Assessment of Environmental Effects – Acid and Metalliferous Drainage

Waikaka Gold Mine

14 June 2022

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MINE WASTE MANAGEMENT
GREENROAD GROUP

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Waikaka Gold Project

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EXECUTIVE SUMMARY

Mine Waste Management Ltd (MWM) has prepared this report for Waikaka Gold Mines Limited (WGM) on the assessment of potential environmental hazards associated with acid and metalliferous drainage (AMD) at the Waikaka Valley Project located to the northeast of Gore, Southland.

AMD is a general term used to describe waters impacted chemically by mining activities and can contain significant quantities of toxic metals, salts, and acidity. AMD is typically generated by the excavation of rocks that contain sulfide minerals, such as pyrite. When these minerals are exposed to oxygen and water, they undergo weathering processes and oxidise, generating acidity and releasing toxic metals. These processes can have deleterious effects for the receiving environment if not managed in an appropriate manner. Best practicable AMD management methods can prevent the oxidation of sulfides, minimise the mobilisation of acidic oxidation products by water, and where necessary control and treat any residual effects such that the effects on the receiving environment are less than minor.

This report indicates that some materials that will be excavated as part of the Waikaka Valley Project will be potentially acid forming (PAF) with a low capacity to generate acidity with the maximum potential acidity (MPA) being 6.8 kg H_2SO_4/t. This includes the following materials:

- Pan tails;
- Sediment pond fines;
- Processing residues;
- Carbonaceous lithologies associated with the Waikaka Quartz Gravels (including carbonaceous clay and carbonaceous gravel);
- Ore; and
- Gore Lignite Measures (GLM).

The primary AMD risk for this project is associated with excavation into the GLM (classified as PAF) to access the ore zone (wash zone) with GLM reporting to all process residue streams. Other lithologies that are classified as PAF include minor carbonaceous lithologies where authigenic pyrite and marcasite have precipitated in the post-depositional environment.

The overall risk to the receiving environment is also a function of material quantities. The PAF materials represent 15% of the total estimated materials that will be disturbed during the project. The greatest AMD hazard is associated with the processing residues, which represent ~10% of the total disturbed materials.

The acid neutralisation capacity (ANC) of the materials is low with ANC values being < 5 kg H_2SO_4/t, which means the ability to neutralise any acidity generated is low. This low ANC is reflective of the mineralogy of the materials being quartz-rich with no carbonate minerals present.

The data can also be used to assess the overall net acid producing potential (NAPP) for the project where NAPP = MPA – ANC. This has been calculated as a NAPP negative value of -140,000 tonnes H_2SO_4 equivalent, which means the materials overall are classified as non-acid forming (NAF). Further analysis indicates that the neutralisation potential ratio (NPR) where NPR = ANC/MPA is 3:1, which also classifies the project as NAF overall. This does not mean that AMD will not occur but suggests with good materials management, the risks for AMD can be minimised such that the effect on the receiving environment is less than minor.

The AMD source hazard characterisation data provided in this report is used to undertake an informed preliminary risk assessment. This risk assessment identifies that:

- Temporary placement (~5 years) of PAF materials in an ex-pit long term stockpile (LTSP) could lead to the generation of AMD during the operational phase of the project. The result could be a requirement for treatment during the operational phase of the project. It is recommended that all PAF materials are placed back in the pit below the long term final water table.
- All PAF materials should be managed to prevent their oxidation and the generation of acidity. Generic engineering controls are described and presented in this report. These engineering controls need to be incorporated into the final mine plan prior to mining commencing to prevent impacts during the operational phase and post closure phase of the project.
- During the operational phase of the mine there is the potential for AMD to be generated and stored oxidation products to form. Performance monitoring of these risks is required with contingency plans in place should control and treatment be required. This approach should be managed by the development of trigger action response plans (TARPs), which would support the site specific environmental / AMD management plan.
- At closure, once the water table rebounds the potential for ongoing oxidation of sulfides is eliminated due to the low flux of oxygen from the atmosphere to sulfide minerals in the backfill.

This characterisation report has identified what materials are likely to be problematic for AMD. The preliminary risk assessment, based on source hazard characterisation data has identified what mine domains containing PAF materials would be a higher risk for AMD. The proposed mine planning and engineering controls available indicate that that risks to the receiving environment can be minimised. Performance monitoring as part of an environmental / AMD management plan, supported by TARPs would be a suitable approach for this project. Adaptive management is recommended, and this philosophy should be embedded in management plans for the site.

Further work is required to understand what water quality risks are expected (i.e., potential contaminants of concern) and how these risks will be managed.

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1 INTRODUCTION:

1.1 Background

Waikaka Gold Mines Limited (WGM) has completed an exploration programme involving air core drilling and bulk sampling for alluvial gold at their Waikaka Valley Project, located to the northeast of Gore, Southland. This exploration programme is designed to support a Feasibility Study (FS) for the project. Mine Waste Management (MWM) was engaged by WGM to provide environmental geochemistry support for the FS. Specifically, this relates to the assessment of the potential for acid and metalliferous drainage (AMD).

AMD is a general term used to describe waters impacted chemically by mining activities and can contain significant quantities of toxic metals, salts, and acidity. AMD is typically generated by the excavation of rocks that contain sulfide minerals, such as pyrite. When these minerals are exposed to oxygen and water, they undergo weathering processes and oxidise, generating acidity and releasing toxic metals.

1.2 Project Description

There are two principal detrital gold transport and recycling pathways in the southern South Island including one through eastern Southland and the other through the Waiau River system to the west (Falconer et al., 2015). The eastern Southland pathway originated during Miocene fluvial drainage southwards from the Otago Schist gold sources, and subsequent recycling has redistributed detrital gold in the Waikaia, Waikaka, and Waimumu placer goldfields.

WGM has obtained positive results from its recent exploration drilling programme of the alluvial gold deposit in the Waikaka Valley, which is at depth of up to 40 m below surface. Drilling involved 17 large diameter bulk sampling pits and a 72 hole air core drilling programme.

WGM have identified that overburden material may have thin carbonaceous layers containing authigenic sulfide minerals, which can also be present in the wash. Other studies (e.g., Falconer et al., 2006) indicate sulfide minerals can occur in the heavy mineral fraction. These sulfide minerals have the potential to generate AMD if not managed correctly.

The current mine plan involves excavating approximately 30 M bcm of overburden and returning these materials back into the pit void. It is anticipated that approximately 2 M bcm may not be returned to the pit immediately (~ 5 years) and will need to be paced within an ex-pit facility identified as the long term stockpile (LTSP). At closure of the mining operation, it is also expected there will be a final terminal mine lake, which is expected to be similar to the current L&M mine pond present at site.

1.3 Report Objectives

The aim of this report is to understand the potential environmental geochemistry effects associated with the proposed mining activities. Specifically, AMD effects associated with the:

- Mine Pit
- Stockpiles;
- Haul Roads;
- Ex-pit overburden landform; and

- Terminal mine lake.

To understand the potential AMD effects the following objectives were proposed:

- Advise sampling and analytical requirements to determine the environmental geochemistry of materials and their AMD potential;
- Review laboratory data and determine potential AMD hazards associated with the project;
- Use characterisation data to consider potential risks for AMD; and
- Identify measures to mitigate the risk of AMD for the project.

1.4 Approach

Mining of sulfide-rich materials can generate AMD. As shown in Figure 1 this can be acid drainage, neutral metalliferous drainage, or saline drainage. Further details on AMD are available in Appendix B

International best practice guidance is available to manage the potential risks of AMD (e.g., International Network for Acid Prevention (INAP), 2010). Such guidance has been used here to assess the potential environmental geochemistry effects of AMD and develop management options such that closure objectives can be achieved. This includes

- confirm closure objectives;
- assess the potential environmental geochemistry effects of the project;
- develop appropriate management processes to ensure effects on the receiving environment are less than minor;
- develop performance monitoring programs to confirm design criteria are being achieved; and
- ensure that closure objectives can be achieved

This guidance can be broken down into six key steps of AMD management as shown in Figure 2.

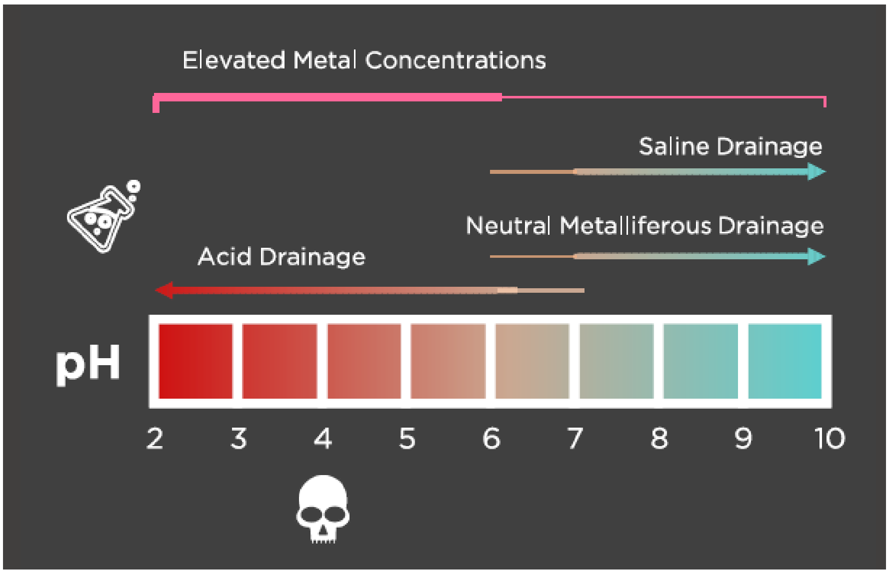

Figure 1. AMD geochemical signatures

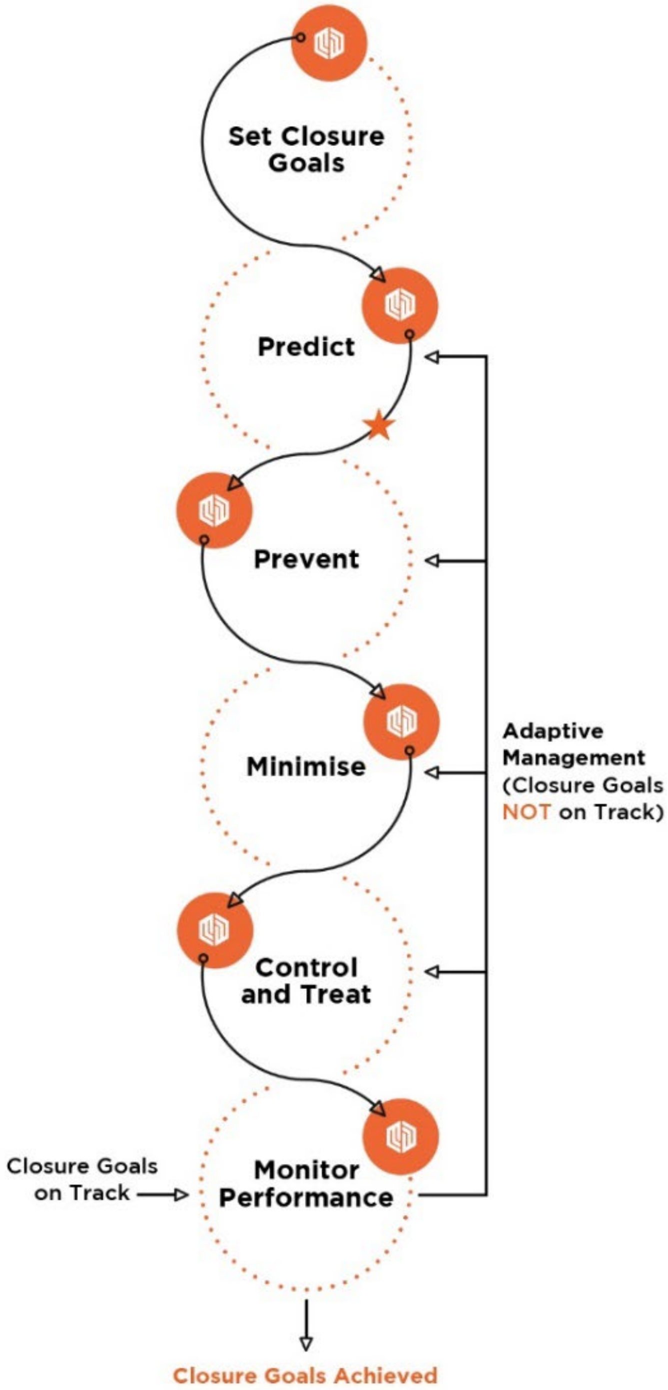

Figure 2. Six steps of AMD management.

2 BACKGROUND

2.1 Introduction

The Waikaka goldfield is located in Southland, New Zealand. The Waikaka Valley Project is located northeast of the township of Gore (~21 km away). The mining lease is located along the Waikaka Stream ~3 km southeast of the Waikaka township (Figure 3).

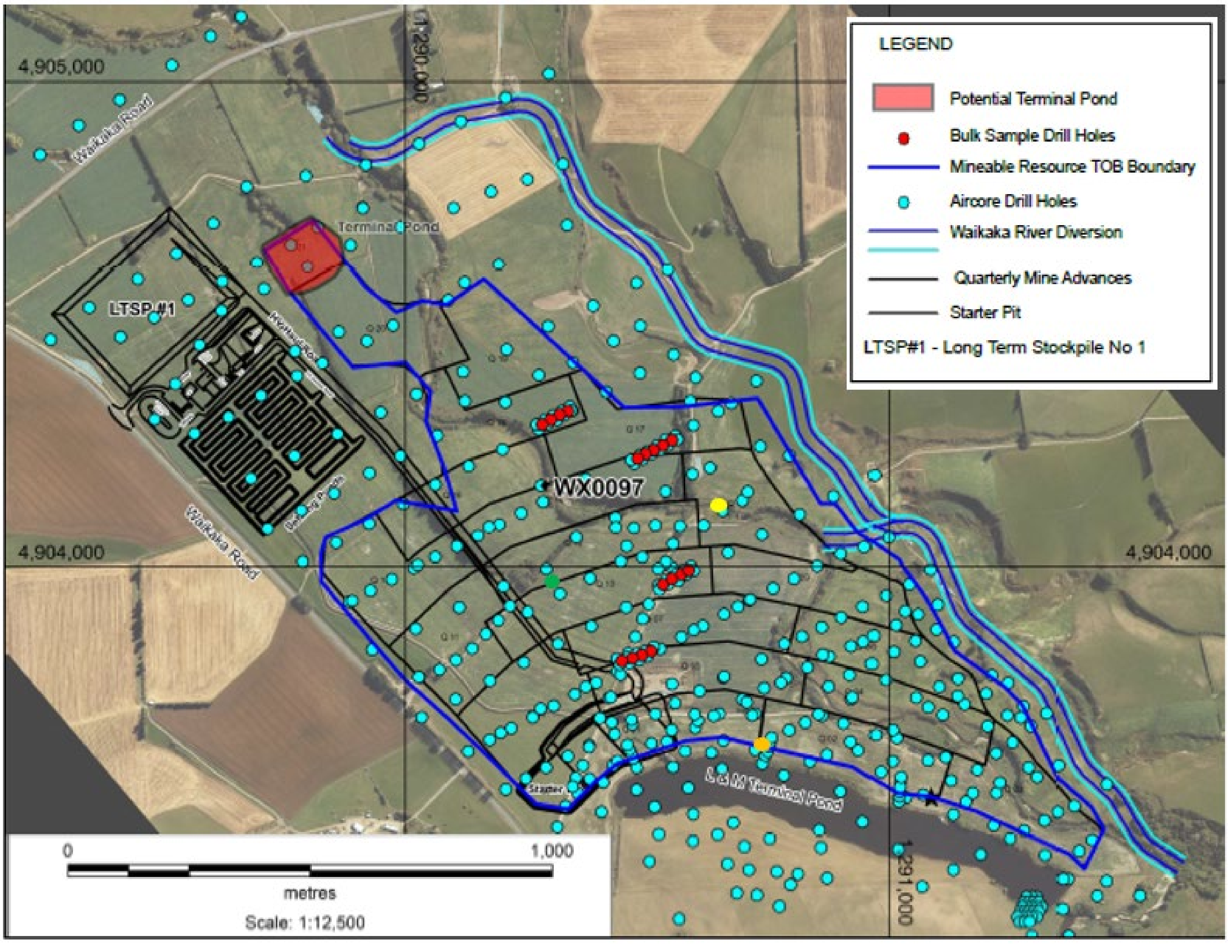

Figure 3: Location of proposed Waikaka Gold Mine near the Waikaka Stream.

Note: the yellow location marker represents the water quality sampling location for the Waikaka Stream; the green Location marker is Bore No. 2; the orange Location Marker is Bore No. 1 (see Table 1).

2.2 Climate

The region surrounding Waikaka is characterized by a mean rainfall of 900 to 1,000 mm/yr; approx. 1,700 h of sun annually; a mean annual temperature of 9.8°C; and an average of 76 ground frosts per year (Falconer and Craw, 2009). December through to February can be considered the warm and dry season whilst April through to September are considered the cold and wet season.

2.3 Surface Water and Groundwater

Southland has four major river catchments, the Waiau, Aparima, Oreti, and Mataura which covers 54 % of the region (~ 18,305 km^2; LAWA, 2020). The remaining area is made up of smaller coastal catchments. The Waikaka Valley Project is within the 2nd largest catchment of Southland, the Mataura

River catchment. (LAWA, 2020). The Waikaka Stream flows into the Mataura River, which is ~1.2 km south of the Gore central business district. Recent water quality monitoring data for the Waikaka River, as supplied by WGM, are shown in Table 1. It is proposed that the Waikaka Stream will be diverted around the project area to access the ore zone (Figure 3).

The main hydrogeological aquifer at the proposed Waikaka Gold Mine predominantly consists of conglomerates, gravels, clays, and other alluvial deposits that overlie the basement, which is the Gore Lignite Measures (GLM). L&M (1999) report that two principal groundwater zones are present:

- A discrete groundwater flow system contained in the upper recent gravels and old dredge tailings with the water table being ~1.5 m below the ground surface coinciding with the water level in the old dredge ponds and river; and
- The sandy gravel gold bearing horizon in the Waikaka Quartz Gravels (WQG) that forms a discrete semi-confined aquifer, which sits on the unconformity with the underlying Gore Lignite Measures (GLM).

An existing mine void, the L&M Pond (Figure 3) is present within the project area (~400,000 m^3), which was associated with earlier mining activities by L&M Mining Ltd. Water quality of this pond was recently sampled (Table 1). It was noted that nitrate concentrations are elevated in the L&M pond and that Cu concentrations are an order of magnitude higher compared to other water sources in the area. Further baseline water quality testing is recommended including dissolved metals.

Table 1. Waikaka water quality data.

Parameter	UNITS	WAIKAKA PUMP BORE	WAIKAKA PUMP TEST BORE 2	WAIKAKA STREAM	L&M POND
Sample Date		9/12/2021	16/11/2021	9/12/2021	16/11/2021
Water Type		GW	GW	SW	SW
General Analysis					
EC	µs/cm	220	231	85	225
pH	-log[H+]	6.56	6.65	7.18	8.28
Turbidity	NTU	23	11	6.4	5.2
Nitrate-Nitrogen	mg/L	<0.01	<0.01	0.32	2.8
Chloride	mg/L	-	19	-	17
Bromide	mg/L	-	-	0.019	-
Total Organic Carbon	mg/L	-	-	2.7	-
E. Coli	MPN/100 mL	<10	<1.0	640	40
Total Analysis					
Phosphorous	mg/L	-	0.14	-	0.05
Arsenic	mg/L	0.0068	0.0047	0.00053	0.00093
Boron	mg/L	<0.005	-	<0.005	-
Cadmium	mg/L	<0.00005	<0.00005	<0.00005	<0.00005
Calcium	mg/L	10	-	5.50	-
Chromium	mg/L	0.00065	<0.0005	0.00054	<0.0005

Parameter	UNITS	WAIKAKA PUMP BORE	WAIKAKA PUMP TEST BORE 2	WAIKAKA STREAM	L&M POND
Cobalt	mg/L	0.00011	0.00022	0.00021	0.00019
Copper	mg/L	0.00055	0.00027	0.00081	0.0013
Iron	mg/L	4.4	5.6	0.79	0.13
Lead	mg/L	0.00071	0.00024	0.00012	<0.0001
Magnesium	mg/L	5.5	-	2.1	-
Manganese	mg/L	0.2	0.21	0.024	0.043
Mercury	mg/L	<0.00005	<0.00005	<0.00005	<0.00005
Potassium	mg/L	1.2	-	0.72	-

Note: Waikaka River water quality sampling location and borehole sample locations are shown in Figure 3.

