confirm the initial findings and expand the waste rock and tailings geochemical databases for mining operations, environmental management and closure planning (EGi, 2004). Since these investigations a number of targeted geochemical investigations have been conducted by GEM to address specific planning and approvals requirements for Barrick. These investigations have included the E42 Modification (GEM, 2008), the Augmentation Project (GEM, 2011a), the Extension Project Pre-Feasibility Study (GEM, 2011b), and the Extension Modification Project (GEM, 2013).

Table 1 provides an historical summary of the geochemical investigations carried out for the CGO to-date. Following is a review of the geochemical characteristics of the waste rock, low grade ore and tailings, and the implications for environmental management and closure planning at CGO from these investigations.

Table 1: Geochemical investigations conducted for the CGO to-date

Geochemical Investigations	Samples Analysed	Test Work Conducted
Environmental Geochemical Assessment of Process Tailings, Mine Rock and Surface Zone Materials (EGi, 1995)	87 Mine Rock, Ore and Surface Materials	Salinity, ABA, NAG, Multi-Elements
	2 Tailings	Salinity, ABA, NAG, Multi-Elements, Leach Columns, CN Atten.
Environmental Geochemical Assessment of Simulated Tailings (EGi, 1996)	1 Oxide Tailings	ABA, NAG, Multi-Elements, CN Speciation and Decay
Environmental Geochemistry Assessment of Proposed Mining Activities (EGi, 1997) - Appendix C in the Cowal Gold Project EIS (North Limited, 1998)	4 Tailings	ABA, NAG, Multi-Elements, CN Decay, Leach Columns
	2 TSF Sub-Soils	ABA, Soil Chemistry, Attenuation Characteristics
	3 Construction Materials	ABA, Soil Chemistry
	2 Waste Rock Composites	Salinity, ABA, Sequential Batch Extraction
Final Void Water Chemistry (EGi, 1998)	1 Groundwater	Pit Water Chemistry Modelling
Geochemical Assessment of Waste Rock and Process Tailings (EGi, 2004)	100 Mine Rock and Ore	Salinity, ABA, NAG, Multi-Elements
	8 Tailings	ABA, NAG, Multi-Elements
Cowal Gold Mine E42 Modification, Tailings and Waste Rock Geochemical Assessment (GEM, 2008)	-	Review of existing data
Review of Cowal Gold Mine Cyanide Destruction (Commonwealth Scientific and Industrial Research Organisation Minerals [CSIRO Minerals], 2010)	5 Tailings	CN Speciation and Decay
Cowal Gold Mine Augmentation Project, Environmental Geochemistry Assessment of Waste Rock and Tailings (GEM, 2011a)	30 Mine Rock and Ore	Salinity, ABA, NAG, Multi-Elements
	5 Tailings (ex-mill)	Salinity, ABA, NAG, ABCC, Multi-Elements
	5 Tailings (discharge & deposited)	Salinity, ABA, NAG, Multi-Elements
	2 Tailings Decant	pH, Salinity, Multi-Element Composition
Cowal Gold Mine Extension Project Pre-Feasibility, Environmental Geochemistry Assessment of Waste Rock, Low Grade Ore and Tailings (GEM, 2011b)	135 Waste Rock	Salinity, ABA, NAG, ABCC, Multi-Elements
	16 Low Grade Ore	Salinity, ABA, NAG, ABCC, Multi-Elements
	30 Ore	Salinity, ABA, NAG, Multi-Elements
Cowal Gold Mine Extension Modification, Environmental Geochemistry Assessment of Waste Rock and Tailings (GEM, 2013)	54 Waste Rock	Salinity, ABA, NAG, Multi-Elements
	11 Low Grade Ore	Salinity, ABA, NAG, Multi-Elements
	5 Ore	ABA, NAG, Multi-Elements

ABA = Acid-Base Account, NAG = Net Acid Generation, ABCC = Acid Buffering Characteristic Curve

2.1 pH, Salinity and Acid Forming Characteristics

The geochemical investigations carried out for the EIS indicated that reactive sulfides occur in the primary waste rock and combined primary tailings (i.e. combined flotation and carbon-in-leach [CIL] tailings). However, due to the presence of moderate to high acid neutralising capacity (ANC) in these materials they are expected to be non-acid forming (NAF). It was also reported that the oxide waste rock and tailings (i.e. CIL tailings from oxide ores) are expected to be NAF due to low reactive sulfide concentrations. These materials were also found to be moderately to highly saline. These findings were based on testing a total of 101 samples representing soil, waste rock, ore (including low grade ore) and tailings carried out by EGi (EGi, 1995; EGi, 1996; EGi, 1997). Subsequent confirmatory test work carried out by EGi in 2004 (100 waste rock and 8 tailings samples) confirmed the expected salinity and acid forming characteristics of these materials (EGi, 2004).

2.2 Metal Enrichment and Solubility

Elemental analyses carried out on selected samples for the EIS and subsequent confirmation testing indicated that the majority of the waste rock and low grade ore was expected to have high concentrations of arsenic (As) and that some of these materials were also expected to have high concentrations of cadmium (Cd), lead (Pb), selenium (Se), antimony (Sb) and zinc (Zn) (EGi, 1997; EGi, 2004). These investigations also predicted high concentrations of As, Cd, Pb, molybdenum (Mo), Sb and Zn in the oxide and primary tailings (EGi, 1997; EGi, 2004). Silver (Ag) was not included in the analytical suite for these investigations.

The potential for release of environmentally significant elements from waste rock and tailings was investigated by EGi in 1995 and 1997. Sequential batch water extractions indicated that leaching of environmentally important elements from waste rock at the CGO was unlikely to be of concern provided near neutral pH values were maintained. Column leach tests carried out on the tailings identified an initial flush of soluble copper (Cu) and Zn from the primary tailings (EGi, 1997). However, it was concluded that this release was most likely associated with the residual CN in the tailings liquor and did not represent a long-term concern (EGi, 1997).

2.3 Tailings Storage Facilities

The results of test work conducted by EGi in 1996 and 1997 indicated that CN in the tailings liquor would decay rapidly in the ponded decant liquor (i.e. in the TSFs) and in the reclaim water (i.e. in the contained water storage) due primarily to the low metal content and high proportion of free CN (75% of the weak acid dissociable cyanide [CN_{WAD}] is present as free CN) (EGi, 1997). Based on this test work it was reported that on-going CN decay in the tailings storage facilities would result in

CN_{WAD} concentrations in the reclaim water from 5 to 10 milligrams per litre (mg/L) when processing oxide ore and 10 to 15 mg/L when processing primary ore (EGi, 1997). Once discharge ceases it is expected that within 2 to 3 months the CN_{WAD} complexes in the ponded decant would decay to very low concentrations.

In April 2010 the INCO process replaced the previously used Caro's Acid method for destruction of the CN in the tailings. The CSIRO Minerals (2010) conducted a review of the changes in CN speciation within the deposited tailings and concluded that since the introduction of the INCO process at the CGO:

- the concentrations of CN_{WAD} and the metal-CN species, including Cu, iron (Fe), nickel and Zn, have remained relatively constant in the tailings; and
- thiocyanate concentrations in the tailings are generally consistent with concentrations resulting from the use of Caro's Acid since the middle of 2008.

The pH and electrical conductivity (EC) of the tailings decant liquor is monitored twice daily (day shift and night shift) at the central decant point of the TSF during tailings discharge. A review of the monitoring data collected from January 2012 to June 2012 at the southern TSF and from March 2012 to June 2012 at the northern TSF indicates a range in pH from 5.2 to 9.5 with an average (median) pH of 8.2, and a range in EC from 0.004 to 0.030 deciSiemens per metre (dS/m) with an average (mean) EC of 0.017 dS/m. These data confirm that the tailings decant liquor is typically non-saline and slightly alkaline.

Sequential batch extraction tests using sub-soil materials from the tailings storage facilities and liquors from the primary and oxide tailings were carried out by EGi in 1997 to determine the attenuation capacity of the sub-soil materials. This test work indicated that CN is only poorly attenuated whereas Cu, Zn and As are generally strongly attenuated by the soils underlying the TSFs (EGi, 1997).

2.4 Pit Void Water Quality

The geochemical test work carried out to-date indicates that the rock types that would be exposed within the pit walls would be NAF (EGi, 1995; EGi, 2004). These investigations also indicated that the primary rock types are likely to contain moderate reactive sulfides (0.5 to 1.0 percent sulfide [%S]) which have a risk of generating moderate sulfate loads when exposed to oxidation within the pit walls. However, given the regional groundwater has a total dissolved solids (TDS) count of around 40,000 to 45,000 mg/L, the contribution of sulfate salts from the pit walls to the overall TDS of pit water is expected to be negligible (EGi, 1997).

2.5 Previous Recommendations for Management

Based on the findings of the previous geochemical investigations the following recommendations for environmental management of the CGO were provided (EGi, 2004):

- The results indicate a very low likelihood of acid rock drainage (ARD) from waste rock and tailings, therefore no special management requirements would be required for ARD control. However, operational monitoring and testing should be carried out on an occasional and as needed basis to confirm the low ARD potential of waste rock with particular focus on any unexpected waste rock types or alteration types which may be exposed during mining.
- The oxide waste rock has relatively high natural salinity and the primary waste rock has the potential to generate soluble salts (i.e. due to the presence of reactive sulfides, sulfate salts such as gypsum would be generated if these materials are left exposed to surficial weathering processes).
- The waste rock and tailings are expected to be enriched with As and some of these materials are also expected to be enriched with other elements including Cd, Mo, Sb, Pb and Zn. These elements should be included in the site water monitoring program on an occasional basis to confirm the expected low leaching potential of these elements.

3.0 Geochemical Assessment Program

This assessment program utilised the results and findings from previous investigations conducted on selected drill-hole samples located within and adjacent to the proposed Modification area, in conjunction with targeted waste rock and ore drill-hole samples of material representative of the Modification area recently collected by Evolution personnel. The results and findings from three drill-hole samples previously reported by GEM, in the report titled Cowal Gold Mine Extension Project Pre-Feasibility, Environmental Geochemistry Assessment of Waste Rock, Low Grade Ore and Tailings report (GEM, 2011b), were used to assess the geochemical characteristics of the waste rock and low-grade ore within the Modification area. The location of these drill-holes, the sample details and test results relevant to the current assessment are provided in Attachment A.

3.1 Testing Methodology

The previous and current assessments included the following standard static geochemical tests and procedures:

- pH and EC determination;
- total sulfur assay;
- ANC determination;
- Net Acid Producing Potential (NAPP) calculation;
- exchangeable cation analysis;
- sulfide S analysis;
- single addition NAG test; and
- multi-element scans on solids and water extracts.

All analyses were performed by Australian Laboratory Services Pty Ltd in Perth and Brisbane, apart from the multi-element scans on the solids and water extracts for the previous investigations (2011) which were performed by Genalysis Laboratories Pty Ltd in Perth.

Following is an overview of the test procedures and how they were used to determine the geochemical classification of the test materials.

3.1.1 pH, Salinity and Sodicity Determination

pH and Electrical Conductivity Determination

The pH and EC of a sample is determined by equilibrating a solid sample in deionised water for a minimum of two hours. Variations to this test include mixing the solids with water at a ratio of 1:2 or 1:5 by weight (w/w), or as a saturated paste. Typically

a ratio of 1:2 is used for providing an indication of the inherent acidity and salinity of a material when it is initially exposed. The salinity rankings based on EC values from 1:5 extracts ($EC_{1:5}$), 1:2 extracts ($EC_{1:2}$) and saturation extracts (EC_{sat}) are provided below in Table 2.

Table 2: Electrical conductivity and corresponding salinity rankings for solid samples equilibrated in deionised water

EC_{1:5} (dS/m)	EC_{1:2} (dS/m)	EC_{sat} (dS/m)	Salinity
< 0.2	< 0.5	< 2.0	Non-Saline
0.2 to 0.3	0.5 to 1.5	2 to 4.0	Slightly Saline
0.3 to 0.4	1.5 to 2.5	4 to 8.0	Moderately Saline
> 0.4	> 2.5	> 8.0	Highly Saline

Source: Rhoades *et al.* (1999)

Exchangeable Cation Analysis

Exchangeable cation analyses are carried out to determine the sodicity of a sample. Sodicity occurs in materials that have high concentrations of exchangeable Sodium (Na) relative to the other major cations Calcium (Ca) and Magnesium (Mg), causing the material to be highly dispersive. The Exchangeable Sodium Percent (ESP) is used to determine the sodicity of a sample by comparing the amount of exchangeable Na to Ca and Mg concentrations. The ESP is used to rank materials according to sodicity and likely dispersion characteristics (Table 3).