GW = Ground water; SW = surface water

Full Laboratory certificates of analysis are provided in Appendix E.

2.4 Geology

The geology of the area includes Otago Schist basement unconformably overlain by a wedge of GLM. A further unconformity separates the GLM from the overlying WQG (L&M, 1999), which are referred to as the Upper Waikaka Sequence.

In the nearby Waimumu district, which is geologically similar to the Waikaka region, unmetamorphosed Tertiary nonmarine sediments are preserved in a structural depression within the Mesozoic basement (Falconer and Craw, 2009). The Tertiary nonmarine strata are dominated by the GLM (Oligocene-Miocene age), which was caused by a large meandering fluvial system. Basal deltaic beds are overlain by extensive, generally fine grained lower-delta plain beds and lignites, which are in turn overlain by extensive upper-delta plain conglomerates and carbonaceous mudstones (Falconer and Craw, 2009). A deltaic setting suggests that older materials of the GLM may be influenced by marine waters (elevated in sulfate) and could contain pyrite and/or other sulfides.

The upper part of this nonmarine GLM is dominated by conglomerates with abundant basement graywacke clasts, and ~ 30 vol. % quartz pebbles derived from the Otago schist (Falconer and Craw, 2009). The gravels contained with the GLM represent the first cycle of sedimentation resulting from the unroofing of the basement terranes further north. Repeated localized recycling of these first cycle sediments has resulted in the formation of quartz pebble conglomerates (QPC). The QPC of the Waimumu district is the same as that in the Waikaka area (Figure 4).

Within the surrounding mining area some of the conglomerates contain abundant sulfide minerals including pyrite, marcasite, and arsenopyrite. Whilst some of the sulfides, namely pyrite and arsenopyrite, are of detrital origin, the majority of these sulfides are authigenic marcasite and variably transported authigenic marcasite that formed diagenetically in reduced horizons. Although pyrite is rare, it is generally confined to specific settings within the QPC, such as in narrow (10 cm) horizons above the water table; and euhedral pyrite and arsenopyrite are common in the heavy mineral concentrates (Falconer et al., 2006). Additionally, WGM have indicated that pyrite has been observed in wash.

The main exploration target at Waikaka is the quartz-rich gravel horizon at the base of the WQG, which are nearly 100% quartz with minimal clay indicating minimal in-situ weathering (L&M, 1999). Overburden consists of both old dredge tailings and WQG that is comprised of thick silt horizons interspersed with thin quartz lenses and layers. Almost all the site has been dredged in the past and the original soils have been destroyed with only remnants of original soils in places (L&M, 1999).

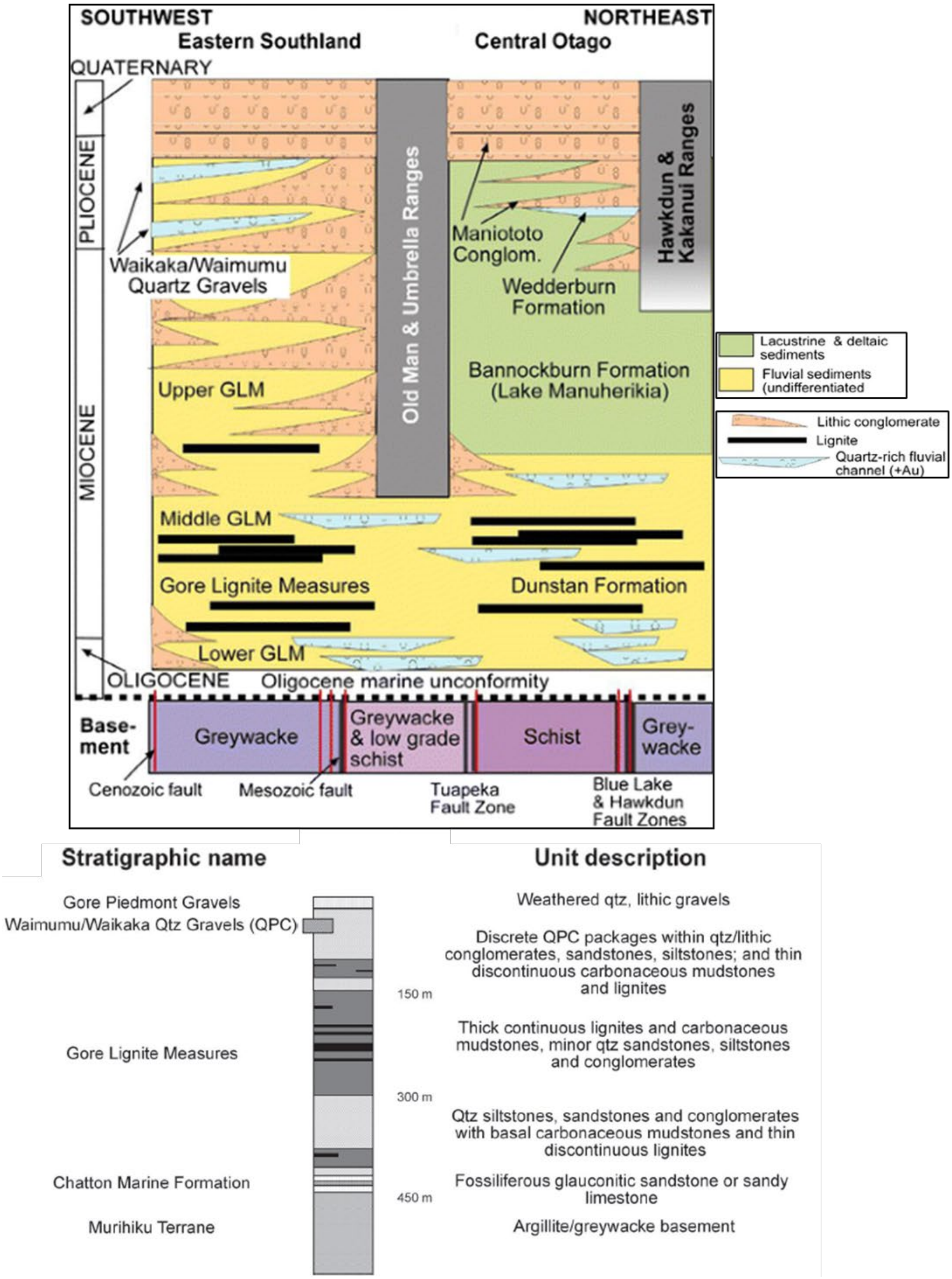

Figure 4. Late Cenozoic stratigraphic column for Eastern Southland.

Modified from D. Craw (2013) and D. Falconer (2009).

2.5 Geoenvironmental Model

No previous geochemical assessments have been undertaken at the proposed Waikaka Gold Mine, however it was identified that overburden material may have thin carbonaceous layers with authigenic sulfides present in places and that sulfides are also present in the wash. Several studies from nearby sites exist (e.g., Falconer et al., 2015; Craw et at., 2013), which have indicated sulfide minerals can occur in the heavy mineral fraction. The geoenvironmental model and previous studies suggest the following materials could be problematic in regards to AMD:

- Carbonaceous zones where there is the potential for authigenic pyrite formation within the post depositional environment;
- Wash zones, which may contain pyrite and other sulfides;
- Materials in the vicinity of the water table; and
- General overburden samples.

2.6 Mine Plan

The proposed Waikaka Gold Mine will be developed using excavators and trucks to remove the overburden to access the ore zone (wash). The area has previously been mined, with dredge tails near the surface and the L&M pit pond to the south of the project area. The following information is provided from the proposed Waikaka mine plan.

2.6.1 Mine Staging

The project will require the development of general infrastructure including site access, parking, offices, workshops, and the wash plant. Other infrastructure includes the haul roads, pit area, backfill, long term (ex-pit) stockpile (LTSP), run-of-mine (ROM) pad, settling ponds, and the final terminal mine lake. Mining will commence in the south of the project and progressively move northwards as shown by the mine staging (Figure 5) heading down dip.

2.6.2 Pit Design and In-pit Materials Management

It is proposed that mining will occur by the construction of benches down into the pit void. The cut bench height in the cut faces will generally match the lift heights in the back-fill overburden disposal area (OBDA). Generally, it is anticipated that cut face height and corresponding lift height in the OBDA will be < 5 m in height. The mining block size may increase as the open pit progresses down dip to the north and that the cut height and lift height may trend towards a 10 m height.

Coarse wash tailings will be added to the top of the OBDA as a suitable running surface. Generally, the thickness of the wash tailings will be 0.25 - 0.5 m, which is a function of the mining depth (20 m to 40 m) with wash tailings being required for the running surface (every 5 -10 m). Waikaka note there will be other gravel zones in the overburden that will provide material for the running surfaces to assist trafficability.

The placement of overburden in the OBDA is likely to be by dozer-push where trucks dump short of the tiphead and then the materials are pushed over the working face of the advancing OBDA utilising a D10 bulldozer, or similar. Where possible the trucks will unload as close as practicable to the tiphead crest, although consideration is needed for health and safety related issues.

Within the OBDA it is anticipated there will be a series of turkey nest ponds, which will be developed for the disposal of the Settling Pond Fines (SPF). Waikaka propose that these will have to be encapsulated in the overburden lifts to minimise the potential for destabilising the OBDA working slopes. It is anticipated that the clay from the overburden should be suitable for forming low permeability embankments for these turkey nest ponds.

Problematic materials with the potential to generate AMD can be placed within the in-pit OBDA. WGM indicates that such materials can be encapsulated with clay materials sourced from the overburden. Materials placed within the OBDA will remain in an unsaturated state until mining is completed, at which point the groundwater level will be allowed to rebound. It is anticipated this rebound will be to current levels (< 1 m below the ground surface).

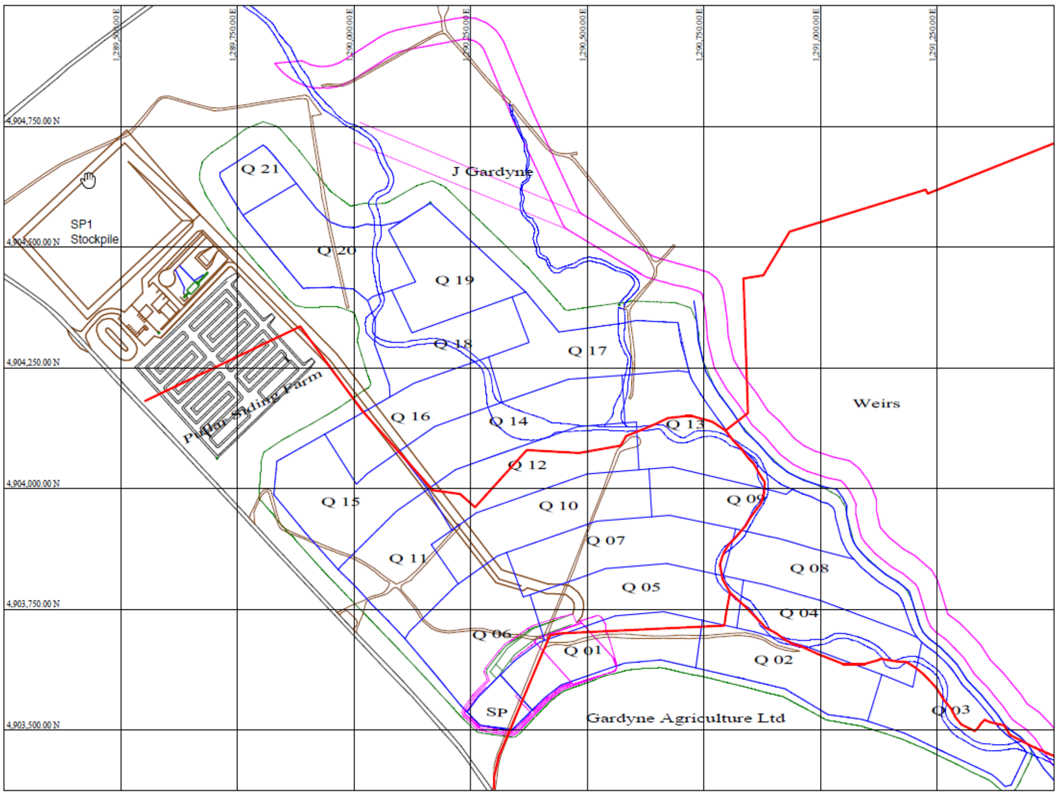

Figure 5. WGM Infrastructure and mine staging

2.6.3 Water Management Infrastructure

The following key mine infrastructure is required for water management as part of the project.

2.6.3.1 <u>Floor drains and pit sumps</u>

Due to the dip of the basement GLM rocks to the north and mining approach (mining down dip), all flow from the OBDA will flow back to pit sumps, which provides an ideal monitoring location for AMD effects associated with the backfilled materials.

The following drainage systems are required:

- Floor drains and pit sumps are required to dewater the working pit. The floor drains will generally be excavated into both the basal floor materials (Gore Lignite Measures) and the across the top of Wash directed towards the basal floor.

- Drainage from the stripping benches or cut benches on the advancing panel will generally be directed down the access ramps where possible down to the wash bench or piped down the benches to the basal floor collection system.

The proposed pit floor undulates along strike and down dip so it will be necessary to either cut into undulations or have transfer pumps between the pit floor sumps. The floor drains (0.5 – 3 m in depth) will be shallow, similar to table drain designs, and will enable flow in the down dip direction and across or around the wash extraction panels.

The pit sump(s) will have the pump(s) for delivering the water to the wash plant system. The pit sumps and the rising pipeline from the pit floor to the ground surface will need to be regularly shifted, probably on a monthly basis.

The materials scheduled provided by Waikaka indicates that:

- 16,800 m^3 of GLM will be excavated for pit drains;
- 2000 m^3 of GLM will be excavated for pit floor sumps; and
- GLM is expected to have a specific gravity (SG) of 2.6 t/m^3.

2.6.3.2 Settling ponds

Mine-influenced water is pumped to from the pit sumps to the Wash Plant and the remaining TSS in solution after processing is managed through the settling ponds as shown in Figure 3. It is proposed that the fine clay / colloidal material fraction from the wash plant will settle in the settling ponds. This material is identified as the settling pond fines (SPF) and is anticipated to be 16% (by volume) of the total wash. The SPF will be removed from the settling ponds and will be placed within the backfill as explained in Section 2.6.2.

The settling ponds will discharge along the western ditch into the L&M Pond before discharge to the Waikaka Stream. The effects of mine-influenced water (TSS and AMD) should be monitored at this discharge point.

2.6.3.3 L&M Pond

The L&M Pond will be partially backfilled with material from the first traverse (i.e., stages Q01, Q02, and Q03). It is anticipated a pond will remain for a final water polishing stage before discharge to the Waikaka Stream. During mining it is anticipated that seepage from the L&M pond back to the pit will occur.

2.6.4 Ore

The target ore horizon are the materials setting directly over the GLM, which is expected to be 2-3 m thick, including 0.2 m of GLM, which will be excavated along with the gold-bearing horizon. Ore will be placed on the ROM pad.

2.6.5 Long Term Stockpile

It is anticipated, based on the current mine plan that approximately 2 M bcm may not be returned to the pit immediately (~ 5 years) and will need to be paced within an ex-pit facility. This long term stockpile (LTSP) is shown in Figure 3. Current mine plans indicate that a permanent LTSP is not required.

2.6.6 Terminal Pit Lake

At closure of the mining operation, it is also expected there will be a terminal pit lake. It is anticipated by WGM that the terminal pit lake will be a flow through system, with in-flow water comparable to background water and the terminal pit lake water quality being comparable to the L&M Pit Pond (Table 1). At mine closure the pit lake could receive the final pond fines and the 100,000 m^3 of material used to construct the settling ponds.

2.6.7 Material Quantities

Material quantities for the project have been provided by WGM and are shown in Table 2. These data were derived with the following assumptions:

- The SPF are assumed to be 16% (by volume) of the total wash
- Carbonaceous overburden are assumed to be 5.8% (by volume) of the total overburden, which has been calculated from bulk sample results. Note: the carbonaceous overburden determined from aircore drilling is 3.2% (by volume). The value of 5.8% is therefore a conservative number.
- The GLM includes: 16,800 m^3 of GLM that will be excavated for pit drains; and 2000 m^3 of GLM that will be excavated for pit floor sumps.
- Specific Gravities (SG) have been provided by WGM. The SG for the SPF has been derived based on the difference between the total wash (less pan tails and process residues) divided by the material volumes.
- The bulk density of the SPF once excavated is expected to be 1.98 due to the moisture content of these materials. Moisture content is estimated to be ~20%.

Table 2. Waikaka material quantities (dry basis).

MATERIAL	MATERIAL VOLUMES (m^3)	SG	MATERIAL QUANTITY (tonnes)
Total Wash	**2,814,361**	**2.7**	**7,598,775**
Pan tails	12.8	3.2	40.96
Silt pond fines	450,298	2.7	1,215,798
Process residues	2,364,050	2.7	6,382,936
Total Overburden	**27,868,003**	**2.6**	**72,456,808**
Non-carbonaceous overburden	26,251,659	2.6	68,254,313
Carbonaceous overburden	1,616,344	2.6	4,202,495
Gore Lignite Measures	**18,800**	**2.6**	**48,880**
Total materials disturbed	**30,701,164**		**80,104,463**

3 METHODOLOGY

The following section provides details on the sample and analysis programme (SAP) for materials collected. Samples are used for geochemical characterisation to understand potential environmental geochemistry hazards associated with AMD. Geochemical characterisation is typically undertaken by acid base accounting (ABA) methodologies.

3.1 Sampling Program

Two different sample mediums were provided by WGM to MWM to assess as part of the investigation of potential environmental geochemistry risks for the project. These samples included:

- 5 pan tailing concentrate samples (Pan Tails); and
- 39 aircore drill samples, which represents samples from a full drillhole (drillhole WX0097).

In total 44 samples were submitted for ABA testing. It was anticipated that complete analysis of one drillhole would identify potential geochemical risks for a range of materials identified in Section 2.5.

3.1.1 Pan Tails

Bulk samples were obtained by WGM to assess the gold recoveries of the target horizon. Bulk sampling involved 1.2 m diameter casing (1168 mm internal diameter) driven down to the basement rock and then a piling bucket wheel excavator was used to remove material. Four bulk sample sites were selected (Figure 6). Samples from the gold-bearing target horizon were separated and processed to obtain a pan tailing concentrate sample (Pan Tails). The process for obtaining the Pan Tails sample is provided in Figure 7.

The Pan Tails represents one waste stream that would be generated from the proposed mining operation. As shown in Table 3 the Pan Tails represent a small percentage of the total sample interval following processing. Pan Tails were assessed for total sulfur and paste pH as an indicator of AMD risk for these materials. WGM also completed an assessment of the Pan Tails by optical microscopy (Appendix C) with some samples assessed by ABA methods also being assessed by optical microscopy (Table 3).

Table 3. List of pan tail samples and analysis programme

HOLE ID	SITE	DEPTH (M)	SAMPLE INTERVAL (M)	OPTICAL MICROSCOPY (AND SAMPLE SIZE FRACTION)	PAN TAILS % OF TOTAL SAMPLE INTERVAL*	PASTE pH	TOTAL S (WT%)
BSE1	E	39.4 – 41.2	1.8	0.2 – 0.4 mm	0.016%	✓	✓
BSE4	E	38.5 – 41.5	3.0	NA	0.009%	✓	✓
BSE5	E	38.0 – 41.0	3.0	<0.2 mm	0.010%	✓	✓
BSJ2	J	21.9 – 25.5	3.6	< 0.2 mm; and 0.2 – 0.4 mm; and magnetics	0.008%	✓	✓
BSJ3	J	22.4 – 25.6	3.2	NA	0.011%	✓	✓

** - based on a density of 1.98 t/m^3*

NA – Not assessed

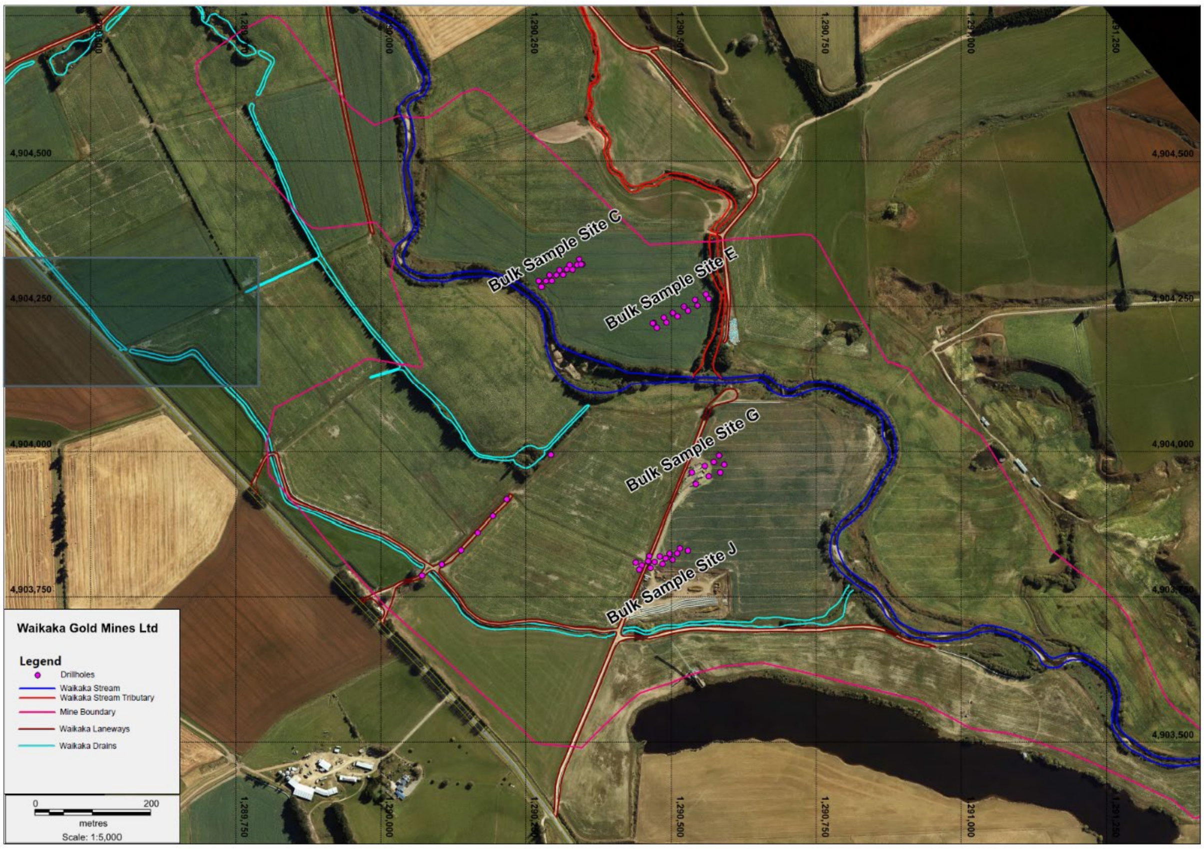

Figure 6. Aerial and schematics of the sample sites for the pan tails.

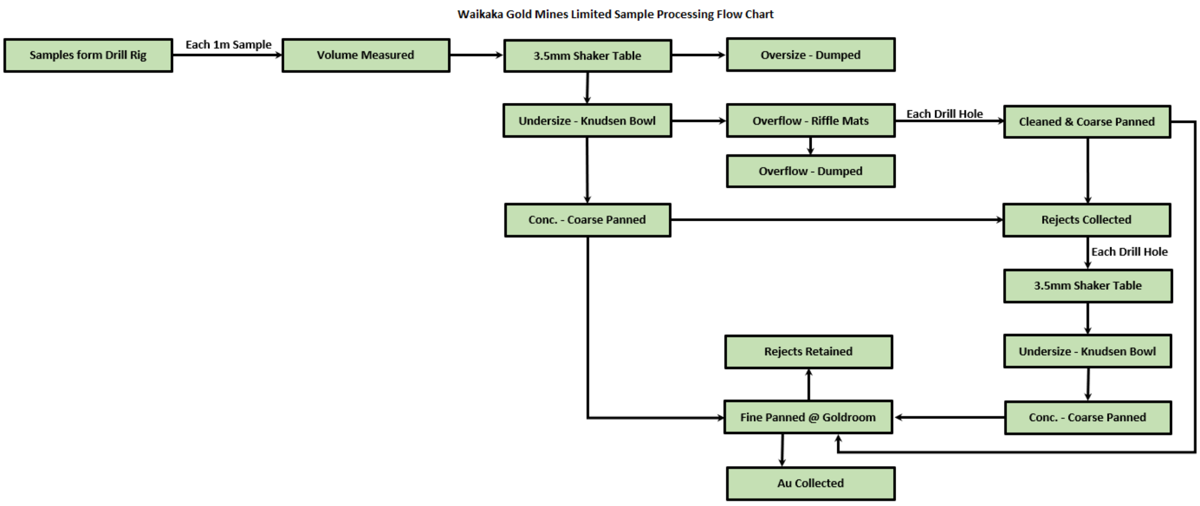

Figure 7. Waikaka Gold Pan Tails Processing Flow Path

3.1.2 <u>Aircore Samples</u>

Waikaka provided 39 aircore drill samples from Drillhole WX0097 that were taken at metre intervals from 3 m[1] depth to the bottom of the hole at 42 m where the GLM was intercepted. The purpose of one metre sampling interval for this drillhole was to provide an assessment of typical materials that would be intercepted during mining. Although one hole does not provide a complete assessment of any spatial

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[1] *Samples were not obtained from 0 – 3 m as this area was open holed by the drilling contractors and comprised larger rocks and reworked historic alluvial tailings.*

lithological variations across the project area, it does provide guidance on what units may be higher risk in regard to AMD.

The aircore drillholes were drilled to basement and sampled in one metre intervals by the drilling contractor. For some holes the basal alluvial materials overlying the GLM and the ore-bearing horizon may include some GLM. As noted in Section 2.6 the mining model allows for 0.2 m of GLM to be excavated along with the gold-bearing horizon. Hence samples taken at the bottom of the Upper Waikaka Sequence and containing some GLM are considered reasonable in this regard to understand the AMD risk for wash zone materials

Appendix D provides the geological log for drillhole WX0097 with Table 4 presenting the characteristics of the samples selected for laboratory testing and the subsequent analysis programme. .

Table 4. List of samples selected for analysis for drillhole WX0097 and analysis plan.

SAMPLE DESCRIPTION	NUMBER OF SAMPLES	PASTE pH	TOTAL S (Wt%)	ANC (kg H_2SO_4/t)
Clay	22	✓	✓	✓
Carbonaceous Clay	2	✓	✓	✓
Sandy Clay	2	✓	✓	✓
Gravely Clay	1	✓	✓	✓
Gravel	8	✓	✓	✓
Carbonaceous Gravel	1	✓	✓	✓
Clayey Gravel	1	✓	✓	✓
Clayey Gravel - Top of GLM	1	✓	✓	✓
GLM	1	✓	✓	✓
Total No. samples	**39**			

3.2 Geochemical Analysis Methodology

The samples were analysed by ABA methodologies with key AMD classification parameters determined including:

- Paste pH;
- Total sulfur content;
- Maximum potential acidity (MPA);
- Acid neutralising capacity (ANC);
- Net acid producing potential (NAPP); and
- Neutralisation Potential Ratio (NPR).

3.2.1 Paste pH

Paste pH was determined with electrochemical probes calibrated using certified buffers and standards following the AMIRA (2002) methodology. Slurries were prepared at a 1:2 ratio of finely ground sample (typically < 75 µm) to deionised water. Paste pH is an industry standard test used to determine if the sample is already influenced by stored acidity / AMD (e.g., AMIRA, 2002).

3.2.2 Total Sulfur and Maximum Potential Acidity

The total sulfur of the samples was determined by high temperature combustion in a LECO furnace and sulfur dioxide detection by an infra-red cell. The infra-red cell output was calibrated against the value of a known standard sample to provide the total sulfur concentration of the sample.

The acid generation potential of a rock is determined by measuring the sulfur (or sulfide) content and calculating the MPA that would be generated, assuming all the sulfur (or sulfide) is present as pyrite and completely oxidises to iron hydroxide where:

MPA = S (wt%) x 30.6 Units: kg H_2SO_4/t

3.2.3 Acid Neutralisation Capacity

The ANC of the sample was determined by the modified Sobek method where a known amount of standardised hydrochloric acid (HCl) is added to an accurately weighed sample, allowing the sample time to react, then back-titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl (AMIRA, 2002). The amount of acid consumed by reaction with the sample is then calculated. ANC is an industry standard test used to determine if the acid neutralisation capacity of a sample.

3.2.4 Net Acid Production Potential

The NAPP is a measure of the samples overall acid generating capacity and is calculated by subtracting the ANC from MPA. A negative NAPP indicates a net neutralisation capacity, and the sample can be classified as non-acid forming (NAF). A positive NAPP indicates a net acid generation capacity, and the sample can be classified as potentially acid forming (PAF). NAPP, MPA, and ANC are expressed in kg H_2SO_4 per tonne equivalent.

3.2.5 Neutralisation Potential Ratio

The NPR is another common method to assess the potential to generate acid rock drainage, which is based on the Price (2009) classification methodology. The Price (2009) classification system uses the ratio between ANC and MPA to classify samples as PAF, NAF or UC, where the Neutralisation Potential Ratio (NPR) = ANC/MPA.

3.3 AMD Classification

Two general methods are used to classify a sample in regards to its acid or base geochemical nature when there is not a site-specific validated AMD classification approach. These include:

- AMIRA (2002) methodology (Table 5); and
- Mine Environment Neutral Drainage (MEND) methodology (Price, 2009) using the ratio of ANC to MPA (Table 6).

For this work NAG[2] testing was not undertaken given that carbonaceous materials can affect the test results (generation of humic and fulvic acids). Instead NAPP was used to identify samples that are PAF versus samples that are NAF using the AMIRA (2002) methodology. NPR was calculated from these data for classification using the Price (2009) methodology.

Table 5. AMIRA (2002) acid base accounting classification system.

CLASSIFICATION	CRITERIA	COMMENTS
Potentially Acid Forming (PAF)	NAPP > 0 NAG pH < 4.5	Sample always has a significant sulfur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material.
Non-Acid Forming (NAF)	NAPP < 0 NAG pH ≥4.5	Sample may, or may not, have a significant sulfur content but the ANC availability is more than adequate to neutralise the acid that theoretically could be produced.
Uncertain (UC)	NAPP > 0; NAG pH ≥4. NAPP < 0; NAG pH < 4.5	An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results.

Table 6. MEND (Price, 2009) acid base accounting classification system.

CLASSIFICATION	CRITERIA	COMMENTS
Potentially Acid Forming (PAF)	ANC/MPA < 1	Potentially acid generating material, unless sulfide minerals are non-reactive, or ANC is preferentially exposed on surfaces.
Non-Acid Forming (NAF)	ANC/MPA > 2	Non-potentially acid generation material, unless ANC is insufficiently reactive, extremely reactive sulfides are present, or preferential exposure of sulfides is found in the material.
Uncertain (UC)	1 ≤ ANC/MPA ≤ 2	Possibly PAF if ANC is insufficiently reactive or is depleted at a faster rate than sulfides.

Further details on ABA and how to predict AMD are provided in Appendix B.

3.4 Geochemical Signature (Water Quality)

The geochemical signature or water quality from a material type can be inferred from ABA characterisation data. However, further information is required to determine the expected water quality (concentration). This can be determined from datasets such as geo-environmental models, field data, and laboratory tests such as kinetic testing.

Kinetic testing generally involves oxidising a material sample in the presence of water to understand trends in water quality, determine potential contaminants of concern (PCOC), and quantify oxidation

[2] NAG = Net Acid Generation, where the NAG test involved the oxidation of the sample in H_2O_2, measurement of the final NAG pH and then back titration to determine the NAG acidity.

rates, neutralisation rates, and contaminant loads with respect to time. Such data are used to determine the potential for acid rock drainage, neutral metalliferous drainage, or saline drainage, and quantification of potential contaminants of concern for risk assessments.

AMD waters can be sub-divided into three general water types depending on their pH and concentration of sulfate and metals.

- Acid Rock Drainage (ARD) – has high acidity, low pH drainage, and has occurred due to the oxidation of acid producing sulfide minerals. ARD generally contains significant dissolved toxic metals.
- Neutral Metalliferous Drainage (NMD) - often referred to as metalliferous drainage where the acid produced by the oxidation of sulfide minerals has been neutralised by other minerals such as carbonates, with the resultant waters having high toxic metal concentrations but circum-neutral pH.
- Saline Drainage (SD) – which refers to waters that are close to neutral-to-alkaline in pH with elevated sulfate.

4 RESULTS AND DATA ANALYSIS

The following section provides results for the AMD characterisation programme and interpretation of these data.

4.1 Acid Base Accounting Data

ABA data for samples obtained from the project area are summarised in in the following sections. Full ABA data summaries and laboratory certificates are provided in Appendix E.

4.1.1 Results

ABA results are presented in Table 7 for the Pan Tails and samples from Drillhole WX0097 and ABA data based on material type are summarised in Table 8.

Table 7. ABA Data

HOLE ID	SAMPLE INTERVAL (M)	ANALYSIS DATE	MATERIAL	PASTE pH	TOTAL SULFUR	MPA	ANC	NAPP	NPR	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
Units				-log[H+]	wt%	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t			
LOR				0.01	0.005	0.153	1.0	-			
BSE1	39.4 - 41.2	11/10/2021	Pan Tails	3.9	7.46	228	0[B]	228.28	0.0004[A]	PAF	PAF
BSE4	38.5 - 41.5	11/10/2021	Pan Tails	4.3	1.18	36.1	0[B]	36.11	0.003[A]	PAF	PAF
BSE5	38 - 41	11/10/2021	Pan Tails	6.2	0.42	12.9	0[B]	12.85	0.008[A]	PAF	PAF
BSJ2	21.9 - 25.5	11/10/2021	Pan Tails	6.7	0.02	0.612	0[B]	0.61	0.16[A]	PAF	PAF
BSJ3	22.4 - 25.6	11/10/2021	Pan Tails	7.5	0.03	0.918	0[B]	0.92	0.11[A]	PAF	PAF
WX0097	3 - 4	13/10/2021	Clay	8.19	0.0025[C]	0.077	5.12	-5.04	66.9	NAF	NAF
WX0097	4 - 5	13/10/2021	Clay	7.61	0.006	0.184	3.66	-3.47	19.9	NAF	NAF
WX0097	5 - 6	13/10/2021	Clay	7.08	0.0025[C]	0.077	1.46	-1.39	19.1	NAF	NAF
WX0097	6 - 7	13/10/2021	Clay	6.99	0.008	0.245	3.41	-3.17	13.9	NAF	NAF
WX0097	7 - 8	13/10/2021	Clay	7.52	0.015	0.459	2.92	-2.46	6.35	NAF	NAF
WX0097	8 - 9	13/10/2021	Clay	7.37	0.0025[C]	0.077	2.67	-2.60	34.9	NAF	NAF
WX0097	9 - 10	13/10/2021	Clay	7.2	0.012	0.367	3.4	-3.04	9.27	NAF	NAF
WX0097	10 - 11	13/10/2021	Clay	7.33	0.011	0.337	3.16	-2.82	9.39	NAF	NAF
WX0097	11 - 12	13/10/2021	Clay	7.24	0.017	0.52	4.22	-3.70	8.12	NAF	NAF
WX0097	12 - 13	13/10/2021	Gravel	6.36	0.017	0.52	0.6	-0.08	1.16	NAF	UC
WX0097	13 - 14	13/10/2021	Clay	6.08	0.018	0.551	3.02	-2.47	5.48	NAF	NAF
WX0097	14 - 15	13/10/2021	Clay	7.15	0.031	0.949	3.62	-2.67	3.82	NAF	NAF
WX0097	15 - 16	13/10/2021	Clay	6.54	0.034	1.04	3.02	-1.98	2.9	NAF	NAF
WX0097	16 - 17	13/10/2021	Clay	7.38	0.02	0.612	3.02	-2.41	4.93	NAF	NAF

HOLE ID	SAMPLE INTERVAL (M)	ANALYSIS DATE	MATERIAL	PASTE pH	TOTAL SULFUR	MPA	ANC	NAPP	NPR	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
WX0097	17 - 18	13/10/2021	Clay	7.02	0.01	0.306	3.02	-2.71	9.86	NAF	NAF
WX0097	18 - 19	13/10/2021	Clay	6.71	0.045	1.38	4.2	-2.83	3.05	NAF	NAF
WX0097	19 - 20	13/10/2021	Clay	6.24	0.047	1.44	2.4	-0.96	1.67	NAF	UC
WX0097	20 - 21	13/10/2021	Carbonaceous Clay	6.5	0.08	2.45	1.8	0.65	0.735	PAF	PAF
WX0097	21 - 22	13/10/2021	Clay	6.93	0.009	0.275	2.4	-2.13	8.72	NAF	NAF
WX0097	22 - 23	13/10/2021	Clay	7.13	0.009	0.275	3	-2.73	10.9	NAF	NAF
WX0097	23 - 24	13/10/2021	Clay	6.89	0.008	0.245	1.2	-0.96	4.91	NAF	NAF
WX0097	24 - 25	13/10/2021	Clayey Gravel	7.07	0.01	0.306	3	-2.70	9.81	NAF	NAF
WX0097	25 - 26	13/10/2021	Gravel	7.28	0.0025[C]	0.077	0.6	-0.52	7.85	NAF	NAF
WX0097	26 - 27	13/10/2021	Gravel	7.96	0.0025[C]	0.077	2.33	-2.26	30.50	NAF	NAF
WX0097	27 - 28	13/10/2021	Gravely Clay	6.83	0.013	0.398	3.5	-3.10	8.80	NAF	NAF
WX0097	28 - 29	13/10/2021	Clay	6.88	0.011	0.337	3.5	-3.16	10.4	NAF	NAF
WX0097	29 - 30	13/10/2021	Sandy Clay	7.02	0.01	0.306	4.67	-4.36	15.25	NAF	NAF
WX0097	30 - 31	13/10/2021	Sandy Clay	6.04	0.027	0.826	3.5	-2.67	4.24	NAF	NAF
WX0097	31 - 32	13/10/2021	Clay	6.2	0.031	0.949	3.5	-2.55	3.69	NAF	NAF
WX0097	32 - 33	13/10/2021	Clay	6.42	0.031	0.949	2.38	-1.43	2.51	NAF	NAF
WX0097	33 - 34	13/10/2021	Carbonaceous Clay	5.61	0.03	0.918	1.19	-0.27	1.30	NAF	UC
WX0097	34 - 35	13/10/2021	Carbonaceous Gravel	7.26	0.017	0.52	2.97	-2.45	5.72	NAF	NAF
WX0097	35 - 36	13/10/2021	Gravel	7.53	0.009	0.275	3.57	-3.29	13.0	NAF	NAF
WX0097	36 - 37	13/10/2021	Gravel	7.52	0.0025[C]	0.077	2.38	-2.30	31.1	NAF	NAF
WX0097	37 - 38	13/10/2021	Gravel	7.7	0.0025[C]	0.077	1.2	-1.12	15.7	NAF	NAF
WX0097	38 - 39	13/10/2021	Gravel	7.49	0.0025[C]	0.077	1.2	-1.12	15.7	NAF	NAF

HOLE ID	SAMPLE INTERVAL (M)	ANALYSIS DATE	MATERIAL	PASTE pH	TOTAL SULFUR	MPA	ANC	NAPP	NPR	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
WX0097	39 - 40	13/10/2021	Gravel	7.73	0.0025[C]	0.077	1.2	-1.12	15.7	NAF	NAF
WX0097	40 - 41	13/10/2021	Clayey Gravel - Top of GLM[D]	5.85	0.147	4.5	1.2	3.30	0.267	PAF	PAF
WX0097	41 - 42	13/10/2021	GLM	5.7	0.222	6.79	2.4	4.39	0.353	PAF	PAF

[A] – NPR calculated using an ANC of 0.1 kg H_2SO_4/t for calculation purposes.

[B] – assumed ANC of 0 kg H_2SO_4/t given the sample only represents the heavy mineral fraction.

[C] – reported as half the limit of reporting (LOR) = <0.005 wt%.