Table 3: ESP, sodicity and likely dispersion characteristics of samples

ESP	Sodicity	Dispersion
< 6	Non-Sodic	Not Dispersive
6 to 15	Slightly Sodic	Slightly Dispersive
15 to 30	Moderately Sodic	Moderately Dispersive
> 30	Highly Sodic	Highly Dispersive

3.1.2 Acid Forming Characteristic Evaluation

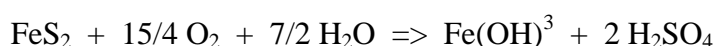
A number of test procedures are used to assess the acid forming characteristics of mine waste materials. The most widely used assessment methods are the ABA and the NAG test. These methods are referred to as static procedures because each involves a single measurement in time.

Acid-Base Account

The ABA involves laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and

weathering of silicates). The values arising from the ABA are referred to as the maximum potential acidity (MPA) and the ANC, respectively. The difference between the MPA and ANC value is referred to as the NAPP.

The MPA is calculated using the total sulfur content of the sample. This calculation assumes that all of the sulfur measured in the sample occurs as pyrite (FeS₂) and that the pyrite reacts under oxidising conditions to generate acid according to the following reaction:



According to this reaction, the MPA of a sample containing 1 %S as pyrite would be 30.6 kilograms of H₂SO₄ per tonne of material (i.e. kg H₂SO₄/t). Hence the MPA of a sample is calculated from the total sulfur content using the following formula:

$$\text{MPA (kg H}_2\text{SO}_4\text{/t)} = (\text{Total \%S}) \times 30.6$$

The use of the total sulfur assay to estimate the MPA is a conservative approach because some sulfur may occur in forms other than pyrite. Sulfate sulfur and native sulfur, for example, are non-acid generating sulfur forms. Also, some sulfur may occur as other metal sulfides (e.g. covellite, chalcocite, sphalerite and galena) that yield less acidity than pyrite when oxidised.

The acid formed from pyrite oxidation would to some extent react with acid neutralising minerals contained within the sample. This inherent acid neutralisation is quantified in terms of the ANC and is determined using the Modified Sobek method. This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back titrating the mixture with standardised sodium hydroxide to determine the amount of unreacted HCl. The amount of acid consumed by reaction with the sample is then calculated giving the ANC expressed in the same units as the MPA, which is kg H₂SO₄/t.

Determination of the ANC using the Modified Sobek provides an indication of the total neutralisation capacity of a material. However, in some materials not all mineral phases would be readily available to neutralise sulfide generated acidity. For these material types ABCCs can be used to determine the amount of ANC that is available to neutralise any sulfide generated acidity under more natural weathering conditions. The ABCCs are obtained by slow titration of a sample with acid while continuously monitoring pH and plotting the amount of acid added against pH. Careful evaluation of the plot provides an indication of the portion of ANC within a sample that is readily available for acid neutralisation.

The NAPP is a theoretical calculation commonly used to indicate if a material has the potential to produce acid. It represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H₂SO₄/t and is calculated as follows:

$$\text{NAPP} = \text{MPA} - \text{ANC}$$

If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, which indicates that the material may be acid generating.

The ANC/MPA ratio is used as a means of assessing the risk of acid generation from mine waste materials. A positive NAPP is equivalent to an ANC/MPA ratio less than 1, and a negative NAPP is equivalent to an ANC/MPA ratio greater than 1. Generally, an ANC/MPA ratio of 3 or more signifies that there is a high probability that the material is not acid generating.

Figure 3 is an ABA plot which is commonly used to provide a graphical representation of the distribution of sulfur and ANC in a sample set. The plotted line shows where the NAPP = 0 (i.e. ANC = MPA or ANC/MPA=1) (Figure 3). Samples that plot to the lower-right of this line have a positive NAPP and samples that plot to the upper left of it have a negative NAPP. Figure 3 also shows the plotted lines corresponding to ANC/MPA ratios of 2 and 3.

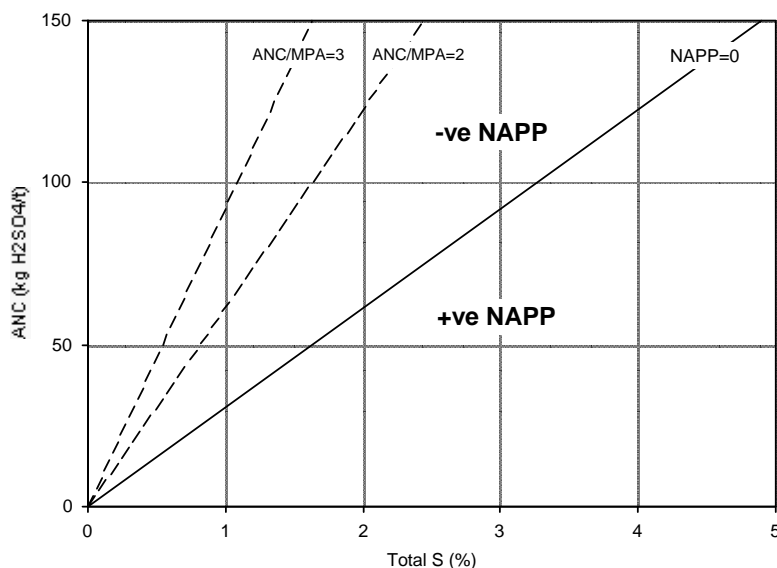


Figure 3: Typical acid-base account plot

Net Acid Generation Test

The NAG test involves the addition of hydrogen peroxide to a sample to oxidise the contained reactive sulfide, then measurement of pH and titration of any net acidity produced. A Net Acid Generation pH (NAGpH) < 4.5 indicates that acid conditions remain after all acid generating and acid neutralising reactions have taken place and a NAGpH > 4.5 indicates that any generated acidity has been neutralised. Therefore, the NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and is used to complement the results of the theoretical NAPP predictions.

3.1.3 Multi-Element Analysis

Multi-element scans are primarily carried out on solid samples to identify any elements that are present at concentrations that may be of environmental concern with respect to water quality and revegetation. The assay results from the solid samples are compared to the average crustal abundance for each element to provide a measure of the extent of element enrichment. The extent of enrichment is reported as the Geochemical Abundance Index. However, identified element enrichment does not necessarily mean that an element would be a concern for revegetation, water quality, or public health and this technique is used to identify any significant element enrichments that warrant further examination.

Multi-element scans are also performed on liquor samples to determine the chemical composition of the solution and identify any elemental concerns for water quality.

3.2 Geochemical Classification

The acid forming potential of a sample is classified on the basis of the ABA and NAG test results into one of the following categories:

- Barren.
- Non-Acid Forming (NAF).
- Potentially Acid Forming (PAF).
- Acid Forming (AF).
- Uncertain (UC).

Barren

A sample classified as barren essentially has no acid generating capacity and no acid buffering capacity. This category is most likely to apply to highly weathered materials. In essence, it represents an 'inert' material with respect to acid generation. The criteria used to classify a sample as barren may vary between sites, but it generally applies to materials with a total sulfur content < 0.1 %S and an ANC < 5 kg H₂SO₄/t.

Non-Acid Forming

A sample classified as NAF may or may not have a significant sulfur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulfide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. A sample is usually defined as NAF when it has a negative NAPP and a final NAGpH ≥ 4.5 .

Potentially Acid Forming

A sample classified as PAF always has a significant sulfur content, the acid generating potential of which exceeds the inherent ANC of the material. This means there is a high risk that such a material, even if pH circum-neutral when freshly mined or processed, could oxidise and generate acidic drainage if exposed to atmospheric conditions. A sample is usually defined as PAF when it has a positive NAPP and a final NAGpH < 4.5 .

Acid Forming

A sample classified as AF has the same characteristics as the PAF samples however these samples also have an existing pH of less than 4.5. This indicates that acid conditions have already been developed, confirming the acid forming nature of the sample.

Uncertain

An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAGpH > 4.5 , or when the NAPP is negative and NAGpH < 4.5).

Figure 4 shows a typical geochemical classification plot for mine waste materials where the NAPP values are plotted against the NAGpH values. Samples that plot in the upper left quadrante, with negative NAPP values and NAGpH values greater than 4.5, are classified as NAF. Those that plot on the lower right quadrante, with positive NAPP values and NAGpH values of 4.5 or less, are classified as PAF. Samples that plot in the upper right or lower left quadrates of this plot have an uncertain geochemical classification (UC) due to a contradiction in the acid-base and NAG test results, and further testing is required to determine the geochemical classification of these material types.

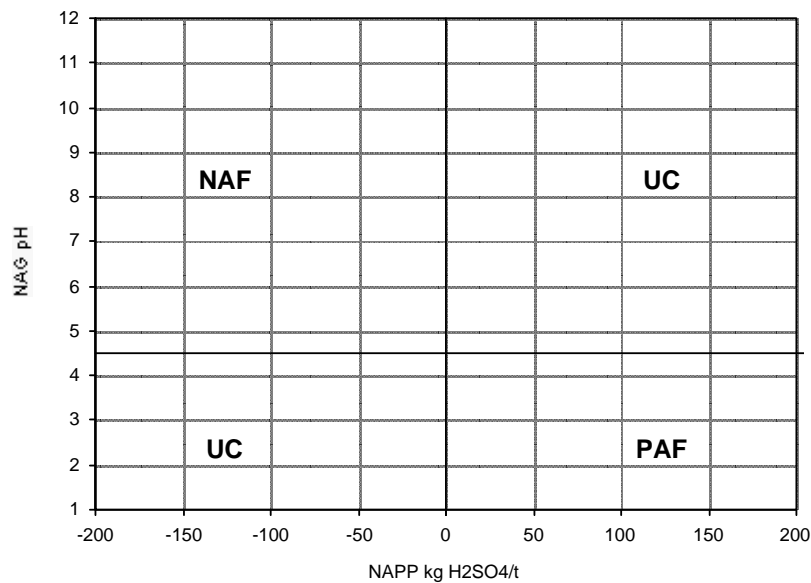


Figure 4: Typical geochemical classification plot

3.3 Sample Selection and Preparation

A total of 18 drill-hole samples of the primary (fresh) Diorite, including 10 waste rock samples and 8 ore samples, were collected by Evolution personnel as part of the CGO operational geochemistry monitoring program to confirm the low ARD potential of any unexpected waste rock types or alteration types which may be exposed during mining, as previously recommended by GEM (GEM, 2013). Table 4 provides the sample type and depth interval information for these samples. The ore samples were included in this program in order to provide a comparative indication of any changes to the geochemical characteristics of the tailings resulting from the proposed development.

Table 4: Sample details for the current investigations.

Material Type	Sample ID	Depth (m)			Lithology
		From	To	Interval	
Waste Rock	11494	544	545	1	Diorite
	19170	440	441	1	Diorite
	19173	443	444	1	Diorite
	19117	390	391	1	Diorite
	19120	393	394	1	Diorite
	19167	437	438	1	Diorite
	19178	447	448	1	Diorite
	19175	444	445	1	Diorite
	11496	546	547	1	Diorite
11498	548	549	1	Diorite	
Ore	20866	625	626	1	Diorite
	11527	574	575	1	Diorite
	11521	569	570	1	Diorite
	11514	562	563	1	Diorite
	11513	561	562	1	Diorite
	11505	554	555	1	Diorite
	20868	627	628	1	Diorite
	12031	572	573	1	Porphyritic diorite

4.0 Waste Rock and Low Grade Ore Geochemistry from Previous Assessment

The geochemical test results for the waste rock and low grade ore samples from the previous investigations are provided in Attachment A, and a summary of the acid forming characteristic results is provided in Table 5.

Table 5: Summary of the pH and EC, and acid forming characteristics for the waste rock and low grade ore samples from the previous investigations.