[D] – this sample is likely to also contain some GLM, which is likely to be a function of the sampling interval.

Table 8. ABA data based on material type

MATERIAL	NO. OF SAMPLES		PASTE pH	TOTAL SULFUR	MPA	ANC	NAPP	NPR	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
UNITS			-log[H+]	wt%	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t			
LOR			0.01	0.005	0.153	1.0	-			
PAN TAILS	5	Min	3.9	0.02	0.612	0[B]	0.612	0.0004[A]		
		Median	6.2	0.42	12.9	0[B]	12.85	0.008[A]	PAF	PAF
		Mean	5.72	1.82	55.8	0[B]	55.8	0.057[A]	PAF	PAF
		Max	7.5	7.46	228	0[B]	228	0.057[A]		
CLAY	22	Min	6.08	0.0025[C]	0.077	1.20	-5.04	1.67		
		Median	7.05	0.012	0.352	3.02	-2.63	8.42	NAF	NAF
		Mean	7.0	0.017	0.529	3.10	-2.58	11.9	NAF	NAF
		Max	8.19	0.047	1.44	5.12	-0.956	66.9		
CARBONACEOUS CLAY	2	Min	5.61	0.03	0.918	1.19	-0.271	0.735		
		Median	6.06	0.055	1.68	1.49	0.188	1.02	UC	PAF

MATERIAL	NO. OF SAMPLES		PASTE pH	TOTAL SULFUR	MPA	ANC	NAPP	NPR	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
		Mean	6.06	0.055	1.68	1.49	0.188	1.02	UC	PAF
		Max	6.5	0.08	2.45	1.80	0.648	1.30		
SANDY CLAY	2	Min	6.04	0.01	0.306	3.50	-4.361	4.24		
		Median	6.53	0.019	0.566	4.08	-3.517	9.74	NAF	NAF
		Mean	6.53	0.019	0.566	4.08	-3.517	9.74	NAF	NAF
		Max	7.02	0.027	0.826	4.67	-2.67	15.3		
GRAVELY CLAY	1		6.83	0.01	0.3978	3.5	-3.10	8.80	NAF	NAF
GRAVEL	8	Min	6.36	0.0025[C]	0.077	0.6	-3.29	1.16		
		Median	7.53	0.0025[C]	0.077	1.2	-1.12	15.7	NAF	NAF
		Mean	7.45	0.005	0.120	1.64	-1.48	16.3	NAF	NAF
		Max	7.96	0.017	0.520	3.57	-0.083	31.1		
CARBONACEOUS GRAVEL	1		7.26	0.02	0.520	3.0	-2.45	5.72	NAF	NAF
CLAYEY GRAVEL	1		7.07	0.01	0.306	3.0	-2.70	9.81	NAF	NAF
CLAYEY GRAVEL – TOP OF GLM[D]	1		5.85	0.15	4.50	1.2	3.30	0.267	PAF	PAF
GLM	1		5.7	0.22	6.79	2.4	4.39	0.353	PAF	PAF
TOTAL NUMBER OF SAMPLES	44									

[A] – *NPR calculated using an ANC of 0.1 kg H_2SO_4/t for calculation purposes.*

[B] – *calculated using an assumed ANC of 0 kg H_2SO_4/t.*

[C] – *reported as half the limit of reporting (LOR) = <0.005 wt%.*

[D] – *this sample is likely to also contain some GLM, which is likely to be a function of the sampling interval.*

4.2 Quality Assurance / Quality Control

Quality assurance and quality control (QA/QC) is an essential step to ensure the data are correct and the sample is classified correctly using these data. The following quality control was undertaken by the laboratories using replicate samples:

- ANC replicate testing: Sample WX0097 14-15 m; and
- Sulfur replicate testing: Samples WX0097 13-14 m; WX0097 31-32 m; and BSE1 (Table 9).

Table 9. QA/QC data

SAMPLE ID	LAB ID	TOTAL SULFUR	TOTAL SULFUR (REP)	ANC	ANC (REP)	RELATIVE PERCENT DIFFERENCE
		wt%	wt%	kg H_2SO_4/t	kg H_2SO_4/t	%
WX0097 13 – 14 m	21/985-11	0.018	0.017			5.6
WX0097 14 – 15 m	21/985-12			3.62	3.02	16.6
WX0099 31 -32 m	21/985-29	0.031	0.034			9.7
BSE1	21/969-01	7.46	7.43			0.4

Note: Total S data provided by SGS laboratories – Lab Ref WP008459; ANC data provided by Verum Laboratories – Lab Ref 21/985; REP = replicate sample

Replicate testing demonstrated that results were reasonable with < 10% relative percent difference (RPD) for total sulfur. The variance in the ANC replicate test was higher with a RPD of ~17%. ANC often is variable at lower ANC values.

An ABA reference sample was analysed as an additional QA/QC step (PAF 1905-002) for ANC with a replicate undertaken (Table 10). Results for the PAF reference sample testing were within the 95% confidence interval indicating the laboratory approach is suitable.

Table 10. PAF reference sample QAQC.

SAMPLE	SAMPLE ID	ANC
PAF Ref Sample (1905-002)	1905-002	3.58 ± 0.25
Lab Analysis	PAF1905-1	3.36
	PAF1905-2	3.60

NOTE: ± values indicate the 95% confidence interval as provided by the reference sample manufacturer.

4.3 Analysis

The data suggests there are four general types of materials present within the project area (excluding historic dredge materials) based on potential risk for AMD and the geo-environmental model. The following materials are discussed:

- Pan tails;
- Non-carbonaceous overburden (including clay, sandy clay, gravely clay, gravel, and clayey gravel of the Upper Waikaka Sequence);
- Carbonaceous overburden associated with the Upper Waikaka Sequence (including carbonaceous clay and carbonaceous gravel); and
- Gore lignite measures (including basal samples containing the GLM).

4.3.1 Pan Tails Mineralogy

The mineralogy of the pan tails is very similar to the heavy mineral content of the Waimumu Quartz Gravels, which are of similar age and lithology. Common minerals include:

- Zircon;
- Garnet (up to 3 forms);
- Ilmenite; and
- Iron sulfide (pyrite or marcasite).

Whilst pyrite is the common form of sulfide present, marcasite has also been observed (Appendix C). These two minerals can be problematic for AMD as they can produce acidic drainage an release toxic metals.

4.3.2 Paste pH

Paste pH results for the pan tails were variable with three samples having circum-neutral pH values (pH 6.32, 6.7, and 7.5) and two samples having acidic paste pH (pH 3.9 and 4.3). The low paste pH values suggest oxidation of the sulfide minerals and the formation of acidic oxidation products that will generate AMD.

The paste pH of the clay samples was circum-neutral with pH values between 6.04 to 8.19, although the carbonaceous clay had a paste pH of 5.61. The gravel materials had a similar pH to the clay with pH values between 6.36 and 7.96. The paste pH of the clayey gravel – top of GLM was slightly acidic with a pH of 5.85 and the GLM had a paste pH of 5.7.

4.3.3 Total Sulfur and Maximum Potential Acidity

Total sulfur data (mean) is presented in Figure 8 for various materials. Two of the pan tail samples had the highest total sulfur of 1.18 and 7.46 wt%, which also corresponded to the lowest paste pH values. The high sulfur values generated MPA values of 36.1 – 228 kg H_2SO_4/t, although other pan tail samples were more variable ranging from <1 - 12.9 kg H_2SO_4/t.

The clay materials generally had total S < 0.05 wt%, except for the carbonaceous clay material that had total sulfur values of up to 0.08 wt%. This trend was reflected in the MPA values that were generally < 1.4 kg H_2SO_4/t except for the outlier carbonaceous clay sample (WX0097 20 – 21 m) at 2.5 kg H_2SO_4/t.

Total sulfur values for the gravel samples mostly remained below the LOR (0.005 wt%); the maximum value recorded was 0.017 wt%. The MPA reflected this with all values remaining < 0.55 kg H_2SO_4/t.

For the clayey gravel – top of GLM the total sulfur, although low (<0.15 wt%), was higher than most other materials tested with an MPA of 4.5 kg H_2SO_4/t. This will be a function of 0.4 m of this sample being GLM. The GLM sample had a total sulfur of 0.22 wt% and a MPA of 6.79 kg H_2SO_4/t.

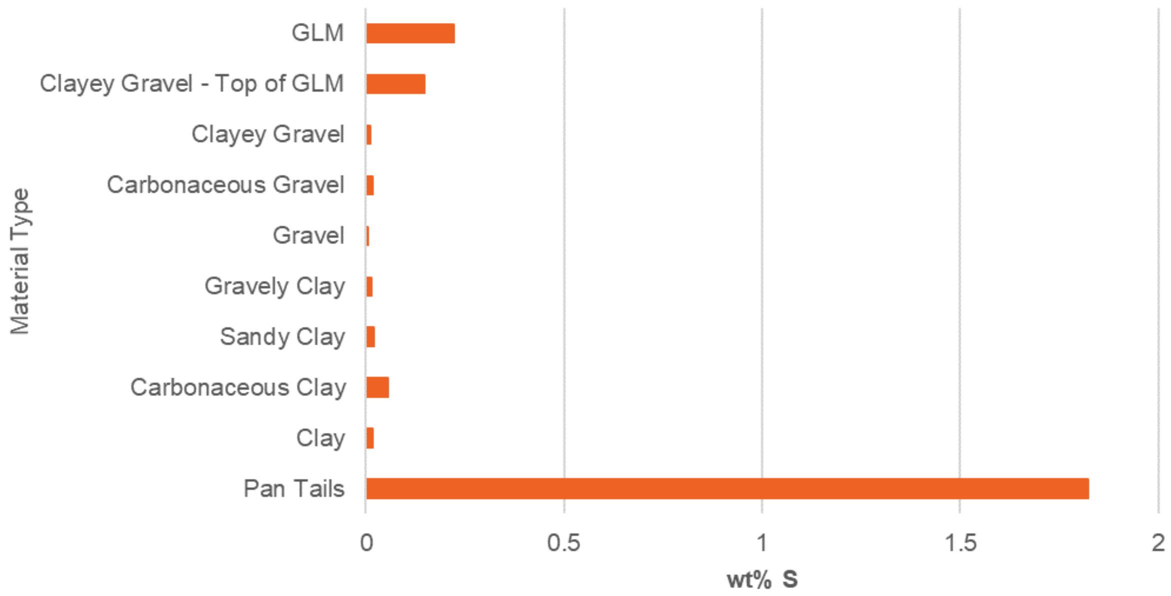

Figure 8. Mean total sulfur values for individual material types.

Total sulfur is often a good guide to the potential risk of AMD, where AMD be acid rock drainage, neutral metalliferous drainage, or saline mine drainage. Figure 8 shows the following groupings:

- Pan Tails with a mean sulfur content > 1.5 wt%;
- GLM and materials mixed with GLM with a mean sulfur content of 0.15 - 0.22 wt%;
- Carbonaceous overburden materials (clay, gravels) with a mean sulfur content of ~0.02 – 0.05 wt%; and
- Non-carbonaceous overburden materials with a mean sulfur content ~< 0.02 wt%

The process residues and materials that contain GLM are the highest risk for AMD. The pan tails are most likely elevated due to the ore feed containing GLM. Other materials have much lower sulfur content and risk for AMD. Carbonaceous overburden materials are generally slightly elevated compared to non-carbonaceous overburden materials.

4.3.4 Acid Neutralisation Capacity

ANC values for the WX0097 drillhole samples were relatively consistent with values ranging from 0.60 - 5.12 kg H_2SO_4/t. The gravel samples generally had the least ANC whist the clay samples tended to have higher ANC values. The clayey gravel – top of GLM sample and GLM had an ANC of 1.2 kg H_2SO_4/t and 2.4 kg H_2SO_4/t respectively. For the pan tails ANC was not analysed. For these samples ANC was assumed to be 0 kg H_2SO_4/t.

Generally, ANC values are low reflecting minor acid neutralisation capacity and minor / no carbonate minerals. This is not unusual given the geological environment. Data suggests clay lithologies have a slightly higher capacity to neutralise acidity, which is likely to be a function of cation exchange with the clay minerals present. Such low ANC values suggest that limited neutralisation is available for any acidity generated by the project activities.

4.3.5 Net Acid Production Potential

Most samples had negative NAPP values with eight samples having a positive NAPP value. All pan tail samples had a positive NAPP (between 0.6 kg H_2SO_4/t and 228 kg H_2SO_4/t). The clayey gravel – top of GLM sample and GLM sample had high NAPP values (relative to the other samples) of 3.3 kg H_2SO_4/t and 4.4 kg H_2SO_4/t respectively. One of the carbonaceous clay samples had a positive NAPP value of 0.65 kg H_2SO_4/t.

4.3.6 Neutralisation Potential Ratio

Data indicates that 10 samples had NPR < 2 with all other samples having NPR's > 2 (NAF). Of the 10 samples with a NPR <2 the results indicated that:

- The pan tails all had NPR values between 0.0004 - 0.16 resulting in the material being classified as PAF;
- One carbonaceous clay sample, along with the clayey gravel – top of GLM and GLM were also classified as PAF with NPR values between 0.27 - 0.74; and
- One clay sample, one carbonaceous clay sample, and one gravel sample had NPR values between 1.16 and 1.67 and were classified as uncertain (UC).

4.3.7 Alluvial Overburden

Data suggests that in general the materials associated with the overburden are non-acid forming. Some carbonaceous-bearing overburden can be classified as PAF and total sulfur values are slightly higher than non-carbonaceous overburden, however total potential acidity as measured by MPA suggest that the risk is low with MPA < 2 kg H_2SO_4/t.

Surficial historic dredge materials have also not been assessed and might be problematic if pyrite has precipitated around the water table (~1.5 m depth). Although given the age of the dredge materials the quantity of pyrite is likely to be low compared to undisturbed ground.

4.3.8 Gore Lignite Measures

The bottom of drill hole WX0097 ended in the Gore Lignite Measures, with the 1 m ore zone sample containing 0.4 m of GLM. Data demonstrates these materials are PAF, although the potential for AMD quantity is low and would be classified as PAF – low capacity by many industry accepted standards (e.g., DFAT, 2016).

Minor amounts of GLM will be excavated for drainage in the pit floor and the pit sump. WGM anticipate removing 0.2 m of GLM (dilution) during the extraction of the ore zone. GLM will report to the mineral residue streams including the pan tails. These materials should be treated as PAF.

4.3.9 Carbonaceous Materials

WGM has noted that the carbonaceous grey materials are easily recognised and could be visually identified by the excavator operator, which will support appropriate materials management as the results indicate these materials are higher risk than other materials.

4.4 AMD Classification

Samples were classified using the NAPP (AMIRA, 2002) and the Price (2009) classification schemes. Results are summarised for all materials in Table 11.

Results indicate that materials that will be excavated with higher AMD risk include materials containing carbonaceous matter. Following processing it is expected that the pan tails will also be a risk for AMD. Given that all materials processed will contain GLM it is also anticipated that other waste streams from the processing plant will also be PAF (see Figure 7).

Table 11. AMD classification of materials

MATERIAL	SAMPLE NO.	NAPP CLASSIFICATION (AMIRA, 2002)	PRICE (2009) CLASSIFICATION
Pan Tails	5	PAF	PAF
Clay	22	NAF	NAF
Carbonaceous Clay	2	UC	PAF
Sandy Clay	2	NAF	NAF
Gravely Clay	1	NAF	NAF
Gravel	8	NAF	NAF
Carbonaceous Gravel	1	NAF	NAF
Clayey Gravel	1	NAF	NAF
Clayey Gravel - Top of GLM	1	PAF	PAF
GLM	1	PAF	PAF

Classifications are based on mean data for MPA and ANC where the sample population > 1.

AMIRA (2002) and Price (2009) AMD classification methods provided similar results with only the carbonaceous clay material being lightly different (as shown in Table 11). These materials should be treated as PAF as a conservative approach.

5 AMD RISK ASSESSMENT

The data presented in this report was used to determine the key materials that could be a source hazard for AMD. The following section discusses the potential AMD source hazards, potential risks, and management requirements to minimise the potential effects of AMD.

5.1 AMD Source Hazard Materials

The geochemical assessment has identified the following materials are potentially a source hazard for AMD:

- Pan tails;
- Sediment pond fines;
- Processing residues;
- Carbonaceous lithologies associated with the WQG (including carbonaceous clay and carbonaceous gravel);
- Ore; and
- Gore Lignite Measures.

ABA data indicates what materials are a potential environmental geochemical hazard. However, the overall risk to the receiving environment is also a function of material quantities. The AMD source hazard for each material type can be determined from the material quantities (Table 2) and MPA data. Table 12 presents several key assessments of individual materials using ABA data which include:

- Total acid potential (tonnes): determined from the materials quantity (tonnes) multiplied by the MPA (mean) to determine the total potential acid that could be generated by the material;
- Total acid potential (%): determined for each material type as a percentage of the total potential acidity; and
- Total ANC (tonnes), determined from the materials quantity (tonnes) multiplied by the ANC (mean) to determine the total ANC that is available within the material types.

Overall, the greatest material volumes are associated with the overburden (~90%) with the wash / ore zone representing the remainder (~10%) with 0.1% associated with GLM. Data indicates that 14.8% of the materials will be problematic in regards to AMD (pan tails, silt pond fines, process residues, carbonaceous overburden, and GLM) representing 57.5% of the total acid potential for the project.

The data summary demonstrates that although some materials are PAF, the potential capacity for AMD is low and would be classified as PAF – low capacity by many industry accepted standards (e.g., DFAT, 2016). The exception to this is the pan tails (NAPP of 55.8 kg H_2SO_4/t, however, the risk to the receiving environment is low given the very small volumes of materials. ANC data suggests in general there is limited ANC, which means little capacity to buffer any acidity generated.

The data can also be used to assess the overall NAPP for the project, which has been calculated as NAPP negative with a value of -140,000 tonnes, and a NPR of 3:1 classifying the project as NAF overall. This does not mean that AMD will not occur but suggests with good materials management, the risks of AMD can be minimised such that the effect on the receiving environment is less than minor.

Table 12. AMD hazard source for WGM materials.

MATERIAL	MATERIAL VOLUMES (m^3)	MATERIAL QUANTITY (tonnes)	MATERIAL QUANTITY (%)	MPA (MEAN) kg H_2SO_4/t	TOTAL ACID POTENTIAL (tonnes)	TOTAL ACID POTENTIAL (%)	ANC (MEAN) kg H_2SO_4/t	TOTAL ANC (tonnes)
Total Wash	2,814,361	7,598,775						
Pan Tails	12.8	40.96	0.00005%	55.8	2.28	0.003%	0	0
Silt pond slimes	450,298	1,215,798	1.5%	4.5	5,469	7.865%	1.2	1,459
Process residues	2,364,050	6,382,936	8.0%	4.50	28,712	41.290%	1.2	7,660
Total Overburden	27,868,003	72,456,808						
Non-carbonaceous overburden	26,251,659	68,254,313	85.2%	0.433	29,578	42.536%	2.83	192,846
Carbonaceous overburden	1,616,344	4,202,495	5.2%	1.295	5,444	7.829%	1.99	8,353
Gore Lignite Measures	18,800	48,880	0.1%	6.7932	332	0.478%	2.40	117
Total Materials	30,701,164	80,104,463			69,537			210,434

** - Includes 0.2 m of GLM within the ore.*

*** - Material volumes relate to the excavation of drainage ditches and the construction of pit floor sumps into the GLM.*

**** - Material volumes related to the ~ 1-2 m surrounding the GLM as this material will likely be processed.*

[A] – ANC assumed 0 kg H_2SO_4/t

Re follow.

5.2 Closure Objectives – Water Quality

Closure objectives for water quality need to be defined for the project including monitoring for potential contaminants of concern (PCOC). The current assumption is that an ANZG 95% limit (ANZG, 2018) will be applied to water quality discharges from the mine site. This assumption needs to be reviewed by aquatic eco-toxicologists.

PCOC associated with AMD are likely to include low pH, acidity, Fe, Al, dissolved metals and sulfate. A column leach test has been established to determine potential contaminants of concern for the project (MWM, 2022). This involves leaching of a sample containing Gore Lignite Measures using the AMIRA (2002) column leach test procedure. Further information is provided in Section 7.2.4 on this work.

It is recommended that water quality compliance monitoring will be required within the Waikaka Stream to monitor any effects associated with discharge from the proposed operation.