Waste Type		pH _{1:2}	EC _{1:2}	Total S	MPA	ANC	NAPP
			(dS/m)	(%S)	(kg H ₂ SO ₄ /t)		
Transported Mat. (1 sample)		6.7	2.872	0.02	1	2	-1
Saprolite (4 samples)	Min	6.1	2.861	0.03	1	1	-1
	Max	7.7	6.022	0.04	1	2	1
	Aver.	7.4	5.826	0.04	1	1	0
Saprock (10 samples)	Min	6.2	0.704	<0.01	0	1	-287
	Max	9.2	5.299	0.02	1	287	0
	Aver.	6.9	1.797	0.01	0	5	-5
Volcaniclastic (18 samples)	Min	8.4	0.314	<0.01	0	27	-152
	Max	9.0	0.679	0.56	17	163	-16
	Aver.	8.9	0.508	0.33	10	73	-65
Intrusives (3 samples)	Min	8.5	0.354	<0.01	0	51	-150
	Max	9.0	0.475	0.10	3	153	-51
	Aver.	8.6	0.366	0.01	0	53	-52
Extrusives (1 sample)		8.8	0.534	0.58	18	141	-123
Fault Zone (2 samples)	Min	8.4	0.595	0.49	15	134	-171
	Max	8.9	0.660	1.00	31	186	-103
	Aver.	8.7	0.628	0.75	23	160	-137
Waste Rock (39 samples)	Min	6.1	0.314	<0.01	0	1	-287
	Max	9.2	6.022	1.00	31	287	1
	Aver.	8.6	0.595	0.08	2	40	-36
Low Grade Ore (5 samples)	Min	6.4	0.508	<0.01	0	4	-63
	Max	8.6	3.498	0.83	25	88	-3
	Aver.	7.7	1.029	0.01	0	15	-14

NOTE: Because the pH is a log-scale the average pH values presented are median (geometric mean) values.

NOTE: Shaded Waste Rock row represents a summary of the Transported Material, Saprolite, Saprock, Volcaniclastic, Intrusives, Extrusives and Fault Zone samples combined.

4.1 pH, Salinity and Sodicity

The pH of these samples is typically neutral to slightly alkaline. The pH_{1:2} values for the waste rock samples range from 6.1 to 9.2 with an average (median) of 8.6 and for the low grade ore samples range from 6.4 to 8.6 with an average (median) of 7.7 (Table 5).

The EC of these samples ranges widely from non-saline to highly saline with EC_{1:2} values for the waste rock samples ranging from 0.314 to 6.022 dS/m and for the low grade ore samples ranging from 0.508 to 3.498 dS/m. As expected, the saline samples (i.e. EC_{1:2} > 0.5 dS/m) are restricted to the oxide materials, including Transported Material, Saprolite and Saprock.

The ESP and EC_{1:2} values for selected samples are plotted on Figure 5 to show the salinity and sodicity rankings. This plot shows that the selected samples range from non-sodic to highly sodic. The oxide waste rock samples are generally moderately to highly sodic, with ESP values ranging from 20.0 to 49.3 %, and the primary waste rock types (i.e. Volcaniclastics, Intrusives, Extrusives and Fault Zone material) are ranked as non-sodic, with ESP values ranging from 4.5 to 6.3 %.

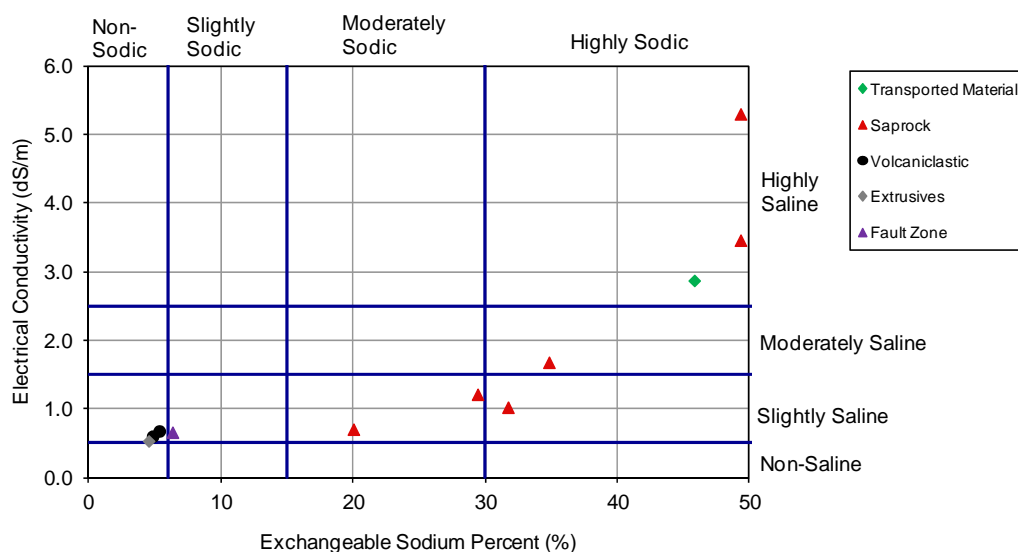


Figure 5: Salinity and sodicity ranking for selected waste rock samples from the previous investigations.

4.2 Acid Forming Characteristics

The acid forming characteristics results from the previous assessment of these waste rock and low grade ore are provided in Attachment A (Table A1). The total sulfur content for the waste rock samples ranges from <0.01 to 1.00 %S with an average of 0.08 %S, and the low grade ore samples range from <0.01 to 0.83 %S. As expected,

the oxide samples, including the Transported Material, Saprolite and Saprock, typically have low sulfur contents, below 0.05 %S.

The ANC values for the waste rock samples range widely from 1 to 287 kg H₂SO₄/t with an average of 40 kg H₂SO₄/t. However, the oxide waste samples typically have a relatively low ANC with average values <5 kg H₂SO₄/t, while the primary waste samples, including the Volcaniclastics, Intrusives, Extrusives and Fault Zone material, typically have a moderate to high ANC with average values ranging from 53 to 160 kg H₂SO₄/t. The ANC of the low grade ore samples range from low to moderate with values ranging from 4 to 88 kg H₂SO₄/t and an average value of 15 kg H₂SO₄/t.

Figure 6 is a plot of the total sulfur content against the ANC value for the different waste rock types and low grade ore. Samples that plot above the NAPP=0 (ANC/MPA=1) line are NAPP negative indicating an excess in acid buffering capacity over potential acidity. Samples that plot above the ANC/MPA=2 line have at least a two-fold excess in acid buffering over acid potential and those that plot above the ANC/MPA=3 line have a three-fold excess. This plot shows that, apart from one sample with an anomalously high ANC of 287 kg H₂SO₄/t (i.e. sample 1535DD066/4), the oxide waste rock samples have low sulfur contents (< 0.1 %S) and ANC values (< 10 kg H₂SO₄/t), and are considered to be geochemically barren. The primary waste rock samples are all NAPP negative and the majority of these samples (i.e. all but two samples) have ANC/MPA ratios greater than 3, while the low grade ore samples are all NAPP negative with ANC/MPA ratios greater than 3 indicating that these materials have a significant excess in acid buffering over inherent acid potential.

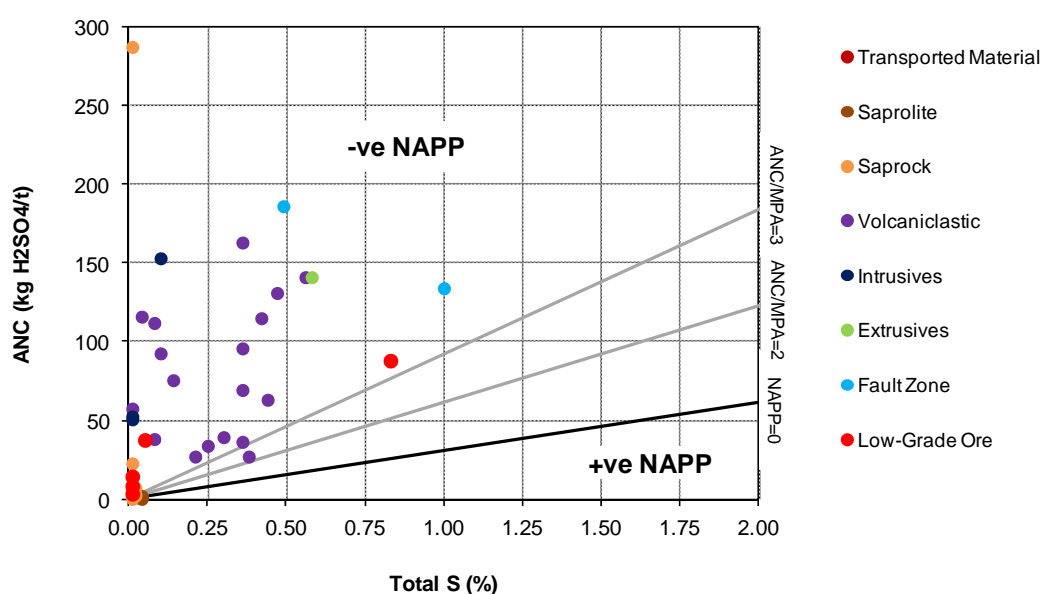


Figure 6: Acid-base account plot for the waste rock and low grade ore samples from the previous investigations.

Based on the acid-base results, eight of these samples were selected for NAG testing. The samples selected for NAG testing have an ANC/MPA ratio of less than 4 and a total sulfur content greater than 0.01 %S. The results of these tests are provided in Attachment A (Table A1). The NAPP values for these samples are plotted against the NAGpH on Figure 7 showing that all of the NAPP negative and zero samples have NAGpH values above 4.5 confirming that these samples are all NAF. The NAPP positive sample (sample 1535DD051/3) also has NAGpH value above 4.5 and based on this, this sample is classified as UC. However, the sulfide-sulfur content of this oxidised (saprolite) sample is 0.01 %S indicating that the majority of the contained sulfur most likely occurs as non-reactive sulfate. Based on this, it is expected that the material represented by this sample would be NAF.

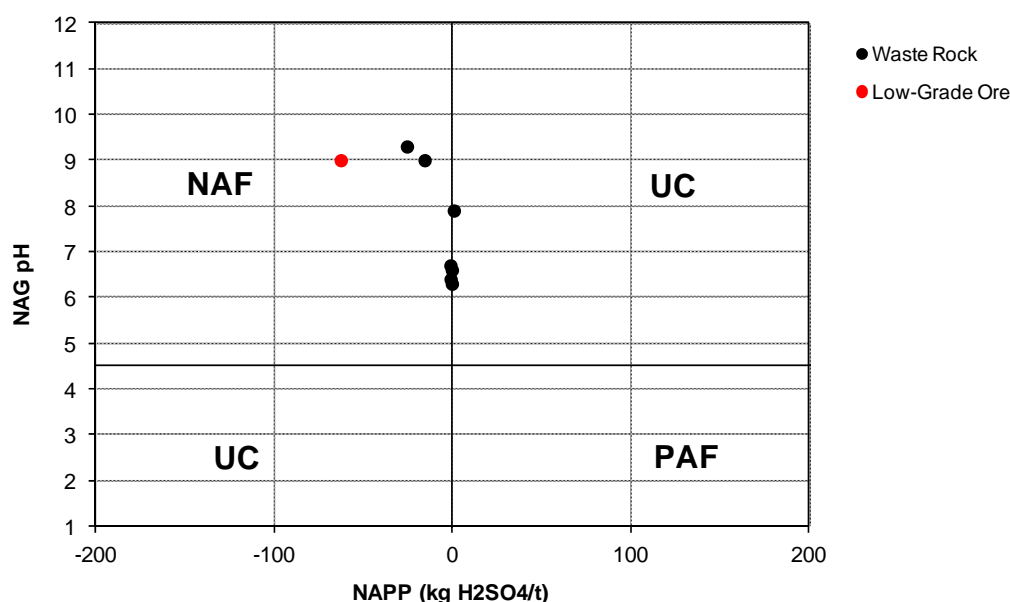


Figure 7: Geochemical classification plot for the waste rock and low grade ore samples from the previous investigations.

Based on these results it is expected that the waste rock and low grade ore from the Modification area would be NAF and that some of these materials are likely to be relatively acid consuming due to moderate to high ANC values resulting in NAPP values of less than minus 100 kg H₂SO₄/t. However, the primary waste rock and low grade ore materials are expected to contain moderate sulfides and, although NAF, these materials are likely to develop saline conditions, similar to the oxide waste rock, if allowed to oxidise when exposed during mining.

Selected ABCC determinations, provided in Attachment A (Figure A2) indicate that all of the ANC in most of the high ANC materials is expected to be readily available to neutralise any sulfide generated acidity.

4.3 Metal Enrichment and Solubility

Multi-element scans were performed on 7 of the waste rock samples and 4 of the low-grade ore samples. The results from these analyses and the geochemical abundance indices are provided in Attachment A (Tables A3 and A4). These results indicate that As and Sb are significantly enriched in the majority of the waste rock and low grade ore samples and that Ag, Cd and to a lesser extent Se, are significantly enriched in some of these samples. The average crustal abundance and concentration ranges of As and Sb in the waste rock and low grade ore samples are provided in Table 6.