5.3 AMD Risk Assessment

Based on the identification of AMD hazards for materials that will be excavated and produced at site a preliminary AMD risk assessment was undertaken using a source – pathway - receptor (SPR) analysis (e.g., Figure 9) to understand potential risks for the WGM project.

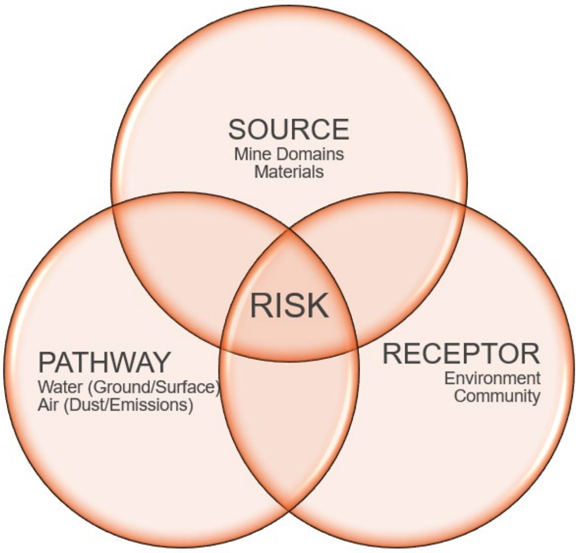

Figure 9. Generic SPR Model

Potential source hazard materials have been identified (Section 5.1) and any mine domains that contain these materials. For this project potential pathways include groundwater and surface waters with key receptors for the risk assessment being the Waikaka River and the final terminal pit lake that will remain as a final water body. Table 13 provides a high-level preliminary AMD risk assessment based an understanding of the material properties and the proposed mine plan.

It is recommended this risk assessment be updated as the mine plan matures, with the availability of additional environmental geochemistry data, and before operations commence to ensure all significant risks are addressed.

Table 13. Preliminary AMD Risk Assessment.

MINE DOMAIN	RISK	RISK	PROPOSED CONTROLS (PRELIMINARY)#	PROPOSED PERFORMANCE MONITORING (PRELIMINARY)#	RESIDUAL RISK
Ex-pit long term (waste rock) stockpile (LTSP)	The placement of PAF materials in this mine domains could lead to oxidation of sulfides and mobilisation of AMD to surface waters and groundwater. This is a higher risk for the project as this could create a source of AMD.	HIGH	1. Ensure no carbonaceous materials, or processing residues are placed in this mine domain. 2. Ensure no PAF materials are placed in this mine domain. 3. Consider appropriate engineering controls (Section 6). 4. Integration of the geochemistry model into geological model to develop material schedules to ensure no PAF material is scheduled for the LTSP. 5. Return all materials in the LTSP back into the pit void as part of closure activities / mine sequencing	1. Carbonaceous materials can be identified visually by excavator operators. 2. QA/QC geochemical testing of materials to confirm they are NAF and validate the geochemical model.	LOW
ROM Pad	Materials will contain PAF materials, which could lead to surface run-off and infiltration to groundwaters. This risk is only present during the operational phase of mining project.	MODERATE	1. Construct ROM Pad base to be low permeability to limit water seepage to underlying alluvial sediments. 2. Minimise time that ore is stockpiled. 3. Ensure all surface run-off is directed to sediment ponds 4. Consider appropriate engineering controls (Section 6).	1. Monitor drainage water quality from ore stockpiles. 2. Paste pH / EC testing of materials to check for oxidation.	LOW

MINE DOMAIN	RISK	RISK	PROPOSED CONTROLS (PRELIMINARY)#	PROPOSED PERFORMANCE MONITORING (PRELIMINARY)#	RESIDUAL RISK
In-Pit OBDA (Operational Phase)	In the short term during the operational phase of the mine, before the water table rebounds, sulfide minerals in these materials could oxidise. This could lead to the formation of AMD during operations.	MODERATE	1. Minimise time that overburden is exposed, particularly PAF materials 2. Consider appropriate engineering controls (Section 6). 3. Ensure all PAF materials are placed below the long term water table (<5 m). 4. Ensure all surface run-off is directed to in-pit ponds.	1. Monitor drainage water quality from OBDA. 2. Paste pH / EC testing of materials to check for oxidation products. 3. Water quality monitoring within the Settling Ponds.	LOW
In-Pit OBDA (Closure Phase)	During the operational phase of the mine before the water table rebounds sulfide minerals could oxidise. This could lead to the formation of stored acidic oxidation products (acidity, PCOC). These PCOC could be mobilised during the water table rebound affecting groundwaters.	MODERATE	1. Minimise time that overburden is exposed, particularly PAF materials. 2. Ensure all PAF materials are placed below the long term water table (<5 m). 3. Consider the addition of limestone to mitigate any acidity. 4. Consider appropriate engineering controls (Section 6).	1. Monitor drainage water quality from OBDA. 2. Paste pH / EC testing of materials to check for oxidation products. 3. Monitoring of groundwater bores (lagging performance indicator).	LOW
Pit Void	Waters with the pit void could be affected by AMD, which could be released to groundwaters (seepage) and surface waters (pumping).	MODERATE	1. All drainage from the OBDA will be collected in drains excavated into the GLM, which will act as a low permeability layer (control). 2. All impacted waters will be pumped to the settling pond where treatment can be undertaken for mine-impacted waters.	1. Monitoring of pit sumps for pH and EC 2. OBDA performance monitoring. 3. Monitoring of the settling pond inflow (pH, EC). 4. Groundwater monitoring downstream of the site (lagging performance indicator).	LOW

MINE DOMAIN	RISK	RISK	PROPOSED CONTROLS (PRELIMINARY)#	PROPOSED PERFORMANCE MONITORING (PRELIMINARY)#	RESIDUAL RISK
Settling Ponds	The settling ponds will receive all mine-impacted waters from the site and could be affected by AMD.	MODERATE	1. Treatment of AMD impacted waters could be undertaken with the settling ponds using NaOH or $Ca(OH)^2$ as needed.	1. Monitoring of pit sumps for pH and EC 2. OBDA performance monitoring. 3. ROM Pad performance monitoring 4. Monitoring of the settling pond inflow (pH, EC).	LOW
Terminal Mine Lake	At the completion of mining there will be a terminal mine lake at the top of the catchment area. Groundwater flow into this pit lake is from upstream alluvial gravels. PAF materials in the OBDA could affect the water quality	LOW	1. Ensure the final OBDA slopes are compacted to prevent seepage from the OBDA into the pit lake. 2. Mining up-gradient means that final pit void water quality is related to inflow water.	1. Water quality monitoring of the terminal pit lake during filling and post closure until water quality trends are stable.	LOW

 # - subject to further assessments based on the final mine plan

6 AMD MANAGEMENT OPTIONS

The preliminary AMD Risk Assessment indicates that some materials are PAF with a low capacity to generate AMD. However, the ANC of the materials is also low and minor acidity could generate discrete occurrences of AMD. In this regard AMD management methodologies are required including prevention, minimisation, and control and treat. The following section describes the management options available. Such options need to be assessed further prior to mining commencing.

6.1 Prevention and Minimisation

The prevention of sulfide mineral oxidation and the minimisation of water flow through sulfide-rich materials are the key management mechanisms for the source control of AMD. Such methodologies have the potential to enable source control of AMD rather than accepting and utilising a treatment in perpetuity approach for AMD.

Industry experience indicates that WRSs are typically the principal mine domain associated with contaminant generation and typically can account for 60 – 80% of the site pollution load (e.g., Weber et al., 2017). Hence, if WRSs are constructed to minimise oxygen ingress and avoid interactions with water there is the opportunity to significantly reduce the main source of contaminants reporting to the receiving environment. This can reduce the need for long term treatment.

The flux of oxygen into a poorly constructed WRS is typically higher than the flux of oxygen into a tailings storage facility (TSF):

- Within a TSF the oxygen flux is driven by a chemical gradient (no oxygen at depth versus atmospheric oxygen concentrations at the surface); and
- Within a WRS the oxygen flux is often driven by the advective flow of oxygen (temperature differences, barometric pressure differences) along coarser waste rock layers that form within poorly constructed WRDs.

The oxygen flux (as evidenced by oxidation products) is shown in Figure 10

Fig A: Tailings – Difussion of oxygen Fig B: Waste Rock Stack – Advection of oxygen

Figure 10. Diffusion of oxygen into a TSF as shown by Fe oxidation products, and advection pathways within a WRS as shown by oxidation at angle of response tipheads.

Source: Miller et al., 2003: ICARD 2003 ARD Prediction Short Course.

Often these advective oxygen pathways into a waste rock stack are associated with high tipheads (> 4-6 m in height) leading to grainsize segregation and the formation of basal rubble layers and chimney zones due to the process of end tipping (Figure 11).

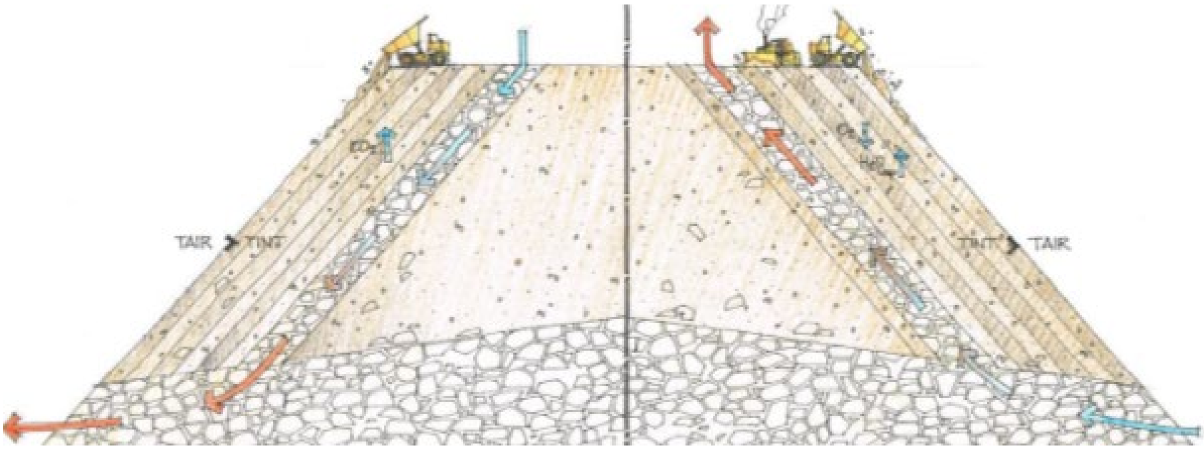

Figure 11. Waste Rock Stack chimney zones and rubble layers.

Source: Pearce et al., 2016

International research (INAP, 2020) has demonstrated that one of the most effective methods to minimise advective ingress of oxygen into waste rock stacks is to minimise the height of the tiphead to <4-6 m and ensure that each lift has a compacted running surface, which reduces the size of the advective cell (both vertically and horizontally into the WRS (Figure 12 and Figure 13).

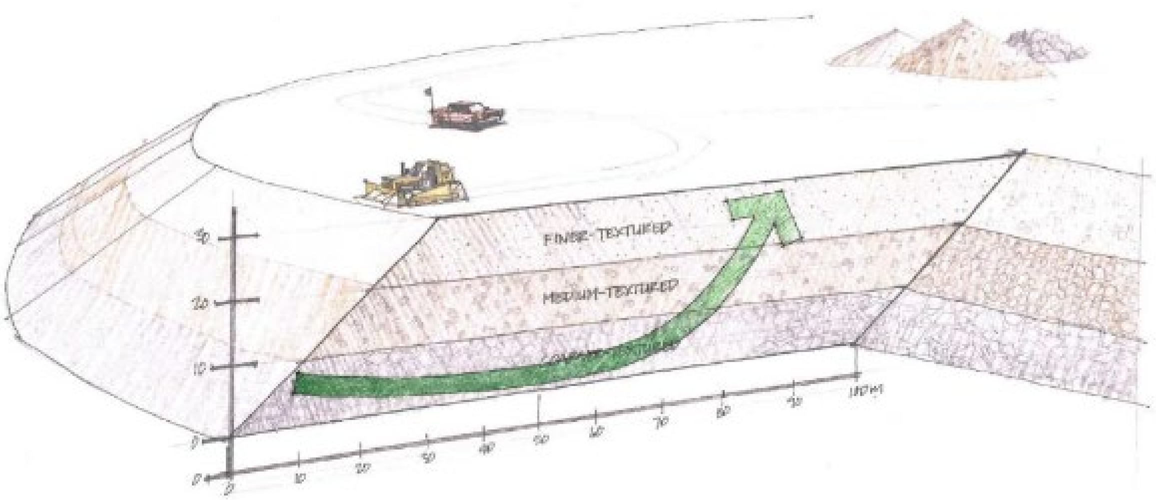

Figure 12. Conceptual gas transport regime in a WRS with no engineering controls.

Source (INAP, 2020): Significant horizontal ingress along the basal chimney zone and significant vertical rise upwards along chimney zones.

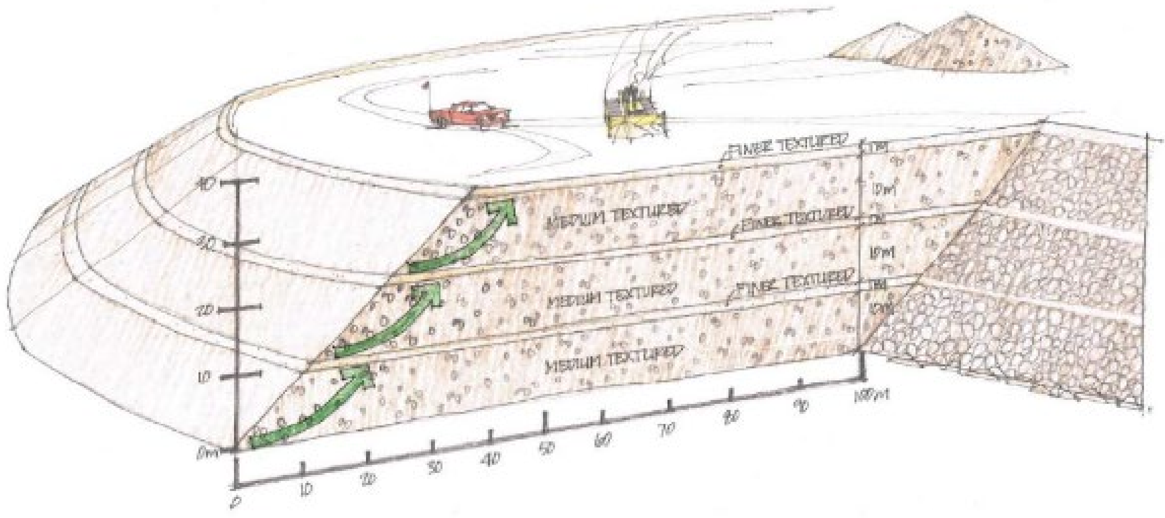

Figure 13. Conceptual gas transport regime into a WRS with trafficked air-entry disrupting running surfaces.

Source (INAP, 2020): Limited oxygen ingress horizontally due to a lack of a basal rubble layer; limited vertical oxygen rise due to running surfaces.

6.2 Potential Engineering Controls – Waikaka Gold Mine

The following principles could be applied as engineering controls to minimise the effects of AMD including techniques to prevent the ingress of oxygen and techniques to minimise the mobilisation of contaminants.

No PAF materials should be placed within the ex-pit long term stockpile (LTSP). All PAF materials should be placed in the pit backfill below the long term water table (< 5 m) to prevent ongoing sulfide mineral oxidation. Engineering controls that should be considered to minimise AMD risks include:

6.2.1 Short lifts

It is recommended that PAF materials be placed in short lifts (< 4 - 6 m) or by paddock dumping. This will prevent grainsize segregation and minimise the advective ingress of oxygen into materials.

It is recommended that ore being placed on the ROM pad is also paddock dumped, or when weather conditions are not appropriate (i.e., wet) that short 2 m lifts are used, to minimise the potential oxidation of sulfide minerals in the ore.

6.2.2 Encapsulation

PAF materials should be placed within the OBDA as a cell followed by encapsulation with NAF materials. These PAF cells should have a low permeability layer placed above them and be set back from the edge of the in-pit backfill to limit oxygen ingress. Further detailed design is required prior to mining commencing.

6.2.3 Clean Water Diversion

Water is the primary pathway for the mobilisation of contaminants from PAF materials. Management methodologies could include:

- Diversion of run-on water from key mine domains containing PAF materials (ROM Pad, OBDA, pit void);
- Design of the OBDA area surfaces to shed water, where ponding of water on overburden is avoided (e.g., sediment sumps); and
- Flattening out paddock dumped materials to shed water before significant rainfall events.

6.3 Control and Treat

The potential for AMD at the Waikaka Gold Mine is low with some materials being classified as PAF – low capacity (DFAT, 2016) and the overall project NAPP potential being negative with a NPR of 3:1. However, the materials have low ANC and any acidity generated could lead to AMD. Proactive management of AMD using engineering controls is recommended as explained in Section 6.1 and Section 6.2.

As there is the potential for poor water quality it is recommended that in additional to the engineering controls proposed, that consideration is given to control and treatment of AMD should it occur. This option should form part of the adaptive management plan for the project and include suitable performance monitoring as shown in Table 12.

With all PAF materials being placed back in the OBDA and all drainage from these materials being directly to the pit sump there is an effective control strategy in place for PAF materials and processing residues. All process water is discharged via the settling pond and then via the L&M Pond.

If treatment of AMD was required there is effective monitoring locations (e.g., pit sump, settling pond) to confirm whether treatment is required. Treatment could be undertaken using the settling ponds. Simple caustic (NaOH) or lime ($Ca(OH)_2$) dosing systems could be established to treat any acidity generated.

6.4 Performance Monitoring

Performance monitoring is an important aspect of AMD management and should include leading and lagging performance monitoring programs to confirm design criteria are being achieved. Performance monitoring provides the data for trigger action response plans (TARPs) in case there is a variance from the expected case and further actions are required to minimise potential effects. This report suggests that performance monitoring should include, for instance:

- Geochemical characterisation of materials (pre excavation for sulfides and post placement for sulfide oxidation products);
- Monitoring of water quality within the pit sump; and
- Monitoring of water quality discharged to the settling ponds.

Further performance monitoring should be assessed prior to mining activities commencing to focus on key projects AMD risks.

7 SUMMARY AND RECOMMENDATIONS

The following summary and preliminary recommendations are provided for this project.

7.1 Summary

The data presented in this report suggests there are some materials associated with this project that could generate AMD. Based on the assessment presented in this report the risk for AMD is low, which is based on the following key clarifications:

- In regards to the source hazard the quantity of acid that could be generated is relatively low and materials are classified as PAF – low capacity (DFAT, 2016)
- There is potential minor acidity that could be generated by carbonaceous overburden (2.45 kg H_2SO_4/t) and materials that contain the Gore Lignite Measures (4.5 – 6.8 kg H_2SO_4/t).
- Data indicates that 15% of the materials to be excavated are potentially acid forming (PAF) and could generate AMD. The remaining materials (85%) are NAF and are unlikely to generate acidity.
- Engineering controls are available to prevent the oxidation of sulfide minerals and minimise the mobilisation of acidic oxidation products that lead to AMD.
- It is proposed by WGM that all PAF materials will be returned to the in-pit OBDA and will be placed below the water table. In the long term this will eliminate oxygen ingress, ongoing sulfide mineral oxidation, and long term AMD risks.

However, the acid neutralisation capacity (ANC) of the materials is low with ANC values being < 5 kg H_2SO_4/t, which means the ability to neutralise any acidity generated is low. Hence, there is the potential for AMD at the project and performance monitoring will be required to determine if treatment is required during the operational phase of the project. Further work is required to understand potential acidity loads. This should be undertaken prior to mining activities commencing

7.2 Further Investigations

7.2.1 Baseline Water Quality

A number of water samples have been collected from site. It is recommended further samples are obtained including the assessment of dissolved metals. Contaminants should align with those contaminants identified from column leach testing (MWM, 2022).

7.2.2 Dredge Materials

Previous research (Falconer et al., 2006) suggests that pyrite can be associated with the water table. A discrete water table is at ~ 1.5 m for the project area (L&M, 1999), which is within the dredge materials. These materials were not assessed as part of this assessment. Given the age of the dredge materials the quantity of pyrite is likely to be low compared to undisturbed ground. Samples should be obtained from the dredge material to confirm if there is a risk for AMD from these materials if the project commences.

7.2.3 Geochemical ABA characterisation

The project has analysed one complete drillhole to understand the risk for the project area. Whist this provides a good understanding of materials that may be problematic in regard to AMD there is limited spatial coverage. It is recommended that further geochemical testing be undertaken once operations commence to validation assumptions in this report.

The determination of the potential for AMD assumes that all sulfur measured is contained within pyrite. This may be conservative. Sulfur speciation work on a select number of samples from the overburden would refine the estimate of maximum potential acidity.

7.2.4 Column Leach Testing

PCOC associated with AMD are likely to be low pH, acidity, Fe, Al, dissolved metals and sulfate. A column leach test has been established to determine potential contaminants of concern for the project (MWM, 2022). The sample chosen was from drillhole WX0097 at 40-41 m containing 0.4 m of GLM. The sample is classified as PAF having a NAPP of 3.3 kg H_2SO_4/t.

These data will help provide guidance on water quality monitoring requirements based on PCOC.

It is recommended that additional columns be established to determine the water quality generated by the carbonaceous overburden materials and the non-carbonaceous overburden. Understanding the potential risks to water quality for these materials will be important and whether the assumption that the carbonaceous materials are PAF remain valid.

7.3 Management Plan

It is recommended an environmental / AMD management plan be developed for the project, which should be supported by performance monitoring and adaptive management processes. It is recommended this management plan be developed prior to mining activities commencing.

The management plan needs to address the following activities:

- Materials characterisation (validation testing)
- Performance monitoring of key project risks
- Compliance monitoring
- Closure

For effective AMD management it is recommended that AMD training is provided to key project staff to provide a general understanding of AMD and how to manage the associated AMD risks

The management plan should utilise adaptive management principles. Adaptive management is a recognised management option under the Resource Management Act (RMA) (e.g., Leckie, 2017). Effective adaptive management is supported by understanding the nature and duration of possible events that could occur, monitoring these events, and then having options in place should there be variance from the expected condition. This requires:

- Understanding the risks;
- Monitoring (as early warning, i.e., performance monitoring);

- Variance planning; and
- Trigger Action Response Plans (TARPS).

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9 LIMITATIONS

Attention is drawn to the document "Limitations", which is included in Appendix F of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A ABBREVIATIONS

ABBREVIATION	DEFINITION
ABA	Acid base accounting
AEE	Assessment of Environmental Effects
AMD	Acid and metalliferous drainage, which can also include low metal saline drainage
AMDMP	Acid and metalliferous drainage management plan
AMIRA	Australian Minerals Industry Research Association
ANC	Acid neutralisation capacity
ANZG	Australia and New Zealand Guidelines for Fresh and Marine Water Quality (2018)
ARD	Acid Rock Drainage
bcm	Bench cubic metres
DFAT	Department of Foreign Affairs and Trade, Commonwealth of Australia
FS	Feasibility Study
GLM	Gore Lignite Measures
GW	Ground Water
HCl	Hydrochloric Acid
INAP	International Network for Acid Prevention
LOM	Life of mine
LOR	Limit of reporting
LTSP	Long-term stockpile
MEND	Mine Environment Neutral Drainage Programme (Canada)
Mt	Million tonnes
MPA	Maximum potential acidity
MWM	Mine Waste Management Ltd
NAF	Non-acid forming
NAPP	Net acid production potential
NMD	Neutral Metalliferous Drainage
NP	Net percolation
NPR	Neutralisation Potential Ratio
OBDA	Overburden Disposal Area (Backfill)
PAF	Potentially acid forming
Pan Tails	Pan Tailings Concentrate Samples
PCOC	Potential Contaminants of Concern
PSD	Particle size distribution
QA/QC	Quality assurance and quality control
QPC	Quartz pebble conglomerate

RMA	Resource Management Act
RPD	Relative Percent Difference
ROM	Run of mine
SAP	Sample and Analysis Plan
SD	Saline Drainage
SPF	Settling Pond Fines
SW	Surface Water
TARPS	Trigger Action Response Plans
TMF	Tailings Management Facility
TSS	Total Suspended Sediment
UC	Uncertain
UWS	Upper Waikaka Sequence
WGM	Waikaka Gold Mine
WQ	Water Quality
WQG	Waikaka Quartz Gravels
WRL	Waste Rock Landform

APPENDIX B WHAT IS AMD / HOW TO PREDICT AMD

FACT SHEET 1 - WHAT IS AMD

Acid and metalliferous drainage (AMD) is a general term used to describe waters impacted chemically by mining activities and can contain significant quantities of toxic metals, salts, and acidity.

AMD is typically generated by the excavation of rocks that contain sulfide minerals, such as pyrite. When these minerals are exposed to oxygen and water, they undergo weathering processes and oxidise, generating acidity and releasing toxic metals.

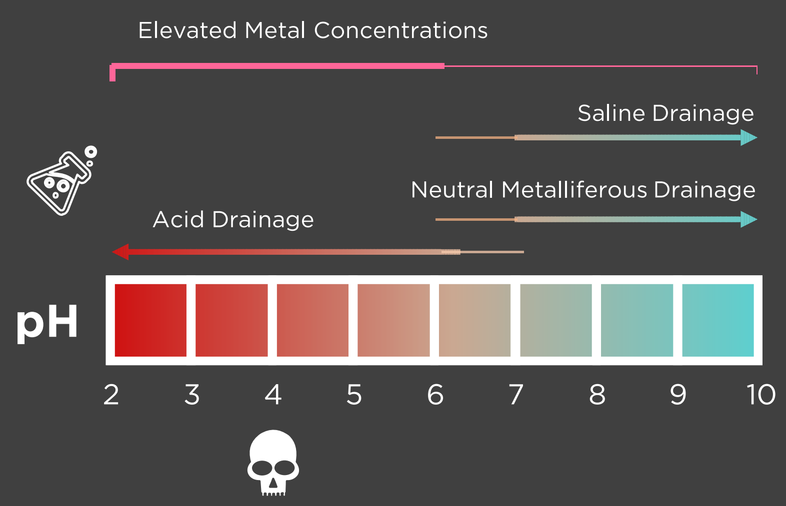
The oxidation of pyrite is explained by Equations 1-3 where the ferric (Fe^{3+}) iron precipitates in a goethite or ferrihydrite type form (iron-oxyhydroxide) such as the orange precipitate seen in the image.

- **Equation 1:** $FeS_2 + {}^{7}/_{2}\ O_2 + H_2O \longrightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$
- **Equation 2:** $Fe^{2+} + {}^{1}/_{4}\ O_2 + H^+ \longrightarrow Fe^{3+} + {}^{1}/_{2}\ H_2O$
- **Equation 3:** $Fe^{3+} + 3H_2O \longrightarrow Fe(OH)_3 + 3H^+$

Microorganisims play an important part in the oxidation of sulfide minerals and the formation of AMD. Such bacteria can increase sulfide oxidation rates by many orders of magnitude.

Once acidity and metals are generated they can then be mobilised by any water sources, including rainfall, run-on water, water from dust suppression, or water added via processing. It is important to note that this can occur in both high rainfall and low rainfall environments.

AMD waters can be sub-divided into three general water types depending on their pH and concentration of sulfate and metals.



Acid Rock Drainage (ARD):
Has high acidity, low pH drainage, and has occurred due to the oxidation of acid producing sulfide minerals. ARD generally contains significant dissolved toxic metals.

Neutral Metalliferous Drainage (NMD):
Often referred to as metalliferous drainage where the acid produced by the oxidation of sulfide minerals has been neutralised by other minerals such as carbonates, with the resultant waters having high toxic metal concentrations but circum-neutral pH.

Saline Drainage (SD):
Which refers to waters that are close to neutral-to-alkaline in pH with elevated sulfate.

AMD EFFECTS

AMD can create a number of other health, safety, environmental, and community issues:

- Acute short term and chronic long term effects of interactions with acid waters and waters containing elevated metals where pathways include skin contact, ingestion, and inhalation.
- Metals derived from AMD entering the food chain (bio accumulation) causing health issues for animals, livestock, and humans.
- Sedimentation and smothering of drainage channels with metal-rich precipitates.
- Increased erosion rates for sulfidic materials.
- Interaction of AMD with concrete (acid- and sulfate- attack) leading to degradation of site infrastructure.
- Spontaneous combustion.
- Generation of gases such as carbon dioxide and hydrogen sulfide, which may be at fatal concentrations.
- Generation of low oxygen air, which can be fatal.
- Visual impacts and negative stakeholder perceptions.
- Impacts on business reputation and business sustainability including social licence / social value.
- Ability to close sites affected by AMD and long term treatment costs and risks.

AMD LEGACY EFFECTS

AMD MANAGEMENT TRAINING SERIES: FACT SHEET 1

Internationally, there are many examples of historical legacy sites where AMD has not been managed correctly resulting in significant impacts to the environment.

For instance:

- In Spain, the **Rio Tinto River** is coloured red due to iron, from sulfide mineral oxidation and is highly acidic. (see image)

  This is the result of AMD from thousands of years of base metal mining for gold, silver, and copper within the Iberian Pyrite Belt.

- **Iron Mountain**, a historical minesite in California, is another example. Untreated AMD from the site was causing fish kills in the river and the build-up of contaminated sediments in the downstream receiving environment.

- **Mount Lyell**, Tasmania is one of Australia's worst AMD sites where 100 million tonnes of sulfidic tailings were dumped into the Queen River resulting in low pH and elevated metals.

Modern mining companies must address the risks of AMD through sustainable best practicable management options to prevent the creation of future legacy sites

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FACT SHEET 4 - HOW TO PREDICT AMD

AMD MANAGEMENT TRAINING SERIES

Prediction of the potential for AMD, the type (being acidic, neutral metalliferous, or saline drainage), severity, time to onset, and subsequent longevity are determined by a process of materials characterisation.

Each project will have different AMD characterisation requirements to understand potential effects and risks for the project, which is specific to the deposit type, alteration styles, material quantities, weathering effects, physical setting, and regulatory setting.

Materials should be characterised so that material-specific AMD risks are understood, and hence also, the potential geochemical risks for mine domains containing these materials. Furthermore:

1. Understanding the potential AMD characteristics for various materials and subsequent mine domains enables a risk assessment based on scientific and engineering data to determine management options.
2. An **AMD risk assessment** is a fundamental step in AMD prediction and will be revisited many times over the project life.
3. The AMD risk assessment process determines the AMD management requirements for the project (e.g., prevention, minimisation, control and treat).
4. Hence, prediction drives AMD management options.

Prediction has several components, potentially requiring more detail as the mine matures through exploration, mine development, mine operation, and mine closure. The components of prediction can be simplified as follows:

1. Geoenvironmental Models
2. Material Characterisation
3. Material Geochemical Signature
4. Water Quality Predictions
5. AMD Risk Assessment

GEOENVIRONMENTAL MODELS (ANALOGUE MODELS)

Geoenvironmental models provide fundamental information on the type of deposit and the likely environmental risks associated with geochemistry (e.g., Plumlee, 1999). It has been suggested that deposit type can contribute to 30% of the maximum potential AMD risks for a site (Richards et al, 2006), which means that important information can be gained from understanding the deposit type.

Further information can be gained from analogue models, which include:

- Local mine operations that disturb similar geological materials;
- Other mine domains (e.g., waste rock dumps, pit voids); and
- Knowledge and data about specific problematic lithological materials.

Such analogue models can be used to provide evidence of similar geochemical effects and risks. Often such information is obtained from desktop investigations and provide initial guidance on the potential AMD risks for a project.

Visual Clues

- Are there any visual indicators of AMD generation such as iron oxide crusts on exposed rocks or iron oxide precipitates in nearby streams?

Analogue Models

- Are there any other mines in the area, which have targeted the same lithologies, minerals, ore type? Do these mines have issues with AMD?
- Globally, are these types of mines known to have AMD issues?

MATERIAL GEOCHEMICAL CHARACTERISATION

Material geochemical characterisation, or source hazard characterisation, is a fundamental step in the assessment of any project in regards to the potential risks for AMD. Materials should be characterised so that AMD risks are understood, and hence also, the potential geochemical risks for mine domains containing these materials.

Characterisation involves assessment of:

- **Geochemical Nature** (Acid Base Accounting), for instance, potentially acid forming (PAF); or non-acid forming (NAF).
- **Geochemical Signature** of water quality (potential effects), for instance acidic, metalliferous, or saline drainage.

Material Sampling Program

Several guidance documents are available to assist the development of a project specific sampling and analysis program (AMIRA, 2002; Price, 2009; INAP, 2010; DTIR, 2016), which all give consideration to the following:

- Project phase;
- Quantity of material to be disturbed through mining;
- Existing datasets;
- Variability of critical parameters (geology / alteration / mineralogy / degree of weathering); and
- Social value and regulatory requirements.

Where prior information is not available, a common guide to an initial sampling frequency is provided in the below table (variations presented in both Price, 2009, and DTIR, 2016).

Tonnage of Unit (metric)	Minimum Number of Samples
<10,000	3
<100,000	8
<1,000,000	26
<10,000,000	80
>10,000,000	Few hundred

Testing (chemical and physical) involves the use of geoenvironmental models, laboratory tests, field tests, and other observations. Further information on acid base accounting (ABA) to understand the geochemical nature of materials as well as test methodologies to understand the potential geochemical signature are provided in Fact Sheet 11 (Laboratory Test Methods).

*Although this fact sheet is focused on AMD characterisation, there are other environmental geochemical effects that might be identified during investigations including risks associated industrial diseases (asbestosis, silicious), carcinogenic compounds (e.g., As), radioactivity, spontaneous combustion, and greenhouse gas emissions, which all have potential receptors (environment, community, closure).

Geochemical Nature (Acid Base Accounting)

Acid base accounting (ABA) uses laboratory data to determine if the material is NAF or PAF, which is based on the difference or ratio between acid forming and acid neutralising minerals in the rock. Classification is typically based on either (or both) the AMIRA (2002) or Price (2009) classification schemes until site-specific classification systems are developed. Examples are available in the GARD Guide (INAP, 2010) and the Leading Practice Sustainable Development Program for the Mining Industry - Preventing Acid and Metalliferous Drainage (DTIR, 2016).

The acid generating potential of a rock is determined by measuring the sulfur (or sulfide) content and calculating the maximum potential acidity (MPA) that would be generated, assuming all the sulfur (or sulfide) is present as pyrite and completely oxidises.

The acid neutralisation capacity (ANC) is determined by laboratory testing (acid digestion), which is designed to assess neutralising minerals in the material. ANC can also be calculated from carbonate content where data are available and there is confidence in the approach.

$$\text{MPA} = \text{S (wt\%)} \times 30.63 \qquad \text{Units: kg } H_2SO_4/t$$

MPA and ANC data are fundamental data for ABA for determining the net acid producing potential (NAPP) where NAPP positive data suggests the sample is PAF and NAPP negative data suggests the sample is NAF.

$$\text{NAPP} = \text{MPA} - \text{ANC} \qquad \text{Units: kg } H_2SO_4/t$$

The net acid generating capacity (NAG) of a sample can also be determined to provide quantification of the overall acid generating capacity (kg H_2SO_4/t) of a sample where acidity generated reacts with any neutralising minerals to provide an overall final NAG pH.

ABA data can also provide guidance on the potential for neutral metalliferous drainage (NMD), for instance:

- Where elevated sulfide sulfur is present, yet the sample is NAPP negative due to abundant ANC; and
- Where NAG testing provides circum-neutral pH yet significant sulfide oxidation has occurred and metals of potential concern remain in solution.

Additional assessment is often required to understand and quantify the potential for NMD including kinetic testing and other wet laboratory techniques to understand the geochemical signature of the materials.

Further information on test methods is provided in Fact Sheet 11.

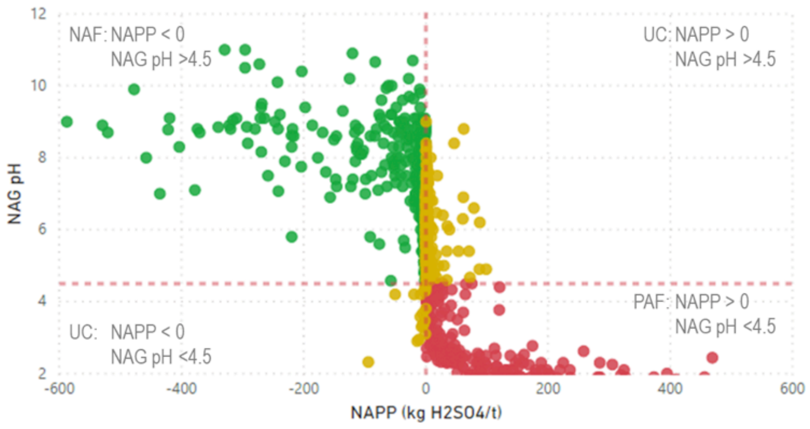
HOW TO PREDICT AMD

AMIRA Classification System

The AMIRA Classification system uses NAPP and NAG pH to classify samples as PAF, NAF or Uncertain (UC). Where NAPP is positive and NAG pH is less than 4.5, samples are classified as PAF. Where NAPP is negative and NAG pH is greater than 4.5, samples are classified as NAF. Samples with conflicting NAPP and NAG pH are classified as UC.

Note that although a sample may be classified as NAF it does not infer low geochemical risk.

High sulfide and high carbonate samples may present NMD or Saline Drainage (SD) risks requiring management.



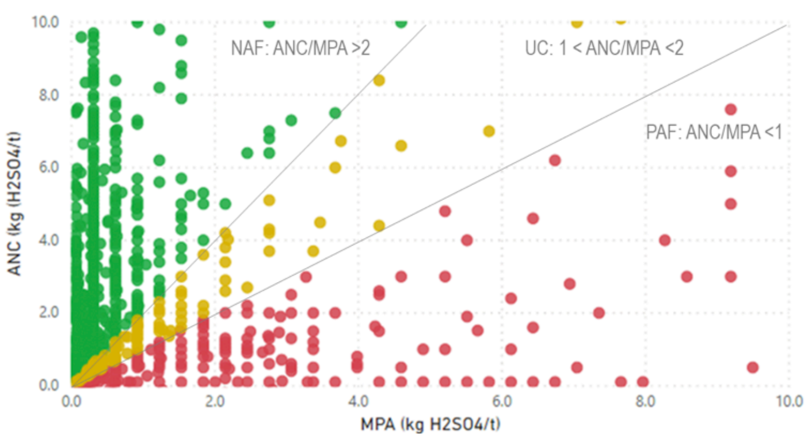
Areas within a plot of NAPP and NAG pH which are classified as NAF, PAF, and UC.

Price Classification System

The Price Classification system uses the ratio between ANC and MPA to classify samples as PAF, NAF or UC, where the Neutralisation Potential Ratio (NPR) = ANC/MPA. When ANC/MPA is less than 1, samples are classified as PAF.

When ANC/MPA is greater than 2, sufficient neutralising capacity is inferred to account for acid production and the samples are classified as NAF. When ANC/MPA is between 1 and 2, samples are classified as UC.

Areas within a plot of MPA and ANC which are classified as NAF, PAF and UC.



HOW TO PREDICT AMD

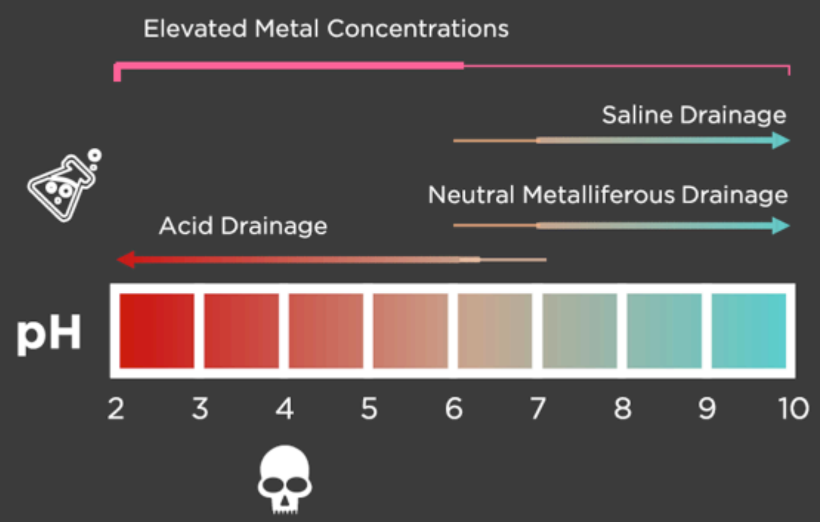
AMD MANAGEMENT TRAINING SERIES: FACT SHEET 4

Geochemical Signature (Water Quality)

The geochemical signature or water quality from a material type can be inferred from ABA characterisation data. However, further information is required to determine the expected water quality, which can include data from geoenvironmental models, field data, and additional laboratory tests such as kinetic column leach testing.