Table 6: Average crustal abundance and concentration range for elements significantly enriched in the waste rock and low grade ore samples from previous investigations.

Element	Average Crustal Abundance (mg/kg)	Concentration Range (mg/kg)	
		Waste Rock	Low Grade Ore
As	1.5	14.2 - 73.2	11.9 - 51.0
Sb	0.2	2.55 - 5.37	2.71 - 3.74

mg/kg = milligrams per kilogram.

Previous investigations identified the significant enrichment of these elements in the waste rock and low grade ore from the current mine pit along with a number of other elements including Ag, Cd, Pb, Se and Zn (EGi, 1995; EGi, 2004).

Multi-element scans were performed on water extracts (1 part sample/2 parts deionised water) from these samples in order to identify any elements that are likely to be readily soluble in the waste rock and low grade ore. The results from these scans are presented in Attachment A (Table A5) and indicate that the high salinity in the oxide waste rock is due to a combination of chloride and sulfate salts (e.g. NaCl and CaSO₄). Consistent with the previous investigations (EGi, 1995; EGi, 2004), these results indicate that the contained metals are expected to be relatively insoluble under the prevailing near neutral pH conditions of these materials.

5.0 Waste Rock and Ore Geochemistry

The geochemical test results for the Diorite waste rock and ore samples collected as part of the CGO operational geochemistry monitoring program (GEM, 2013) are provided in Attachment B and a summary of the acid forming characteristic results is provided in Table 7.

A total of 18 drill-hole samples of the primary (fresh) Diorite, including 10 waste rock samples and 8 ore samples, were collected by Evolution personnel as part of the CGO operational geochemistry monitoring program to confirm the low ARD potential of any unexpected waste rock types or alteration types which may be exposed during mining, as previously recommended by GEM (GEM, 2013). Table 4 provides the sample type and depth interval information for these samples. The ore samples were included in this program in order to provide a comparative indication of any changes to the geochemical characteristics of the tailings resulting from the proposed development.

Table 7: Summary of the pH and EC, and acid forming characteristics for the waste rock and ore samples from the current investigations.

Material Type	pH _{1:2}	EC _{1:2} (dS/m)	Total S (%S)	MPA	ANC	NAPP	NAGpH	
				(kg H ₂ SO ₄ /t)				
Waste Rock (10 samples)	Min	8.9	0.096	0.01	0	55	-113	9.8
	Max	9.7	0.284	1.15	35	117	-20	11.1
	Aver.	9.1	0.126	0.04	1	87	-83	10.6
Ore (8 samples)	Min	8.6	0.098	0.71	22	51	-87	8.4
	Max	9.4	0.289	2.64	81	111	-9	10.0
	Aver.	9.0	0.171	1.08	33	69	-30	9.2

5.1 pH and Salinity

The pH of these samples is typically slightly to moderately alkaline with pH_{1:2} values for the waste rock samples ranging from 8.9 to 9.7 and for the ore samples ranging from 8.6 to 9.4. With EC_{1:2} values ranging from 0.096 to 0.289 dS/m, all of these samples are considered to be non-saline. The EC_{1:2} values are consistent for the different material types, waste rock and ore, with average values 0.126 and 0.171 dS/m, respectively.

5.2 Acid Forming Characteristics

The acid forming characteristics results for the waste rock and ore samples are provided in Attachment B (Table B1). The total sulfur content for the waste rock samples is relatively low, ranging from <0.01 to 1.15 %S with an average of 0.04 %S,

and for the ore samples they are considerably higher, ranging from 0.71 to 2.64 %S with an average of 1.08 %S. Typically 80 to 100% of the total sulfur content occurs as sulfide-sulfur in these samples.

Unlike the highly variable ANC values from low to relatively high detected in the previous drill-hole samples, the ANC of these samples are all relatively high ranging from 55 to 117 kg H₂SO₄/t in the waste rock samples, and from 51 to 111 kg H₂SO₄/t in the ore samples.

The total sulfur contents are plotted against the ANC values for these waste rock and ore samples on Figure 8. This plot shows that all of the samples plot above the NAPP=0 line and are NAPP negative, indicating an excess in acid buffering capacity over potential acidity. All but one of the waste rock samples plot above the ANC/MPA=3 line indicating a three-fold excess in the acid buffering capacity over potential acidity, whereas the ANC/MPA ratio values for the ore samples are typically between 1.5 and 2.5.

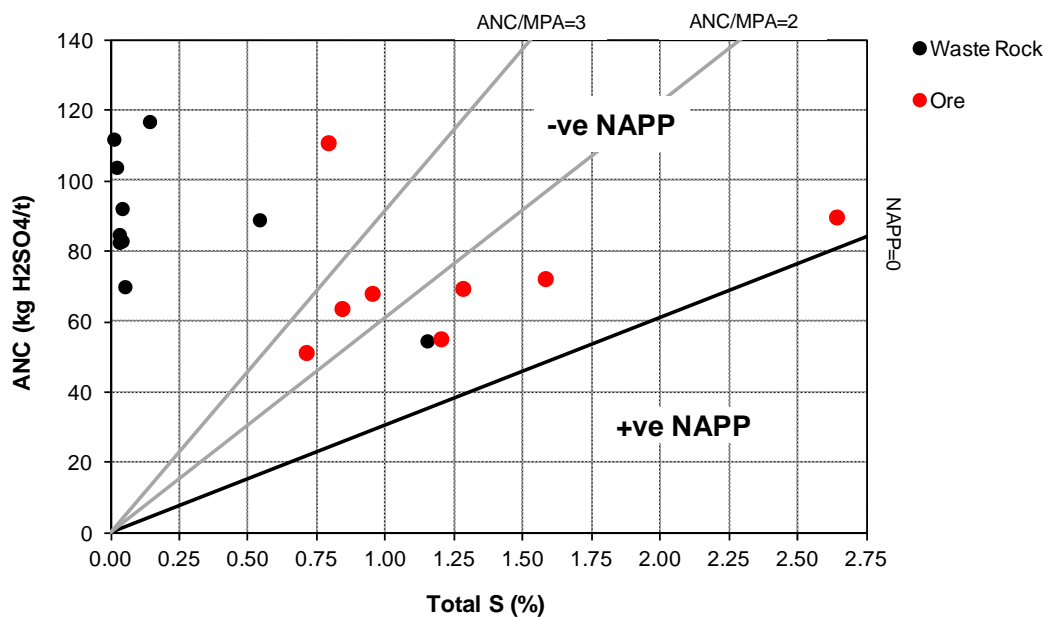


Figure 8: Acid-base account plot for the waste rock and ore samples from the current investigations.

The NAGpH values reported from the standard static NAG test performed on all of these samples are relatively high ranging from 8.4 to 11.1 with an average of 10.6 for the waste rock samples and 9.2 for the ore samples. The NAPP values for these samples are plotted against the NAGpH on Figure 9 confirming that all of these samples are classified as NAF.

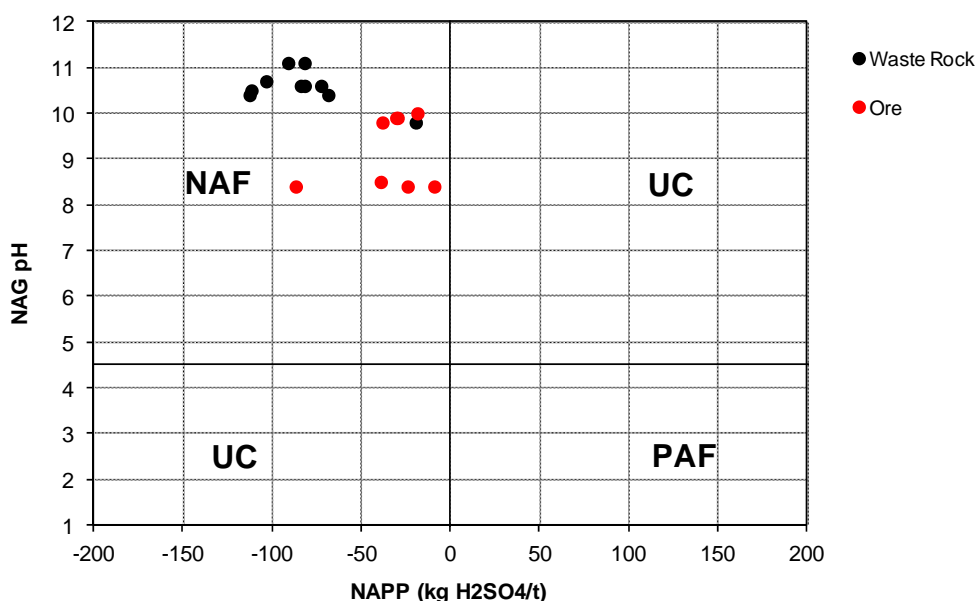


Figure 9: Geochemical classification plot for the waste rock and ore samples from the current investigations.

Based on the assumption that all of the sulfur and carbonate contained within the Diorite ore would report to the tailings during processing, it is expected that the tailings, although being relatively reactive due to a relatively high sulfur and moderate to high ANC, would be NAF.

5.3 Element Composition

Multi-element scans were performed on all of the geochemistry monitoring waste rock and ore samples. The results from these analyses and the geochemical abundance indices for selected environmentally sensitive elements are provided in Attachment B (Tables B2 and B3). The results from these analyses indicate that, consistent with the previous findings (EGi, 1995; EGi, 2004; GEM, 2011; GEM, 2013), As and Sb are significantly enriched in the majority of the waste rock and ore samples and that the majority of the ore samples are also significantly enriched in Ag, Cd and Zn. One of the waste rock samples (sample no. 11496) is also significantly enriched in Ag, Cd and Zn, and it is expected that this sample represents the low-grade ore material.

The average crustal abundance and concentration ranges of As and Sb in the waste rock and Ag, As, Cd, Sb and Zn in the ore samples are provided in Table 8.

Table 8: Average crustal abundance and concentration range for elements significantly enriched in the waste rock and ore samples from the current investigations.

Element	Average Crustal Abundance (mg/kg)	Concentration Range (mg/kg)	
		Waste Rock	Ore
Ag	0.07	-	0.319 – 4.370
As	1.5	4.71 – 147.00	28.00 – 175.50
Cd	0.11	-	0.148 – 19.050
Sb	0.2	0.84 – 3.06	0.91 – 3.33
Zn	75	-	105 – 2400

6.0 Conclusions and Recommendations

For this assessment the results and findings of 44 drill-hole samples representing the waste rock and low grade ore from within or adjacent to the proposed Modification area from a previous assessment conducted by GEM (GEM, 2011b) were utilised to identify any geochemical implications for management of the waste rock emplacements, low grade ore stockpiles, TSFs and the mine pit associated with the proposed development. In addition to these results, 18 drill-hole samples, including 10 waste rock and 8 ore samples, collected from the Modification area and submitted for geochemical characterisation as part of the recommended operational geochemistry monitoring program (GEM, 2013) were used to confirm the NAF nature of the waste rock and to allow for the prediction of any changes to the geochemical characteristics of the tailings resulting from the proposed development.

Following is a summary of the findings from the previous investigations and the resulting management strategies developed for the CGO. These findings are compared to those for the proposed development in order to identify any potential changes that may be required for the management of the waste rock emplacements, low grade ore stockpiles, TSFs, mine pit and the site water quality monitoring programs due to the development.

6.1 Waste Rock Emplacements

The previous investigations indicated that the waste rock from the current pit was expected to be NAF and that the oxide waste rock was expected to be naturally saline. Although the primary waste rock was expected to be non-saline, due to the relatively high reactive sulfide content it was reported that this material had a risk of becoming saline if allowed to oxidise. The waste rock was also found to be significantly enriched with As, Cd, Pb, Se, Sb and Zn. However, it was predicted that, under the near neutral pH condition of the exposed waste rock, these and any other environmentally important elements would remain insoluble.

Based on these findings the following recommendations were provided:

- Due to the low ARD risk no special management requirements would be required for ARD control of the waste rock. However, operational monitoring and testing would need to be carried out on an occasional and as needed basis to confirm the low ARD potential of waste rock with particular focus on any unexpected waste rock types or alteration types which may be exposed during mining.
- Due to the salinity of the oxide waste rock and the potential of the primary waste rock to become saline, release of sulfate salts, such as gypsum, may occur if these materials are left exposed to surficial weathering processes.

- Due to the significant enrichment of As, Cd, Pb, Se, Sb and Zn, it was recommended that these elements be included in the site water monitoring program on an occasional basis to confirm the expected low leaching potential of these elements.