Kinetic testing generally involves oxidising a material sample in the presence of water to understand trends in water quality and quantify oxidation rates, neutralisation rates and contaminant loads with respect to time. Such data is used to determine the potential for acid rock drainage, neutral metalliferous drainage, or saline drainage, which provides an indication of the potential geochemical signature of water quality and initial data for risk assessments.

Further information on test methods is provided in Fact Sheet 11.



Characterisation data, coupled with material schedules, and mine plans can be used to predict water quality from mine domains.

This is an essential step in prediction and such data should be used for risk assessments and can include:

- Numerical modelling;
- Geochemical modelling; and
- Groundwater and surface water modelling.

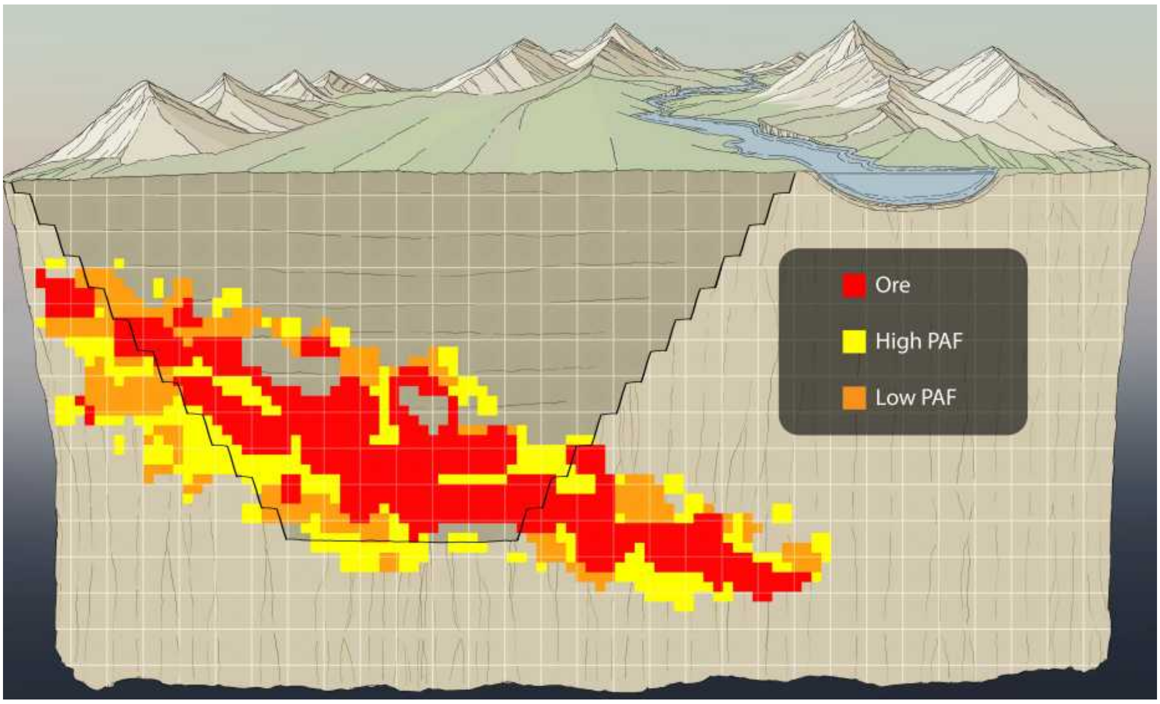
MATERIAL SCHEDULES

The data obtained from materials characterisation processes enables a classification system to be developed. Classification systems are often site-specific and can be used to develop a waste rock block model.

A block model is an essential step in AMD management as it is used to develop a materials schedule for the different material types over the project life cycle. This helps to quantify the potential risk from materials.

For instance, block modelling could indicate:

- That the risk for AMD is low as PAF materials represent a very small fraction of the materials schedule.
- Shortfalls in NAF materials later in the mine life, which could indicate stockpiling may be required.
- Identify higher risk materials that may require more intensive management options.



AMD RISK ASSESSMENT

The data obtained from the geochemical characterisation of materials can be used to support AMD risk assessments, which will become increasing more detailed, coincidental with project development study phases. These risk assessments should be coupled with conceptual site models and an understanding of source-pathway-receptor analysis for informed risk-based decision making processes.

Geochemical characterisation investigations assess source materials to understand potential hazards. To understand possible effects on receptors requires an understanding of pathways, which can include for instance surface water, groundwater, and emissions to air.

NOMENCLATURE

This Fact Sheet, when describing key mine drainage terms, uses South Pacific nomenclature. The following North American synonyms have been summarised from Price (2009):

South Pacific Conventions		North American Conventions	
Potentially Acid Forming	PAF	Potentially Acid Generating	PAG
Non-Acid Forming	NAF	Non-Potentially Acid Generating	Non-PAG
Acid Neutralising Capacity	ANC (kg H_2SO_4/t)	Neutralisation Potential	NP (kg $CaCO_3$/t)
Maximum Potential Acidity	MPA (kg H_2SO_4/t)	Acid Potential[1]	AP (kg $CaCO_3$/t)
Net Acid Production Potential	NAPP (kg H_2SO_4/t)	Net Neutralisation Potential[2]	NNP (kg $CaCO_3$/t)
ANC to MPA Ratio	ANC/MPA	Net Potential Ratio	NPR

[1]AP = 31.25 × %S (kg $CaCO_3$/t)

[2]NNP = NP – AP (different to NAPP which subtracts the acid neutralising capacity from the maximum potential acidity)

Conversion Factors: ANC = 0.98 × NP; MPA = 0.98 × AP

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APPENDIX C OPTICAL MICROSCOPY ANALYSIS

Preliminary observations on Waikaka exploration heavy mineral concentrates

Dave Craw
University of Otago
10 August 2021

Samples supplied, with Noel Becker suggested contents (black text).

Additional comments in red text, mostly supporting the supplied suggestions.

Sample ID	Depth	Remarks
BSC1 cons 0.2mm – 0.4mm	40.4 – 42.3	Zircon, Garnet, Hematite?, Chromite? Magnetics largely removed Abundant zircons At least 3 types of garnet: pale pink = spessartine (Otago?); red = almandine (Otago, Fiordland, Stewart Island?); pink = pyrope (Fiordland or Stewart Island?); yellow may be garnet too. Probable chromite; some octahedral crystal shapes Ilmenite? Probably not hematite Epidote (rare, pale green) Apatite (rare, deep green) Pyrite (crystalline) Gold is very thin flakes, some with Mn oxide(?) staining
BSE1 cons 0.2mm – 0.4mm	39.4 – 41.2	Abundant pyrite or marcasite Dominatly spherical crystalline pyrite and/or marcasite. Probably mostly pyrite, but incipient oxidation commonly turns pyrite to marcasite via direct replacement of textures. Subordinate amounts of other heavies as for BSC1 Gold is very thin flakes
BSE2 cons 0.2mm – 0.4mm	38.7 – 41.2	Abundant pyrite Similar to BSE1 Some spherules Gold is very thin flakes
BSE5 cons <0.2mm	38.0 – 41.0	Mostly zircon Zircons with minor heavies as for BSC1. Minor pyrite Rare euhedral arsenopyrite (this occurs at Waimumu as well) Gold is very thin flakes and smaller thicker particles
BSJ2 cons <0.2mm	21.9 – 25.5	Mostly zircon Similar to BSE2, more pyrite and rare apatite Some spherules Gold is very thin flakes and smaller thicker particles
BSJ2 cons 0.2mm – 0.4mm	21.9 – 25.5	Abundant Hematite? Minor spheres (gas cutting slag?) Same heavies as BSC1; ilmenite not hematite? Gold is very thin flakes Still contains magnetic fraction, including spherules Pyrite

		Abundant chromite? Bulk XRF = 22% Fe, 4% Cr
BSJ2 cons magnetics	21.9 – 25.5	Heavies extracted with magnet. Lots of spheres which I think are gas cut. Predominantly spherules with abundant angular Fe fragments; all probably steel. Bulk XRF = 66%Fe, 2400 ppm Cr => probably Cr-steel. Two populations; some are black; some coated in yellow-brown Fe oxide (rust?) No gold seen
WX0045 11m-18m heavies	11.0 – 18.0	Drillhole sample. Appears to be heaps of pyrite Dominantly pyrite and/or marcasite, variably tarnished Heavy mineral suite similar to BSC1, but sparse No gold seen

Conclusions

Very similar heavy mineral content to Waimumu Quartz Gravels that are of similar age and lithology.

Abundant authigenic iron sulphides (pyrite or marcasite) formed by groundwater, also similar to Waimumu

Possibly no hematite, so very different from Waikaia Pleistocene, where hematite with distinctive red-grey appearance was common. This is very difficult to confirm visually, and hematite is chemically similar to magnetite.

Magnetic spherules are probably contamination from steel-based exploration equipment

APPENDIX D DRILLHOLE WX0097 GEOLOGICAL LOG

Hole_ID	From	to	Lith qualifyer	Lith minor	Lith Dom	colour qualifyer	Colour qualifier minor	Colour dominant	Max Grainsize	Clay %	Comment
WXO97	0	1			N/S						Drill through tailings no sample
WXO97	1	2			N/S						Drill through tailings no sample
WXO97	2	3			N/S						Drill through tailings no sample
WXO97	3	4			C			GY		9	
WXO97	4	5			C			GY		9	
WXO97	5	6		s	C			GY		7	
WXO97	6	7		c	s			GY		4	
WXO97	7	8			C			GY		9	
WXO97	8	9		s	C			GY		7	
WXO97	9	10			C		or	GY		9	
WXO97	10	11		s	C			GY		7	
WXO97	11	12			s			GY		3	
WXO97	12	13		s	g		GY	WH	20	1	
WXO97	13	14			s			GY		4	
WXO97	14	15			c			GY		9	
WXO97	15	16			C	dk		GY		9	lig
WXO97	16	17			C	dk		GY		9	
WXO97	17	18		s	C			GY		8	
WXO97	18	19		s	C			GY		8	lig
WXO97	19	20		s	C	LT	gy	BN		8	lig
WXO97	20	21		s	C	lt	bk	bn		8	lig rich
WXO97	21	22		s	C	LT		GY		7	
WXO97	22	23		s	C	LT		GY		7	
WXO97	23	24	s	g	C		WH	GY	20	6	
WXO97	24	25	c	s	G		GY	WH	20	3	
WXO97	25	26		s	G		GY	WH	20	1	
WXO97	26	27		s	G		GY	WH	20	1	
WXO97	27	28		s	G		GY	WH	20	1	
WXO97	28	29		g	s		WH	GY	20		
WXO97	29	30		s	G		GY	WH	20	1	
WXO97	30	31		s	G		GY	WH	20	1	
WXO97	31	32		s	C	dk		GY		7	
WXO97	32	33		s	C		bk	bN		7	carb clay
WXO97	33	34	c	s	g		GY	WH	20	3	
WXO97	34	35		s	g		GY	WH	20	1	
WXO97	35	36		s	g		GY	WH	20	1	
WXO97	36	37		s	g		GY	WH	20	1	
WXO97	37	38		s	g		GY	WH	20	1	
WXO97	38	39		s	g		GY	WH	20	1	
WXO97	39	40		s	g		GY	WH	20	1	
WXO97	40	41		s	g		GY	WH	20	3	hit GLM 40.6
WXO97	41	42			GLM		CR	GY	20	6	

		OH	Openhole
		TL	Tailings from shollow dredging
c	c	C	Clay
s	s	S	Sand
g	g	G	Gravels
		GLM	Gore Lignite Measures
		N/S	No sample

APPENDIX E ABA SUMMARY AND LABORATORY CERTIFICATES

Table E1. Waikaka acid base accounting results.

UNIQUE ID	VERUM LAB ID	SGS LAB ID	ANALYSIS DATE	HOLE ID	MATERIAL TYPE	FROM (m)	TO (m)	PASTE pH	ACID-BASE ACCOUNTING					AMIRA AMD CLASS	PRICE AMD CLASS
								$pH_{1:2}$	TS	MPA	ANC	NAPP	NPR		
								pH units	wt% S	kg H_2SO_4/t			no units	no units	no units
								0.1	0.005	0.153	1.0	-			
BSE1 39.4 - 41.2	21/969-01	RG002215-001	11/10/2021	BSE1	Pan Tails	39.4	41.2	3.9	7.46	228.3	0[B]	228.3	0.0004[A]	PAF	PAF
BSE4 38.5 - 41.5	21/969-02	RG002215-002	11/10/2021	BSE4	Pan Tails	38.5	41.5	4.3	1.18	36.1	0[B]	36.1	0.003[A]	PAF	PAF
BSE5 38 - 41	21/969-03	RG002215-003	11/10/2021	BSE5	Pan Tails	38.0	41.0	6.2	0.420	12.9	0[B]	12.9	0.008[A]	PAF	PAF
BSJ2 21.9 - 25.5	21/969-04	RG002215-004	11/10/2021	BSJ2	Pan Tails	21.9	25.5	6.7	0.020	0.6	0[B]	0.6	0.16[A]	PAF	PAF
BSJ3 22.4 - 25.6	21/969-05	RG002215-005	11/10/2021	BSJ3	Pan Tails	22.4	25.6	7.5	0.030	0.9	0[B]	0.9	0.109[A]	PAF	PAF
WX0097 3 - 4	21/985-01		13/10/2021	WX0097	Clay	3.0	4.0	8.2	0.0025[C]	0.1	5.1	-5.0	66.9	NAF	NAF
WX0097 4 - 5	21/985-02		13/10/2021	WX0097	Clay	4.0	5.0	7.6	0.006	0.2	3.7	-3.5	19.9	NAF	NAF
WX0097 5 - 6	21/985-03		13/10/2021	WX0097	Clay	5.0	6.0	7.1	0.0025[C]	0.1	1.5	-1.4	19.1	NAF	NAF
WX0097 6 - 7	21/985-04		13/10/2021	WX0097	Clay	6.0	7.0	7.0	0.008	0.2	3.4	-3.2	13.9	NAF	NAF
WX0097 7 - 8	21/985-05		13/10/2021	WX0097	Clay	7.0	8.0	7.5	0.015	0.5	2.9	-2.5	6.35	NAF	NAF
WX0097 8 - 9	21/985-06		13/10/2021	WX0097	Clay	8.0	9.0	7.4	0.0025[C]	0.1	2.7	-2.6	34.9	NAF	NAF
WX0097 9 - 10	21/985-07		13/10/2021	WX0097	Clay	9.0	10.0	7.2	0.012	0.4	3.4	-3.0	9.27	NAF	NAF
WX0097 10 - 11	21/985-08		13/10/2021	WX0097	Clay	10.0	11.0	7.3	0.011	0.3	3.2	-2.8	9.39	NAF	NAF
WX0097 11 - 12	21/985-09		13/10/2021	WX0097	Clay	11.0	12.0	7.2	0.017	0.5	4.2	-3.7	8.12	NAF	NAF
WX0097 12 - 13	21/985-10		13/10/2021	WX0097	Gravel	12.0	13.0	6.4	0.017	0.5	0.6	-0.1	1.16	NAF	UC
WX0097 13 - 14	21/985-11		13/10/2021	WX0097	Clay	13.0	14.0	6.1	0.018	0.6	3.0	-2.5	5.48	NAF	NAF
WX0097 14 - 15	21/985-12		13/10/2021	WX0097	Clay	14.0	15.0	7.2	0.031	0.9	3.6	-2.7	3.82	NAF	NAF
WX0097 15 - 16	21/985-13		13/10/2021	WX0097	Clay	15.0	16.0	6.5	0.034	1.0	3.0	-2.0	2.90	NAF	NAF
WX0097 16 - 17	21/985-14		13/10/2021	WX0097	Clay	16.0	17.0	7.4	0.020	0.6	3.0	-2.4	4.93	NAF	NAF
WX0097 17 - 18	21/985-15		13/10/2021	WX0097	Clay	17.0	18.0	7.0	0.010	0.3	3.0	-2.7	9.86	NAF	NAF
WX0097 18 - 19	21/985-16		13/10/2021	WX0097	Clay	18.0	19.0	6.7	0.045	1.4	4.2	-2.8	3.05	NAF	NAF
WX0097 19 - 20	21/985-17		13/10/2021	WX0097	Clay	19.0	20.0	6.2	0.047	1.4	2.4	-1.0	1.67	NAF	UC
WX0097 20 - 21	21/985-18		13/10/2021	WX0097	Carbonaceous Clay	20.0	21.0	6.5	0.080	2.4	1.8	0.6	0.735	PAF	PAF
WX0097 21 - 22	21/985-19		13/10/2021	WX0097	Clay	21.0	22.0	6.9	0.009	0.3	2.4	-2.1	8.72	NAF	NAF
WX0097 22 - 23	21/985-20		13/10/2021	WX0097	Clay	22.0	23.0	7.1	0.009	0.3	3.0	-2.7	10.9	NAF	NAF
WX0097 23 - 24	21/985-21		13/10/2021	WX0097	Clay	23.0	24.0	6.9	0.008	0.2	1.2	-1.0	4.91	NAF	NAF
WX0097 24 - 25	21/985-22		13/10/2021	WX0097	Clayey Gravel	24.0	25.0	7.1	0.010	0.3	3.0	-2.7	9.81	NAF	NAF
WX0097 25 - 26	21/985-23		13/10/2021	WX0097	Gravel	25.0	26.0	7.3	0.0025[C]	0.1	0.6	-0.5	7.85	NAF	NAF
WX0097 26 - 27	21/985-24		13/10/2021	WX0097	Gravel	26.0	27.0	8.0	0.0025[C]	0.1	2.3	-2.3	30.5	NAF	NAF
WX0097 27 - 28	21/985-25		13/10/2021	WX0097	Gravely Clay	27.0	28.0	6.8	0.013	0.4	3.5	-3.1	8.80	NAF	NAF
WX0097 28 - 29	21/985-26		13/10/2021	WX0097	Clay	28.0	29.0	6.9	0.011	0.3	3.5	-3.2	10.4	NAF	NAF
WX0097 29 - 30	21/985-27		13/10/2021	WX0097	Sandy Clay	29.0	30.0	7.0	0.010	0.3	4.7	-4.4	15.3	NAF	NAF
WX0097 30 - 31	21/985-28		13/10/2021	WX0097	Sandy Clay	30.0	31.0	6.0	0.027	0.8	3.5	-2.7	4.24	NAF	NAF
WX0097 31 - 32	21/985-29		13/10/2021	WX0097	Clay	31.0	32.0	6.2	0.031	0.9	3.5	-2.6	3.69	NAF	NAF
WX0097 32 - 33	21/985-30		13/10/2021	WX0097	Clay	32.0	33.0	6.4	0.031	0.9	2.4	-1.4	2.51	NAF	NAF
WX0097 33 - 34	21/985-31		13/10/2021	WX0097	Carbonaceous Clay	33.0	34.0	5.6	0.030	0.9	1.2	-0.3	1.30	NAF	UC
WX0097 34 - 35	21/985-32		13/10/2021	WX0097	Carbonaceous Gravel	34.0	35.0	7.3	0.017	0.5	3.0	-2.5	5.72	NAF	NAF
WX0097 35 - 36	21/985-33		13/10/2021	WX0097	Gravel	35.0	36.0	7.5	0.009	0.3	3.6	-3.3	13.0	NAF	NAF
WX0097 36 - 37	21/985-34		13/10/2021	WX0097	Gravel	36.0	37.0	7.5	0.0025[C]	0.1	2.4	-2.3	31.1	NAF	NAF
WX0097 37 - 38	21/985-35		13/10/2021	WX0097	Gravel	37.0	38.0	7.7	0.0025[C]	0.1	1.2	-1.1	15.7	NAF	NAF
WX0097 38 - 39	21/985-36		13/10/2021	WX0097	Gravel	38.0	39.0	7.5	0.0025[C]	0.1	1.2	-1.1	15.7	NAF	NAF
WX0097 39 - 40	21/985-37		13/10/2021	WX0097	Gravel	39.0	40.0	7.7	0.0025[C]	0.1	1.2	-1.1	15.7	NAF	NAF
WX0097 40 - 41	21/985-38		13/10/2021	WX0097	Clayey Gravel - Top of GLM[D]	40.0	41.0	5.9	0.147	4.5	1.2	3.3	0.267	PAF	PAF

UNIQUE ID	VERUM LAB ID	SGS LAB ID	ANALYSIS DATE	HOLE ID	MATERIAL TYPE	FROM (m)	TO (m)	PASTE pH	ACID-BASE ACCOUNTING					AMIRA AMD CLASS	PRICE AMD CLASS
								$pH_{1:2}$	TS	MPA	ANC	NAPP	NPR		
								pH units	wt% S	kg H_2SO_4/t			no units	no units	no units
								0.1	0.005	0.153	1.0	-			
WX0097 41 - 42	21/985-39		13/10/2021	WX0097	GLM	41.0	42.0	5.7	0.222	6.8	2.4	4.4	0.353	PAF	PAF

[A] – NPR calculated using an ANC of 0.1 kg H_2SO_4/t for calculation purposes.