The results of this assessment indicate that:

- the oxide waste rock is generally expected to have a near-neutral pH and to be moderately to highly saline and moderately to highly sodic, and the primary waste rock is generally expected to be slightly alkaline, and non-saline and non-sodic;
- all waste rock types are expected to be NAF with the oxide waste rock being geochemically barren (i.e. low sulfur and low ANC) and the primary waste rock being relatively reactive (i.e. moderate to high sulfur and ANC); and
- the majority of the waste rock is expected to be significantly enriched with As and Sb, and some of the waste rock may be significantly enriched with Ag, Cd, Pb and Se.

These results confirm that the waste rock from the current pit and Modification area are geochemically comparable, indicating that the management strategies currently employed for the waste rock emplacements would not need to be modified to accommodate the proposed Modification. Because the waste rock from the Modification area is expected to be geochemically comparable to that from the current pit, the same controls (i.e. the exclusion of materials with higher reactive sulfide contents) on the use of waste rock for rehabilitation (rock armouring) would apply to avoid the development of saline conditions.

6.2 Low Grade Ore Stockpiles

The previous investigations reported that the low grade ore from the current pit was expected to be NAF. This material was found to have a high reactive sulfide content and moderate to high ANC, and therefore, the material was identified to be at risk of becoming highly saline if allowed to oxidise. The low grade ore was also expected to be significantly enriched with As, Cd, Pb, Se, Sb and Zn, however, it was found that under the predicted near neutral pH conditions, the contained environmentally important elements would most likely remain insoluble.

Because of the predicted NAF nature and low ARD risk of the low grade ore, no special management was required for ARD control of the stockpile. However, due to the enrichment of As, Cd, Pb, Se, Sb and Zn it was recommended that these elements be included in the water monitoring program for the stockpile.

This geochemical assessment indicates that the low grade ore from the Modification area is expected to have a moderate sulfur content, with a moderate to high ANC and this material classified as NAF. As with the low grade ore from the current mining operation, this material has a risk of becoming saline if the contained sulfides are allowed to oxidise. Additional to the elements found to be enriched in the existing low grade ore (i.e. As, Cd, Pb, Se, Sb and Zn), the low grade ore from the Modification area is also expected to have significantly enriched concentrations of Ag.

Based on these findings no changes to the current management strategy for the low grade ore stockpile would be required for the Modification.

6.3 Tailings Storage Facilities

Previous analysis of the tailings from the current operations included static geochemical characterisation, multi-element analysis, CN speciation, decay analysis, leach column testing of flotation tailings and primary CIL residues produced from oxide and primary ores. These analyses found that the oxide tailings had a low reactive sulfide content and that the primary tailings had a relatively high reactive sulfide content. However, both tailings types had a moderate to high ANC and were classified as NAF. The oxide tailings were also found to be potentially saline and although the primary tailings were non-saline, the risk of this material developing saline conditions was reported due to the relatively high reactive sulfide content. The oxide and primary tailings were found to be significantly enriched with As, Cd, Mo, Pb, Sb and Zn, however, under the near neutral pH conditions, none of the contained elements were found to be soluble.

Due to the salinity concerns for the oxide and primary tailings it was recommended that the TSF design include a cover in order to avoid development of a salt-pan. Review of recent monitoring data indicates that the tailings decant liquor is typically non-saline and slightly alkaline.

A comparison between the geochemical characteristics of the ore materials from the current operations and proposed Modified pit was used to predict the likely geochemical characteristics of the tailings. The analysis of ore samples from the current pit indicated that the ore had a relatively high reactive sulfide content, and due to a moderately high ANC it was classified as NAF. The ore was also found to be enriched with Ag, As, Cd, Pb, Sb, Se and Zn. Due to the consistency in alteration and mineralisation between the current pit and the Modification area it was expected that the ore and therefore the tailings would be geochemically similar.

The results of the analysis of samples representing the ore from the Modification area confirmed the NAF classification of the ore and indicated the enrichment of Ag, As, Cd, Sb and Zn, confirming the geochemical consistency between the ore of the current pit and the pit Modification area.

Based on these findings it is expected that the tailings from the proposed Modification area would be geochemically similar to the current tailings and the adopted management strategy for the existing TSFs would not need to be modified for the Modification.

6.4 Pit Void Water Quality

The results of this assessment indicate that the oxide and primary waste rock types from the pit Modification area are geochemically similar to those extracted from the pit in the past based on the previous investigations. Based on these findings it is expected that the rock to be exposed in the pit walls would be NAF. However the oxide wall rock is expected to be moderately to highly saline and the primary wall is expected to become saline when oxidised. Due to these characteristics the wall rocks that would be exposed in the proposed Modification area are expected to generate a significant sulfate salt load within the pit void water. However, as noted in previous investigations for the CGO (EGi, 1997), given the regional groundwater has a TDS of around 40,000 to 45,000 mg/L, the contribution of sulfate salts from the pit walls to the overall TDS of pit water is expected to be negligible.

6.5 Site Water Management

The findings of the previous geochemical investigations at the CGO have been used to help develop the site water quality monitoring programs for the pit, waste rock emplacements, low grade ore stockpile, run-of-mine (ROM) ore stockpile, and tailings storage facilities. The parameters include EC, pH, turbidity, dissolved oxygen, temperature, biological oxygen demand, faecal indicators, total hardness, total suspended solids, TDS, Ca, Mg, K, Na, chloride, sulphate, Ag, As, Cd, Mo, Pb, Sb, Se and Zn.

Because the waste rock, pit wall rock, low grade ore, ROM ore and tailings are expected to be relatively geochemically similar to those from the current pit configuration no changes to the site water quality monitoring programs for the pit, waste rock emplacements, low grade ore stockpile, ROM ore stockpile, and tailings storage facilities are expected to be necessary. However, it is recommended that these programs be reviewed on an annual basis, and modified as necessary, in order to maintain and rationalise these programs.

7.0 References

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ATTACHMENT A

Previous Test Results from Drill-Holes E46D3173, 1535DD051 and 1535DD066

Figure A1: Drill-hole locations for the geochemistry assessment program of the Modification Pit Extension.

Table A1: Acid forming characteristics of waste rock and low grade ore samples from drill-hole E46D3173, 1535DD051 and 1535DD066.

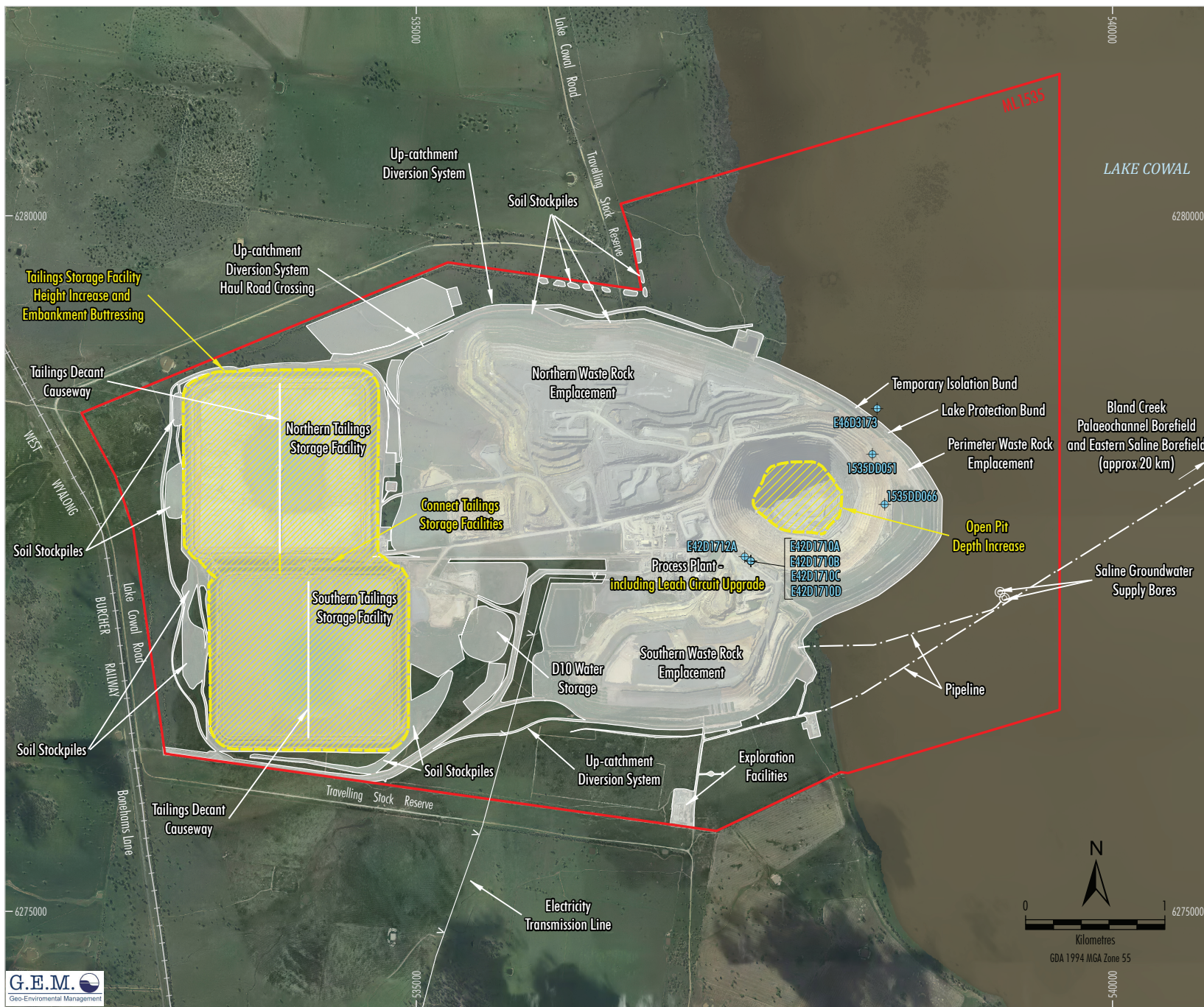
Table A2: Exchangeable cations, cation exchange capacity and exchangeable sodium percent for selected waste rock and low-grade ore samples.

Table A3: Multi-element composition of selected waste rock and low-grade ore samples.

Table A4: Geochemical abundance indices (GAI) of selected waste rock and low-grade ore samples.

Table A5: Chemical composition of water extracts from selected waste rock and low-grade ore samples.

Figure A2: Selected Acid Buffering Characteristic Curves for the waste rock samples



- LEGEND**
- Mining Lease Boundary (ML 1535)
 - Approximate Extent of Approved Surface Development
 - Modification Components
 - + Drill-Hole Sampled

Source: Evolution - Orthophoto (August 2016)



CGO MINE LIFE MODIFICATION

Location of Drill-Holes
Included in the Geochemical
Assessment Program

Figure A-1

Table A1: Acid forming characteristics of waste rock and low grade ore samples from drill-hole E46D3173, 1535DD051 and 1535DD066.

Sample ID	Depth (m)			Waste/ Low Grade Ore	Material Type	Lithology	ACID-BASE ANALYSIS							NAG TEST			ARD Classification	
	from	to	interval				pH _{1:2}	EC _{1:2}	Total %S	Sulfide %S	MPA	ANC	NAPP	ANC/MPA	NAGpH	NAG _(pH4.5)		NAG _(pH7.0)
E46D3173/1	23	25	2	Waste	Transported Material	Alluvium	6.7	2.872	0.02	-	1	2	-1	2.9	6.7	0	1	NAF
E46D3173/2	27	33	6	Waste	Saprolite	-	6.1	5.794	0.04	0.026	1	2	0	1.3	6.6	0	1	NAF
E46D3173/3	43	52	9	Waste	Saprock	Volc. Conglomerate	6.2	3.459	0.02	-	1	3	-2	4.1	-	-	-	NAF
E46D3173/4	67	71	4	Waste	Saprock	Volc. Sandstone	6.5	1.679	<0.01	-	0	3	-3	9.5	-	-	-	NAF
E46D3173/5	73	78	5	Low Grade Ore	Saprock	Volc. Sandstone	6.4	2.383	0.01	-	0	4	-3	12.1	-	-	-	NAF
E46D3173/6	92	104	12	Waste	Saprock	Volc. Conglomerate	6.5	1.704	<0.01	-	0	2	-1	5.2	-	-	-	NAF
E46D3173/7	110	114	4	Waste	Saprock	Volc. Mudstone	6.6	1.025	0.01	-	0	1	0	1.6	-	-	-	NAF
E46D3173/8	115	119	4	Waste	Saprock	Volc. Conglomerate	6.6	1.213	<0.01	-	0	9	-9	30.4	-	-	-	NAF
E46D3173/9	117	118	1	Low Grade Ore	Saprock	Volc. Conglomerate	7.0	1.029	<0.01	-	0	9	-8	28.1	-	-	-	NAF
E46D3173/10	124	130	6	Waste	Volcaniclastic	Conglomerate	8.5	0.660	0.08	-	2	38	-36	15.7	-	-	-	NAF
E46D3173/11	130	132	2	Low Grade Ore	Volcaniclastic	Conglomerate	8.2	0.929	0.05	-	2	38	-36	24.7	-	-	-	NAF
E46D3173/12	133	134	1	Waste	Volcaniclastic	Mudstone	8.6	0.679	0.44	-	13	63	-50	4.7	-	-	-	NAF
E46D3173/13	134	142	8	Waste	Volcaniclastic	Conglomerate	8.9	0.512	0.10	-	3	93	-90	30.3	-	-	-	NAF
E46D3173/14	143	146	3	Waste	Volcaniclastic	Mudstone	9.0	0.515	0.21	-	6	27	-21	4.2	-	-	-	NAF
E46D3173/15	147	149	2	Waste	Intrusives	Dyke	9.0	0.475	0.10	-	3	153	-150	50.0	-	-	-	NAF
E46D3173/16	150	152	2	Waste	Volcaniclastic	Conglomerate	8.9	0.531	0.42	-	13	115	-102	8.9	-	-	-	NAF
E46D3173/17	153	157	4	Waste	Volcaniclastic	Mudstone	8.9	0.427	0.25	-	8	34	-26	4.5	-	-	-	NAF
E46D3173/18	158	164	6	Waste	Volcaniclastic	Conglomerate	8.9	0.503	0.04	-	1	116	-115	94.8	-	-	-	NAF
E46D3173/19	165	167	2	Waste	Fault Zone	-	8.9	0.660	1.00	-	31	134	-103	4.4	-	-	-	NAF
E46D3173/20	170	173	3	Waste	Volcaniclastic	Sandstone	8.9	0.532	0.47	-	14	131	-117	9.1	-	-	-	NAF
E46D3173/21	182	186	4	Waste	Volcaniclastic	Conglomerate	8.9	0.553	0.36	-	11	163	-152	14.8	-	-	-	NAF
E46D3173/22	187	196	9	Waste	Extrusives	Trachyandesite	8.8	0.534	0.58	-	18	141	-123	7.9	-	-	-	NAF
E46D3173/23	197	198	1	Waste	Volcaniclastic	Conglomerate	8.8	0.486	0.56	-	17	141	-124	8.2	-	-	-	NAF
E46D3173/24	199	221	22	Waste	Volcaniclastic	Mudstone	8.8	0.497	0.36	-	11	70	-58	6.3	-	-	-	NAF
E46D3173/25	227	238	11	Waste	Volcaniclastic	Conglomerate	8.8	0.468	0.36	-	11	96	-85	8.7	-	-	-	NAF
E46D3173/26	238	240	2	Waste	Volcaniclastic	Conglomerate	8.9	0.386	0.08	-	2	112	-110	45.8	-	-	-	NAF
E46D3173/27	242	246	4	Waste	Volcaniclastic	Mudstone	8.9	0.314	0.36	0.298	11	37	-26	3.3	9.3	0	0	NAF
E46D3173/28	246	248	2	Low Grade Ore	Volcaniclastic	Mudstone	8.6	0.508	0.83	0.722	25	88	-63	3.5	9.0	0	0	NAF
E46D3173/29	250	255	5	Waste	Volcaniclastic	Mudstone	9.0	0.421	<0.01	-	0	58	-57	188.6	-	-	-	NAF
1535DD051/2	23	49	26	Waste	Saprolite	-	7.5	5.857	0.04	0.01	1	2	-1	1.9	6.4	0	1	NAF
1535DD051/3	50	63	13	Waste	Saprolite	-	7.3	6.022	0.04	0.01	1	1	1	0.4	7.9	0	0	NAF
1535DD051/4	64	80	16	Waste	Saprock	Diorite	7.2	5.299	0.02	-	1	7	-7	12.1	-	-	-	NAF
1535DD051/5	84	95	11	Waste	Saprock	Diorite	7.5	3.056	<0.01	-	0	14	-14	46.7	-	-	-	NAF
1535DD051/6	87	88	1	Low Grade Ore	Saprock	Diorite	7.7	3.498	<0.01	-	0	15	-14	48.0	-	-	-	NAF
1535DD051/7	96	99	3	Waste	Saprock	Dyke	9.2	0.704	<0.01	-	0	23	-23	75.2	-	-	-	NAF
1535DD051/8	100	110	10	Waste	Intrusives	Diorite	8.6	0.366	<0.01	-	0	51	-51	166.3	-	-	-	NAF
1535DD051/9	180	183	3	Waste	Intrusives	Diorite	8.5	0.354	<0.01	-	0	53	-52	172.2	-	-	-	NAF
1535DD051/10	184	189	5	Waste	Fault Zone	-	8.4	0.595	0.49	-	15	186	-171	12.4	-	-	-	NAF
1535DD051/12	228	238	10	Waste	Volcaniclastic	Mudstone	8.5	0.453	0.30	-	9	40	-30	4.3	-	-	-	NAF
1535DD066/2	38	62	24	Waste	Saprolite	-	7.7	2.861	0.03	-	1	1	0	1.4	6.3	0	2	NAF
1535DD066/3	62	97	35	Waste	Saprock	Volc. Mudstone	7.6	2.658	0.02	-	1	3	-3	5.6	-	-	-	NAF
1535DD066/4	100	129	29	Waste	Saprock	Volc. Sandstone	8.0	1.889	<0.01	-	0	287	-287	937.9	-	-	-	NAF
1535DD066/5	129	134	5	Waste	Volcaniclastic	Sandstone	8.6	0.603	0.14	-	4	76	-71	17.7	-	-	-	NAF
1535DD066/6	141	160	19	Waste	Volcaniclastic	Mudstone	8.4	0.554	0.38	0.33	12	27	-16	2.3	9.0	0	0	NAF

KEY

pH_{1:2} = pH of 1:2 extract

EC_{1:2} = Elec Conductivity 1:2 extract (dS/m)

MPA = Maximum Potential Acidity (kgH₂SO₄/t)

ANC = Acid Neutralising Capacity (kgH₂SO₄/t)

NAPP = Net Acid Producing Potential (kgH₂SO₄/t)

NAGpH = pH of NAG liquor

NAG_(pH4.5) = Net Acid Generation capacity to pH 4.5 (kgH₂SO₄/t)

NAG_(pH7.0) = Net Acid Generation capacity to pH 7.0 (kgH₂SO₄/t)

ARD Classification Key

NAF = Non-Acid Forming

PAF = Potentially Acid Forming

Table A2: Exchangeable cations, cation exchange capacity and exchangeable sodium percent for selected waste rock and low-grade ore samples.

Sample ID	Depth (m)		Interval (m)	Material Type	Exchangeable Cations (meq/100g)				CEC (meq/100g)	ESP (%)
	from	to			Ca	Mg	K	Na		
E41D3173/1	23	25	2	Transported Material	1.1	3.0	1.3	4.6	10.0	45.8
E41D3173/3	43	52	9	Saprock	1.4	2.9	1.5	5.6	11.4	49.3
E41D3173/4	67	71	4	Saprock	1.2	2.3	2.8	3.3	9.6	34.8
E41D3173/7	110	114	4	Saprock	1.0	1.8	2.8	2.6	8.2	31.7
E41D3173/8	115	119	4	Saprock	1.8	2.8	2.5	2.9	9.9	29.4
E41D3173/12	133	134	1	Volcaniclastic	18.6	2.1	2.4	1.3	24.4	5.3
E41D3173/19	165	167	2	Fault Zone	11.0	4.9	3.4	1.3	20.6	6.3
E41D3173/22	187	196	9	Extrusives	21.4	2.4	4.1	1.3	29.2	4.5
1535DD051/4	64	80	16	Saprock	8.1	21.9	0.6	29.8	60.5	49.3
1535DD051/7	96	99	3	Saprock	18.7	2.8	0.3	5.4	27.2	20.0
1535DD066/5	129	134	5	Volcaniclastic	19.4	1.7	1.7	1.1	23.9	4.8

Table A3: Multi-element composition of selected waste rock and low-grade ore samples.

Element	Unit	Detect. Limit	Waste Rock							Low-Grade Ore			
			Saprolite		Saprock		Volcaniclastic			Saprock		Volcaniclastic	
			E41D3173/2	1535DD051/3	E41D3173/3	1535D051/7	E41D3173/12	E41D3173/16	E41D3173/20	E41D3173/5	E41D3173/9	E41D3173/11	E41D3173/28
Ag	ppm	0.01	1.99	0.43	0.37	0.94	1.46	0.45	0.44	3.05	0.35	2.02	0.59
Al	%	0.005%	13.61%	12.69%	9.25%	8.58%	6.88%	7.28%	7.35%	8.02%	8.30%	7.96%	7.74%
As	ppm	0.5	42	43.5	73.2	20.4	14.4	14.2	23.1	51	11.9	16.7	15.9
B	ppm	50	<	<	<	<	<	<	<	<	<	<	<
Ba	ppm	0.1	191.1	235.1	374.3	448.0	206.6	254.6	175.1	967.8	205.4	214.9	687.3
Be	ppm	0.05	0.58	0.99	1.09	0.94	0.83	0.81	0.65	1.5	1.01	0.95	0.81
Ca	%	0.005%	0.06%	0.07%	0.06%	4.32%	3.00%	4.12%	4.93%	0.07%	0.48%	2.20%	3.17%
Cd	ppm	0.02	0.30	0.61	0.35	2.26	2.20	0.72	0.58	2.04	0.89	2.92	0.06
Co	ppm	0.1	4.8	7.8	2.5	29.4	14.8	18.5	19.6	107.0	21.4	22.1	21.2
Cr	ppm	2	141	100	27	28	4	7	11	75	25	32	19
Cu	ppm	1	171	124	175	278	57	345	133	197	168	84	24
Fe	%	0.01%	14.54%	9.14%	6.44%	7.67%	5.62%	6.13%	6.40%	7.91%	6.45%	6.74%	6.71%
Hg	ppm	0.01	<	0.08	0.02	0.2	0.05	0.01	0.03	0.02	0.03	0.69	0.02
K	%	0.002%	2.04%	0.53%	2.47%	2.15%	2.81%	3.07%	2.48%	2.72%	3.43%	2.80%	2.12%
Mg	%	0.002%	0.32%	0.28%	0.26%	1.65%	1.30%	1.91%	2.56%	0.24%	0.78%	1.72%	2.67%
Mn	ppm	1	405	554	111	1208	1865	2154	2587	4729	1489	6058	1657
Mo	ppm	0.1	0.8	0.8	1.2	1.0	0.4	0.5	0.3	1.0	0.4	0.6	0.3
Na	%	0.002%	0.34%	0.36%	0.23%	3.50%	0.10%	0.08%	0.24%	0.19%	0.25%	0.15%	0.83%
Ni	ppm	1	10	14	5	16	<	2	3	16	9	9	5
P	ppm	10	389	786	1322	1981	1634	1624	1141	1618	2226	1914	1089
Pb	ppm	0.5	14.7	34.5	165.8	7.5	12.8	8.7	97.1	15.9	7.2	9.2	6
Sb	ppm	0.05	5.37	3.68	3.19	3.46	2.96	2.55	3.31	3.74	3.51	2.92	2.71
Se	ppm	0.01	0.67	0.41	0.12	0.01	0.69	0.12	0.19	0.14	0.09	0.20	0.15
Si	%	0.1%	19.8%	23.6%	30.4%	25.8%	28.8%	25.7%	23.6%	29.5%	31.1%	28.3%	26.6%
Sn	ppm	0.1	1.1	1.8	1.1	1.2	1.0	0.8	0.7	1.0	1.0	1.0	0.9
Th	ppm	0.01	2.95	4.29	2.59	3.22	2.53	1.82	1.44	2.67	2.34	2.18	2.30
U	ppm	0.01	2.58	1.56	2.62	1.70	1.55	1.41	1.11	2.41	1.96	1.70	1.41
V	ppm	1	545	287	148	320	129	209	262	330	245	203	175
Zn	ppm	1	242	107	311	138	189	242	228	659	356	527	97

< element at or below analytical detection limit.

Table A4: Geochemical abundance indices (GAI) of selected waste rock and low-grade ore samples.

Element	*Mean Crustal Abundance	Waste Rock							Low-Grade Ore			
		Saprolite		Saprock		Volcaniclastic			Saprock		Volcaniclastic	
		E41D3173/2	1535DD051/3	E41D3173/3	1535D051/7	E41D3173/12	E41D3173/16	E41D3173/20	E41D3173/5	E41D3173/9	E41D3173/11	E41D3173/28
Ag	0.07	4	2	2	3	4	2	2	5	2	4	2
Al	8.2%	-	-	-	-	-	-	-	-	-	-	-
As	1.5	4	4	5	3	3	3	3	5	2	3	3
B	10	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ba	500	-	-	-	-	-	-	-	-	-	-	-
Be	2.6	-	-	-	-	-	-	-	-	-	-	-
Ca	4.0%	-	-	-	-	-	-	-	-	-	-	-
Cd	0.11	1	2	1	4	4	2	2	4	2	4	-
Co	20	-	-	-	-	-	-	-	2	-	-	-
Cr	100	-	-	-	-	-	-	-	-	-	-	-
Cu	50	1	1	1	2	-	2	1	1	1	-	-
Fe	4.1%	1	1	-	-	-	-	-	-	-	-	-
Hg	0.05	-	-	-	1	-	-	-	-	-	3	-
K	2.1%	-	-	-	-	-	-	-	-	-	-	-
Mg	2.3%	-	-	-	-	-	-	-	-	-	-	-
Mn	950	-	-	-	-	-	1	1	2	-	2	-
Mo	1.5	-	-	-	-	-	-	-	-	-	-	-
Na	2.3%	-	-	-	-	-	-	-	-	-	-	-
Ni	80	-	-	-	-	-	-	-	-	-	-	-
P	1000	-	-	-	-	-	-	-	-	1	-	-
Pb	14	-	1	3	-	-	-	2	-	-	-	-
Sb	0.2	4	4	3	4	3	3	3	4	4	3	3
Se	0.05	3	2	1	-	3	1	1	1	-	1	1
Si	27.7%	-	-	-	-	-	-	-	-	-	-	-
Sn	2.2	-	-	-	-	-	-	-	-	-	-	-
Th	12	-	-	-	-	-	-	-	-	-	-	-
U	2.4	-	-	-	-	-	-	-	-	-	-	-
V	160	1	-	-	-	-	-	-	-	-	-	-
Zn	75	1	-	1	-	1	1	1	3	2	2	-

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

Table A5: Chemical composition of water extracts from selected waste rock and low-grade ore samples.

Parameter	Detection Limit	Waste Rock						Low-Grade Ore					
		Saprolite		Saprock		Volcaniclastic		Saprock		Volcaniclastic			
		E41D3173/2	1535DD051/3	E41D3173/3	1535D051/7	E41D3173/12	E41D3173/16	E41D3173/20	E41D3173/5	E41D3173/9	E41D3173/11	E41D3173/28	
pH	0.1	6.1	7.3	6.2	9.2	8.6	8.9	8.9	6.4	7.0	8.2	8.6	
EC	dS/m	0.001	5.794	6.022	3.459	0.704	0.679	0.531	0.532	2.383	1.029	0.929	0.508
Cl	mg/L	10.0	1190	1340	1135	40	82	16	34	740	250	245	27
SO ₄	mg/L	0.3	188	179	204	18	78	69	64	144	54	45	60
Al	mg/L	0.01	<	0.02	0.01	0.89	0.35	0.66	0.27	0.02	0.15	0.20	0.27
B	mg/L	0.01	0.09	0.01	0.06	0.07	0.05	0.07	0.05	0.05	0.05	0.03	0.07
Ca	mg/L	0.01	41.69	39.10	48.74	1.66	8.72	6.72	7.97	26.58	6.90	12.89	7.01
Cr	mg/L	0.01	<	<	<	<	<	<	<	<	<	<	<
Cu	mg/L	0.010	<	<	<	0.01	<	<	<	<	<	<	<
Fe	mg/L	0.01	<	<	<	1.38	0.12	0.15	0.03	<	0.08	0.10	0.08
K	mg/L	0.1	28.8	10.9	78.1	1.2	66.4	99.3	65.8	91.9	31.2	43.6	58.5
Mg	mg/L	0.01	79.49	72.86	77.21	1.31	6.30	5.44	6.13	37.70	10.40	5.47	4.60
Mn	mg/L	0.01	0.05	0.06	0.05	0.05	0.02	0.01	<	0.08	0.02	0.02	<
Na	mg/L	0.1	634.3	718.0	584.0	186.3	109.6	62.2	97.5	407.1	174.4	181.6	60.2
Ni	mg/L	0.010	<	<	<	<	<	<	<	<	<	<	<
P	mg/L	0.10	<	<	<	0.40	<	<	<	<	<	<	<
Si	mg/L	0.05	8.97	10.03	6.69	7.54	2.3	2.21	1.76	6.77	5.84	2.77	1.8
V	mg/L	0.01	<	<	<	0.16	<	<	<	<	<	<	<
Zn	mg/L	0.01	0.02	<	0.01	<	<	<	<	<	<	<	<
Ag	µg/L	0.01	0.06	<	0.01	<	<	<	<	0.03	<	<	<
As	µg/L	0.1	3	3	3	27	2	2	1	2	1	1	3
Ba	µg/L	0.05	37.2	46.7	44.1	5.3	5.2	31.7	45.2	12.7	1.5	2.1	45.9
Be	µg/L	0.1	<	<	<	<	<	<	<	<	<	<	<
Cd	µg/L	0.02	0.10	1.02	0.08	0.09	0.07	0.04	0.03	0.21	0.05	0.05	0.02
Co	µg/L	0.1	0.4	0.2	0.2	1.5	<	<	<	1.1	0.7	<	<
Hg	µg/L	0.1	<	<	<	<	<	<	<	<	<	<	<
Mo	µg/L	0.05	0.27	0.36	0.19	7.52	7.34	17.73	12.07	0.39	4.12	4.62	14.36
Pb	µg/L	0.5	0.9	0.7	0.7	0.8	1.1	0.8	0.9	0.7	0.6	0.6	1.4
Sb	µg/L	0.01	0.04	0.06	0.06	0.83	0.74	5.61	4.58	0.19	0.78	0.45	4.71
Se	µg/L	0.5	11.7	12.4	11.4	1.6	31.4	1.2	2.3	7.9	3.3	3.3	1.1
Sn	µg/L	0.1	<	<	<	<	<	0.2	<	<	<	<	<
Th	µg/L	0.005	<	<	<	0.026	0.018	0.017	<	<	0.007	0.007	0.006
U	µg/L	0.005	<	<	<	0.124	0.028	0.306	0.114	0.010	0.030	0.030	0.030

< element at or below analytical detection limit.

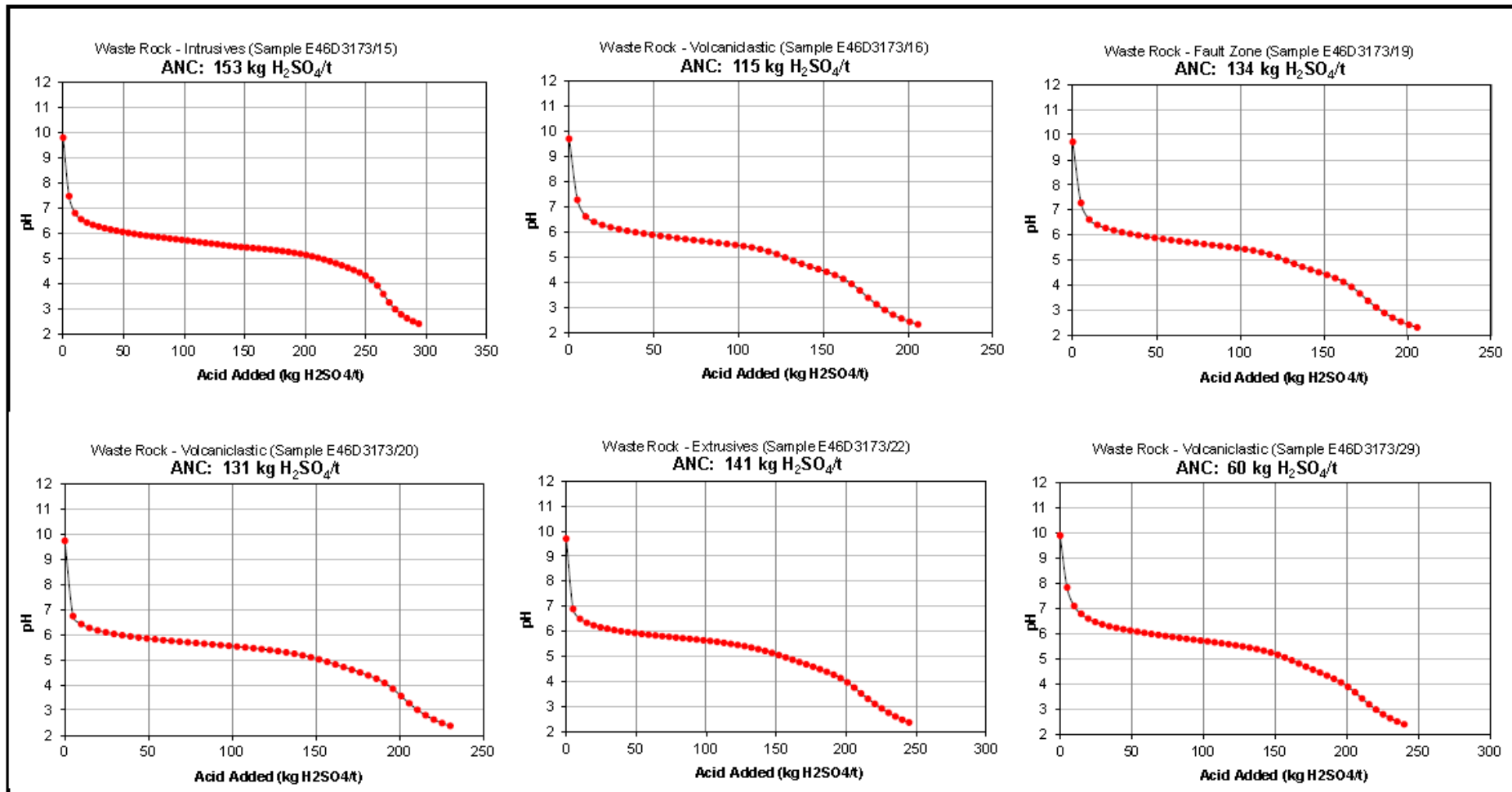


Figure A2: Selected Acid Buffering Characteristic Curves for the waste rock samples.

ATTACHMENT B

Current Waste Rock and Ore Sample Test Results

Table B1: Acid forming characteristics of samples representing waste rock and ore from the Mine Life Modification area.

Table B2: Multi-element composition of samples representing waste rock and ore from the Mine Life Modification area.

Table B3: Geochemical abundance indices (GAI) of samples representing waste rock and ore from the Mine Life Modification area.

Table B1: Acid forming characteristics of samples representing waste rock and ore from the Mine Life Modification area.

Sample ID	Waste/Ore	Lithology	pH _{1:2}	EC _{1:2}	ACID-BASE ANALYSIS						NAG TEST			ARD Classification	
					Total %S	Sulfide %S	MPA	ANC	NAPP	ANC/MPA	NAGpH	NAG _(pH4.5)	NAG _(pH7.0)		
11494	Waste Rock	Diorite	9.4	0.284	<0.01	0.006	0	112	-112	366.0	10.5	0	0	NAF	
19170	Waste Rock	Diorite	9.1	0.123	0.03	0.020	1	85	-84	92.5	10.6	0	0	NAF	
19173	Waste Rock	Diorite	8.9	0.114	0.03	0.030	1	83	-82	90.1	10.6	0	0	NAF	
19117	Waste Rock	Diorite	9.0	0.153	0.54	0.332	17	89	-73	5.4	10.6	0	0	NAF	
19120	Waste Rock	Diorite	9.1	0.129	0.02	0.014	1	104	-103	169.9	10.7	0	0	NAF	
19167	Waste Rock	Diorite	9.0	0.098	0.04	0.035	1	83	-82	67.9	11.1	0	0	NAF	
19178	Waste Rock	Diorite	9.2	0.104	0.04	0.040	1	92	-91	75.4	11.1	0	0	NAF	
19175	Waste Rock	Diorite	8.9	0.096	0.05	0.029	2	70	-69	45.8	10.4	0	0	NAF	
11496	Waste Rock	Diorite	9.3	0.283	1.15	1.150	35	55	-20	1.6	9.8	0	0	NAF	
11498	Waste Rock	Diorite	9.7	0.281	0.14	0.098	4	117	-113	27.3	10.4	0	0	NAF	
20866	Ore	Diorite	9.2	0.183	1.28	1.140	39	70	-30	1.8	9.9	0	0	NAF	
11527	Ore	Diorite	8.8	0.127	0.84	0.781	26	64	-38	2.5	9.8	0	0	NAF	
11521	Ore	Diorite	8.8	0.159	1.20	0.957	37	55	-19	1.5	10.0	0	0	NAF	
11514	Ore	Diorite	9.0	0.196	1.58	1.480	48	72	-24	1.5	8.4	0	0	NAF	
11513	Ore	Diorite	9.1	0.254	2.64	2.410	81	90	-9	1.1	8.4	0	0	NAF	
11505	Ore	Diorite	9.4	0.289	0.79	0.966	24	111	-87	4.6	8.4	0	0	NAF	
20868	Ore	Diorite	8.9	0.098	0.71	0.633	22	51	-30	2.4	9.9	0	0	NAF	
12031	Ore	Porphyritic diorite	8.6	0.159	0.95	1.06	29	68	-39	2.3	8.5	0	0	NAF	
KEY											ARD Classification Key				
pH _{1:2} = pH of 1:2 extract			MPA = Maximum Potential Acidity (kgH ₂ SO ₄ /t)			NAGpH = pH of NAG liquor			NAG _(pH4.5) = Net Acid Generation capacity to pH 4.5 (kgH ₂ SO ₄ /t)			NAF = Non-Acid Forming			
EC _{1:2} = EC of 1:2 extract (dS/m)			ANC = Acid Neutralising Capacity (kgH ₂ SO ₄ /t)			NAG _(pH7.0) = Net Acid Generation capacity to pH 7.0 (kgH ₂ SO ₄ /t)			NAPP = Net Acid Producing Potential (kgH ₂ SO ₄ /t)			PAF = Potentially Acid Forming			

Table B2: Multi-element composition of samples representing waste rock and ore from the Mine Life Modification area.

Element	Unit	Waste Rock										Ore							
		Sample ID	11494	19170	19173	19117	19120	19167	19178	19175	11496	11498	20866	11527	11521	11514	11513	11505	20868
Ag	mg/kg	0.036	0.073	0.153	0.253	0.098	0.131	0.104	0.141	1.38	0.283	0.764	0.319	0.742	4.37	2.91	0.9	0.879	2.03
Al	%	8.13	8.57	8.68	8.08	8.65	8.51	8.95	8.65	6.38	7.82	6.43	6.87	6.75	6.77	7.32	7.28	6.89	7.44
As	mg/kg	8.04	12.1	16.3	9.46	4.71	13.4	10.05	19.5	147	44.7	44	46.3	96.8	111.5	175.5	80.7	30.6	28
B	mg/kg	60	30	30	20	20	40	30	30	70	60	40	30	30	30	40	50	30	10
Ba	mg/kg	504	495	264	467	318	529	282	276	477	290	460	670	800	723	317	227	777	627
Be	mg/kg	1.04	0.78	0.8	0.77	0.99	0.8	0.9	0.78	0.88	1.33	1.27	1.07	0.9	0.86	0.81	1.07	0.89	0.88
Bi	mg/kg	0.018	0.007	<0.005	0.011	0.007	0.014	0.015	0.006	0.04	0.021	0.034	0.021	0.03	0.087	0.136	0.025	0.03	0.041
Ca	%	4.13	4.63	5.51	3.94	4.47	4.71	5.06	5	1.79	4.85	2.63	2.58	2.17	2.57	3.35	3.7	1.91	2.51
Cd	mg/kg	0.102	0.072	0.071	0.054	0.047	0.065	0.192	0.076	4.58	0.186	0.263	0.148	0.159	5.99	19.05	2.62	3.4	12.9
Ce	mg/kg	34.5	24.9	26.7	32.8	35.6	34.4	28.3	26.4	57.4	31.9	53.6	60	63.9	58.4	54.6	62.5	70.6	63.7
Co	mg/kg	11.05	25.6	25.8	24.1	23.4	23.8	24.7	25.7	3.26	10.7	4.64	5.6	5.09	7.15	14.15	12.2	4.81	12.4
Cr	mg/kg	3.1	44.9	45.3	34.3	28.2	35.1	39	46.2	1.6	2.8	7	5.1	2.6	4.4	7.1	2	4.7	2.5
Cs	mg/kg	1.67	0.68	0.38	1.08	1.12	0.62	0.85	0.29	1.67	2.19	1.08	0.63	0.87	1.03	1.3	1.8	0.73	0.37
Cu	mg/kg	23.1	126.5	151.5	143	135.5	165	138	138	214	18.1	50	72.8	70.8	157.5	274	169	166	192
Fe	%	4.5	6.23	6.3	6.66	6.38	6.03	6.35	6.4	3.01	5.71	4.21	4.54	4.53	5.09	5.49	5.86	4.19	5.87
Ga	mg/kg	16.4	16.65	17.25	16.05	16	14.55	16.85	16	13.15	16.1	14.05	14.25	13.3	14.6	15.45	16.7	12.9	16.2
Ge	mg/kg	0.13	0.15	0.14	0.14	0.16	0.16	0.15	0.14	0.17	0.14	0.19	0.19	0.18	0.2	0.19	0.2	0.19	0.21
Hf	mg/kg	2.65	1.805	1.825	2.07	2.16	2.05	2.02	1.69	5.54	2.47	5.05	4.98	5.39	4.9	3.92	3.7	5.37	4.69
In	mg/kg	0.047	0.036	0.044	0.057	0.041	0.049	0.038	0.035	0.054	0.043	0.053	0.057	0.064	0.06	0.082	0.056	0.053	0.12
Hg	mg/kg	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	0.007	0.006	<0.005	0.005	0.051	0.165	0.03	0.027	0.079
K	%	3.31	1.4	0.89	1.47	1.8	2.04	1.48	0.99	3.21	3.38	4.31	4.11	3.52	2.52	2.99	3.03	4.33	2.85
La	mg/kg	15.25	9.81	10.85	12.75	14.25	14.2	11.35	10.45	23.8	14.25	21.3	25.1	27	24.1	21.7	26.7	32.9	26.6
Li	mg/kg	6.9	15.5	16.7	15.2	13.8	11.8	13.8	14.8	4.1	17.4	4.1	8.7	8.2	5.1	5.7	3.3	7.1	12.1
Mg	%	0.98	2.52	2.17	2.33	2.23	2.2	2.24	2.39	0.48	0.91	0.5	0.57	0.49	0.63	0.72	0.97	0.46	1.1
Mn	mg/kg	1120	1230	1255	1505	1375	1230	1300	1285	622	1190	1130	1195	1025	1380	1265	1960	1070	1560
Mo	mg/kg	0.74	0.64	0.6	0.34	0.42	0.96	0.65	0.58	2.11	1.13	1.35	1.17	1.79	2.18	6.26	1.11	1.71	1.7
Na	%	1.575	3.32	3.55	2.91	3.14	2.66	3.47	3.52	0.061	0.225	0.16	1.165	1.61	2.51	2.11	1.48	1.045	2.79
Nb	mg/kg	16.95	2.09	1.945	2.52	2.67	2.52	2.18	1.945	5.57	15.05	5.54	5.52	5.99	5.8	5.32	4.02	5.91	5.17
Ni	mg/kg	1.63	20.9	20.3	15.55	14.65	17.3	18.4	20.5	0.58	1.6	0.5	1.12	0.31	0.61	3.8	1.24	0.44	0.68
P	%	0.126	0.104	0.104	0.154	0.142	0.115	0.109	0.11	0.028	0.121	0.057	0.072	0.065	0.078	0.199	0.309	0.063	0.178
Pb	mg/kg	4.85	4.68	5.81	4.61	3.84	4.69	4.4	4.53	90.6	6.84	8.13	4.55	7.28	9.57	13.65	10.6	9.88	9
Rb	mg/kg	39.4	12.15	7.7	14.75	23.8	23.6	14.7	7.9	34.6	34.4	44.8	42.1	38.3	28.7	33.2	36.6	45.1	29.6
Re	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002
Sb	mg/kg	1.51	1.32	1.16	1.28	1.16	0.9	0.92	0.84	2.89	3.06	1.47	1.15	1.65	1.98	3.33	3.05	1.03	0.91
Sc	mg/kg	7.43	24.8	25.8	24	23.7	22.5	25.8	25.5	11.95	7.41	13.6	15.65	14.15	16.75	21.6	20.2	14.45	18.55
Se	mg/kg	0.015	0.048	0.06	0.074	0.052	0.064	0.051	0.053	0.239	0.043	0.113	0.094	0.122	0.332	0.407	0.162	0.148	0.152
Sn	mg/kg	0.86	1	0.63	0.92	0.86	0.69	0.62	0.62	1.33	0.87	1.56	1.25	2.14	1.27	1.04	1.04	1.59	1.19
Sr	mg/kg	366	758	726	487	641	707	667	851	151	284	194	277	226	258	316	275	212	325
Ta	mg/kg	1.08	0.1	0.1	0.12	0.13	0.13	0.12	0.1	0.28	0.95	0.28	0.28	0.3	0.27	0.25	0.2	0.29	0.27
Te	mg/kg	<0.04	<0.04	<0.04	0.06	0.04	<0.04	0.04	<0.04	0.56	0.04	0.53	0.26	0.38	2.86	1.9	0.56	0.57	1.21
Th	mg/kg	2.32	1.225	1.285	1.395	1.65	1.785	1.545	1.26	4.09	2.2	3.55	3.73	4.03	3.54	2.84	3.04	4.29	3.54
Ti	%	0.49	0.355	0.353	0.419	0.4	0.365	0.36	0.358	0.191	0.457	0.269	0.319	0.297	0.348	0.53	0.469	0.295	0.417
Tl	mg/kg	0.144	0.046	0.033	0.066	0.075	0.062	0.053	0.028	0.134	0.133	0.123	0.093	0.093	0.08	0.104	0.117	0.11	0.061
U	mg/kg	1.07	0.88	0.91	1.01	1.13	1.16	0.99	0.81	2.62	1.05	2.42	2.48	2.52	2.53	1.97	1.85	2.65	2.23
V	mg/kg	109.5	267	269	256	259	257	278	275	5.3	102.5	7	16.6	8.8	16.8	110	139.5	7.9	59.3
W	mg/kg	0.796	0.274	0.435	1.015	0.34	0.496	0.268	0.365	2.08	1.545	2.83	3	2.82	2.77	4.51	3.51	2.11	2.28
Y	mg/kg	18.65	13.7	14.3	15.3	16.75	16.85	14.65	14.1	20.6	17.75	18.65	21.9	21.2	21.2	22.6	26	21.7	25.2
Zn	mg/kg	125	83.8	90.7	137.5	93.3	79.2	117.5	86.3	686	204	105	133.5	139.5	751	2400	419	468	1630
Zr	mg/kg	101.5	68	67.8	75.5	78.2	75.4	72.7	61.1	211	94.8	195.5	188	199.5	184	150.5	143.5	202	173

Table B3: Geochemical abundance indices (GAI) of samples representing waste rock and ore from the Mine Life Modification area.

Element	*Mean Crustal Abundance	Waste Rock										Ore							
		11494	19170	19173	19117	19120	19167	19178	19175	11496	11498	20866	11527	11521	11514	11513	11505	20868	12031
Ag	0.07	-	-	1	1	-	-	-	-	4	1	3	2	3	5	5	3	3	4
Al	8.2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As	1.5	2	2	3	2	1	3	2	3	6	4	4	4	5	6	6	5	4	4
B	10	2	1	1	-	-	1	1	1	2	2	1	1	1	1	1	2	1	-
Ba	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Be	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca	4.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cd	0.11	-	-	-	-	-	-	-	-	5	-	1	-	-	5	6	4	4	6
Co	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cu	50	-	1	1	1	1	1	1	1	2	-	-	-	-	1	2	1	1	1
Fe	4.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
K	2.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg	2.3%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mn	950	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mo	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Na	2.3%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ni	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	14	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Sb	0.2	2	2	2	2	2	2	2	1	3	3	2	2	2	3	3	3	2	2
Se	0.05	-	-	-	-	-	-	-	-	2	-	1	-	1	2	2	1	1	1
Sn	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Th	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V	160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn	75	-	-	-	-	-	-	-	-	3	1	-	-	-	3	4	2	2	4

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.