[B] – assumed ANC of 0 kg H_2SO_4/t given the sample only represents the heavy mineral fraction.

[C] – reported as half the limit of reporting (LOR) = <0.005 wt%.

[D] – this sample is likely to also contain some GLM, which is likely to be a function of the sampling interval. During mining minimal disturbance of the GLM is anticipated.

Verum Group

Report of Analysis

Mine Waste Management
Unit 7, 41 Sir William Pickering Drive
Christchurch

Report Number: 21/969
Issue: 1
Date: 02 November 2021

Order No: WaikaiaGold

Attention: Paul Weber

Sample : 21/969-01 **Date Received**: 15/10/2021
Description : 01 Non routine **Weight Received**: 310g
Customer Ref. : BSE1 Pan Tail Conc Site E1 15/04/21

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	3.9	

Test Code	Sundry Lab Tests	Result	
C703b	Sulphur (as received)	7.46	%w

Sample : 21/969-02 **Date Received**: 15/10/2021
Description : 01 Non routine **Weight Received**: 280g
Customer Ref. : BSE4 Pan Tail Conc Site E4 20/04/21

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	4.3	

Test Code	Sundry Lab Tests	Result	
C703b	Sulphur (as received)	1.18	%w

Sample : 21/969-03 **Date Received**: 15/10/2021
Description : 01 Non routine **Weight Received**: 305g
Customer Ref. : BSE5 Pan Tail Conc Site E5 29/04/21

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.2	

Test Code	Sundry Lab Tests	Result	
C703b	Sulphur (as received)	0.42	%w

Sample : 21/969-04 **Date Received**: 15/10/2021
Description : 01 Non routine **Weight Received**: 310g
Customer Ref. : BSJ2 Pan Tail Conc Site J2 08/05/21

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.7	

Test Code	Sundry Lab Tests	Result	
C703b	Sulphur (as received)	0.02	%w

Sample : 21/969-05 **Date Received**: 15/10/2021
Description : 01 Non routine **Weight Received**: 360g

Customer Ref. : BSJ3 Pan Tail Conc Site J3 11/05/21

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.5	

Test Code	Sundry Lab Tests	Result	
C703b	Sulphur (as received)	0.03	%w

Comments:

This report represents results based upon the sample as provided by the client.

This report may only be reproduced in full.

Mike Young
Laboratory Manager

Verum Group

Mine Waste Management
Unit 7, 41 Sir William Pickering Drive
Christchurch

Report of Analysis

Report Number: 21/985

Issue: 4

Date: 08 December 2021

Order No:

Attention: Paul Weber

Sample : 21/985-01
Description : 01 Non routine
Customer Ref. : 3 - 4m Clay

Date Received: 20/10/2021
Weight Received: 81g lab/264g retained

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	8.19	
451	Acid Neutralising Capacity	5.12	kg H2SO4/t
451a	Acid Neutralising Capacity	0.52	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-02
Description : 01 Non routine
Customer Ref. : 4 - 5m Clay

Date Received: 20/10/2021
Weight Received: 88g lab/305g retained

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.61	
451	Acid Neutralising Capacity	3.66	kg H2SO4/t
451a	Acid Neutralising Capacity	0.37	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.006	%w

Sample : 21/985-03
Description : 01 Non routine
Customer Ref. : 5 - 6m Clay

Date Received: 20/10/2021
Weight Received: 78g lab/280g retained

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.08	
451	Acid Neutralising Capacity	1.46	kg H2SO4/t
451a	Acid Neutralising Capacity	0.15	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-04
Description : 01 Non routine
Customer Ref. : 6 - 7m Clay

Date Received: 20/10/2021
Weight Received: 87g lab/280g retained

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.99	

451	Acid Neutralising Capacity	3.41	kg H2SO4/t
451a	Acid Neutralising Capacity	0.35	%CaCO3

Test Code	**Sundry Lab Tests**	**Result**	
C703a	Sulphur (air dried)	0.008	%w

Sample : 21/985-05 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 89g lab/284g retained
Customer Ref. : 7 - 8m Clay

Test Code	**Acid Mine Drainage - AMIRA International ARD Test Handbook.**	**Result**	
450	pH paste	7.52	
451	Acid Neutralising Capacity	2.92	kg H2SO4/t
451a	Acid Neutralising Capacity	0.30	%CaCO3

Test Code	**Sundry Lab Tests**	**Result**	
C703a	Sulphur (air dried)	0.015	%w

Sample : 21/985-06 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 91g lab/214g retained
Customer Ref. : 8 - 9m Clay

Test Code	**Acid Mine Drainage - AMIRA International ARD Test Handbook.**	**Result**	
450	pH paste	7.37	
451	Acid Neutralising Capacity	2.67	kg H2SO4/t
451a	Acid Neutralising Capacity	0.27	%CaCO3

Test Code	**Sundry Lab Tests**	**Result**	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-07 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 60g lab/242g retained
Customer Ref. : 9 - 10m Clay

Test Code	**Acid Mine Drainage - AMIRA International ARD Test Handbook.**	**Result**	
450	pH paste	7.20	
451	Acid Neutralising Capacity	3.40	kg H2SO4/t
451a	Acid Neutralising Capacity	0.35	%CaCO3

Test Code	**Sundry Lab Tests**	**Result**	
C703a	Sulphur (air dried)	0.012	%w

Sample : 21/985-08 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 88g lab/314g retained
Customer Ref. : 10 - 11m Clay

Test Code	**Acid Mine Drainage - AMIRA International ARD Test Handbook.**	**Result**	
450	pH paste	7.33	
451	Acid Neutralising Capacity	3.16	kg H2SO4/t
451a	Acid Neutralising Capacity	0.32	%CaCO3

Test Code	**Sundry Lab Tests**	**Result**	
C703a	Sulphur (air dried)	0.011	%w

Sample : 21/985-09 **Date Received**: 20/10/2021

Description : 01 Non routine **Weight Received** : 88g lab/235g retained
Customer Ref. : 11 - 12m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.24	
451	Acid Neutralising Capacity	4.22	kg H2SO4/t
451a	Acid Neutralising Capacity	0.43	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.017	%w

Sample : 21/985-10 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 146g lab/538g retained
Customer Ref. : 12 - 13m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.36	
451	Acid Neutralising Capacity	0.60	kg H2SO4/t
451a	Acid Neutralising Capacity	0.06	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.017	%w

Sample : 21/985-11 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 93g lab/230g retained
Customer Ref. : 13 - 14m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.08	
451	Acid Neutralising Capacity	3.02	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.018	%w

Sample : 21/985-12 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 65g lab/240g retained
Customer Ref. : 14 - 15m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.15	
451	Acid Neutralising Capacity	3.32	kg H2SO4/t
451a	Acid Neutralising Capacity	0.34	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.031	%w

Sample : 21/985-13 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 115g lab/336g retained
Customer Ref. : 15 - 16m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.54	

451	Acid Neutralising Capacity	3.02	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.034	%w

Sample : 21/985-14 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 110g lab/295g retained
Customer Ref. : 16 - 17m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.38	
451	Acid Neutralising Capacity	3.02	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.020	%w

Sample : 21/985-15 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 97g lab/314g retained
Customer Ref. : 17 - 18m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.02	
451	Acid Neutralising Capacity	3.02	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.010	%w

Sample : 21/985-16 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 86g lab/263g retained
Customer Ref. : 18 -19m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.71	
451	Acid Neutralising Capacity	4.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.43	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.045	%w

Sample : 21/985-17 **Date Received** : 20/10/2021
Description : 01 Non routine **Weight Received** : 95g lab/226g retained
Customer Ref. : 19 - 20m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.24	
451	Acid Neutralising Capacity	2.40	kg H2SO4/t
451a	Acid Neutralising Capacity	0.25	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.047	%w

Sample : 21/985-18 **Date Received** : 20/10/2021

Description	: 01 Non routine	**Weight Received**	: 80g lab/191g retained
Customer Ref.	: 20 - 21m Carb Clay		

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.50	
451	Acid Neutralising Capacity	1.80	kg H2SO4/t
451a	Acid Neutralising Capacity	0.18	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.080	%w

Sample	: 21/985-19	**Date Received**	: 20/10/2021
Description	: 01 Non routine	**Weight Received**	: 99g lab/374g retained
Customer Ref.	: 21 - 22m Clay		

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.93	
451	Acid Neutralising Capacity	2.40	kg H2SO4/t
451a	Acid Neutralising Capacity	0.25	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.009	%w

Sample	: 21/985-20	**Date Received**	: 20/10/2021
Description	: 01 Non routine	**Weight Received**	: 141g lab/407g retained
Customer Ref.	: 22 - 23m Clay		

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.13	
451	Acid Neutralising Capacity	3.00	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.009	%w

Sample	: 21/985-21	**Date Received**	: 20/10/2021
Description	: 01 Non routine	**Weight Received**	: 123g lab/356g retained
Customer Ref.	: 23 - 24m Clay		

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.89	
451	Acid Neutralising Capacity	1.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.008	%w

Sample	: 21/985-22	**Date Received**	: 20/10/2021
Description	: 01 Non routine	**Weight Received**	: 97g lab/335g retained
Customer Ref.	: 24 - 25m Clayey Gravel		

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.07	

451	Acid Neutralising Capacity	3.00	kg H2SO4/t
451a	Acid Neutralising Capacity	0.31	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.010	%w

Sample : 21/985-23 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 276g lab/840g retained
Customer Ref. : 25 - 26m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.28	
451	Acid Neutralising Capacity	0.60	kg H2SO4/t
451a	Acid Neutralising Capacity	0.06	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-24 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 242g lab/783g retained
Customer Ref. : 26 - 27m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.96	
451	Acid Neutralising Capacity	2.33	kg H2SO4/t
451a	Acid Neutralising Capacity	0.24	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-25 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 147g lab/408g retained
Customer Ref. : 27 - 28m Graveley Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.83	
451	Acid Neutralising Capacity	3.50	kg H2SO4/t
451a	Acid Neutralising Capacity	0.36	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.013	%w

Sample : 21/985-26 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 81g lab/264g retained
Customer Ref. : 28 - 29m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.88	
451	Acid Neutralising Capacity	3.50	kg H2SO4/t
451a	Acid Neutralising Capacity	0.36	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.011	%w

Sample : 21/985-27 **Date Received**: 20/10/2021

Description : 01 Non routine
Weight Received : 138g lab/472g retained
Customer Ref. : 29 - 30m Sandy Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.02	
451	Acid Neutralising Capacity	4.67	kg H2SO4/t
451a	Acid Neutralising Capacity	0.48	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.010	%w

Sample : 21/985-28
Date Received : 20/10/2021
Description : 01 Non routine
Weight Received : 98g lab/266g retained
Customer Ref. : 30 - 31m Sandy Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.04	
451	Acid Neutralising Capacity	3.50	kg H2SO4/t
451a	Acid Neutralising Capacity	0.36	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.027	%w

Sample : 21/985-29
Date Received : 20/10/2021
Description : 01 Non routine
Weight Received : 76g lab/248g retained
Customer Ref. : 31 - 32m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.20	
451	Acid Neutralising Capacity	3.50	kg H2SO4/t
451a	Acid Neutralising Capacity	0.36	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.031	%w

Sample : 21/985-30
Date Received : 20/10/2021
Description : 01 Non routine
Weight Received : 85g lab/268g retained
Customer Ref. : 32 - 33m Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	6.42	
451	Acid Neutralising Capacity	2.38	kg H2SO4/t
451a	Acid Neutralising Capacity	0.24	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.031	%w

Sample : 21/985-31
Date Received : 20/10/2021
Description : 01 Non routine
Weight Received : 59g lab/191g retained
Customer Ref. : 33 - 34m Carbonaceous Clay

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	5.61	

451	Acid Neutralising Capacity	1.19	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.030	%w

Sample : 21/985-32 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 93g lab/276g retained
Customer Ref. : 34 - 35m Carb Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.26	
451	Acid Neutralising Capacity	2.97	kg H2SO4/t
451a	Acid Neutralising Capacity	0.30	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.017	%w

Sample : 21/985-33 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 113g lab/322g retained
Customer Ref. : 35 - 36m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.53	
451	Acid Neutralising Capacity	3.57	kg H2SO4/t
451a	Acid Neutralising Capacity	0.36	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.009	%w

Sample : 21/985-34 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 114g lab/388g retained
Customer Ref. : 36 - 37 Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.52	
451	Acid Neutralising Capacity	2.38	kg H2SO4/t
451a	Acid Neutralising Capacity	0.24	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-35 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 155g lab/411g retained
Customer Ref. : 37 - 38m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.70	
451	Acid Neutralising Capacity	1.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-36 **Date Received**: 20/10/2021

Description : 01 Non routine **Weight Received**: 92g lab/335g retained
Customer Ref. : 38 - 39m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.49	
451	Acid Neutralising Capacity	1.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-37 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 123g lab/461g retained
Customer Ref. : 39 - 40m Gravel

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	7.73	
451	Acid Neutralising Capacity	1.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	<0.005%	%w

Sample : 21/985-38 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 137g lab/397g retained
Customer Ref. : 40 - 41m Clayey Gravel - Top of GLM

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	5.85	
451	Acid Neutralising Capacity	1.20	kg H2SO4/t
451a	Acid Neutralising Capacity	0.12	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.147	%w

Sample : 21/985-39 **Date Received**: 20/10/2021
Description : 01 Non routine **Weight Received**: 135g lab/202g retained
Customer Ref. : 41 - 42m GLM - Gore Lignite Measures

Test Code	Acid Mine Drainage - AMIRA International ARD Test Handbook.	Result	
450	pH paste	5.70	
451	Acid Neutralising Capacity	2.40	kg H2SO4/t
451a	Acid Neutralising Capacity	0.25	%CaCO3

Test Code	Sundry Lab Tests	Result	
C703a	Sulphur (air dried)	0.222	%w

Comments:

This report represents results based upon the sample as provided by the client.

This report replaces report 21/985-3.

This report may only be reproduced in full.

Mike Young
Laboratory Manager

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Certificate of Analysis
Laboratory Reference:211116-123

Attention:		*Final Report:*	**436912-0**
Client:	**WAIKAIA GOLD LTD**	*Report Issue Date:*	**30-Nov-2021**
Address:	**1616 Riversdale, RD 7, Gore, 9777**	*Received Date:*	**16-Nov-2021**
Client Reference:	**Groundwater and surface water**	*Laboratory Activity Dates:*	**16-Nov-2021 - 26-Nov-2021**
Purchase Order:	**Not Available**	*Quote Reference :*	**5453**

Arsenic (TOTAL)Cadmium (TOTAL)Chromium (TOTAL)Cobalt (TOTAL)Copper (TOTAL)Iron (TOTAL)Lead (TOTAL)Manganese (TOTAL) and Mercury (TOTAL) for Surface water from the L&M Pond (Lab ID: 211116-123-2, 6996567 , MET-TO-T_0100 was not received in the correct container. Results may not be representative of the sample at the time of collection.
Escherichia coli (NONE) for Surface water from the L&M Pond (Lab ID: 211116-123-2, 6996569 , STER_0120_I was not received in the correct container. Results may not be representative of the sample at the time of collection.
Arsenic (TOTAL)Cadmium (TOTAL)Chromium (TOTAL)Cobalt (TOTAL)Copper (TOTAL)Iron (TOTAL)Lead (TOTAL)Manganese (TOTAL) and Mercury (TOTAL) for Ground water from Waikaka Water Pump Test Bore 2 (Lab ID: 211116-123-1, 6996563 , MET-TO-T_0100 was not received in the correct container. Results may not be representative of the sample at the time of collection.
Escherichia coli (NONE) for Ground water from Waikaka Water Pump Test Bore 2 (Lab ID: 211116-123-1, 6996568 , STER_0120_I was not received in the correct container. Results may not be representative of the sample at the time of collection.

Sample Details		WATERS	WATERS
Lab Sample ID:		**211116-123-1**	**211116-123-2**
Client Sample ID:			
Sample Date/Time		16/11/2021	16/11/2021
Description:		Ground water from Waikaka Water Pump Test Bore 2	Surface water from the L&M Pond
General Testing			
Chloride	mg/L	19	17
Conductivity (at 25 °C)	µS/cm	231	225
Nitrate Nitrogen (as N)	mg/L	<0.01	2.8
pH (at room temp c. 20 °C)	pH unit	6.65	8.28
Total Phosphorus (as P)	mg/L	0.14	0.05
Turbidity	NTU	11	5.2
Metals			
Total Metals by ICP-MS—Trace (Default Digest)			
Arsenic (Total)	mg/L	0.0047	0.00093
Cadmium (Total)	mg/L	<0.00005	<0.00005
Chromium (Total)	mg/L	<0.0005	<0.0005
Cobalt (Total)	mg/L	0.00022	0.00019
Copper (Total)	mg/L	0.00027	0.0013
Iron (Total)	mg/L	5.6	0.13
Lead (Total)	mg/L	0.00024	<0.0001
Manganese (Total)	mg/L	0.21	0.043
Mercury (Total)	mg/L	<0.00005	<0.00005
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100mL	<1.0	40

*Results marked with * are not accredited to International Accreditation New Zealand. A dash indicates no test performed.*

Where samples have been supplied by the client, they are tested as received.
The results of analysis contained in this report relate only to the sample(s) tested. Where sample collection was performed by the laboratory, the results of analysis contained in this report relate only to the sample(s) collected.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Chloride by Colorimetry/Discrete Analyser	APHA (online edition) 4500-Cl E	5 mg/L	All	Invercargill
Conductivity (at 25 °C) by Electrode	APHA (online edition) 2510 B	2 µS/cm	All	Invercargill
Nitrate Nitrogen (as N) by Colorimetry/Discrete Analyser	Nitrate-N Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.010 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.1 NTU	All	Invercargill
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	APHA (online edition) 3125 B by ICPMS	0.00010 mg/L	All	Auckland
Cadmium (Total)	APHA (online edition) 3125 B by ICPMS	0.00005 mg/L	All	Auckland
Chromium (Total)	APHA (online edition) 3125 B by ICPMS	0.0005 mg/L	All	Auckland
Cobalt (Total)	APHA (online edition) 3125 B by ICPMS	0.00003 mg/L	All	Auckland
Copper (Total)	APHA (online edition) 3125 B by ICPMS	0.0002 mg/L	All	Auckland
Iron (Total)	APHA (online edition) 3125 B by ICPMS	0.002 mg/L	All	Auckland
Lead (Total)	APHA (online edition) 3125 B by ICPMS	0.00010 mg/L	All	Auckland
Manganese (Total)	APHA (online edition) 3125 B by ICPMS	0.0005 mg/L	All	Auckland
Mercury (Total)	APHA (online edition) 3125 B by ICPMS	0.00005 mg/L	All	Auckland
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100mL	All	Invercargill
Preparations				
Digest for Total Metals in Liquids	APHA 3030E Modified (4:1 Nitric:Hydrochloric Acid: 95°C 2 hours)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

Tonia Bulling
KTP Signatory

Watercare
Laboratory Services

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Certificate of Analysis
Laboratory Reference:211209-159

Attention:		*Final Report:*	**439561-0**
Client:	**WAIKAIA GOLD LTD**	*Report Issue Date:*	**20-Dec-2021**
Address:	**1616 Riversdale, RD 7, Gore, 9777**	*Received Date:*	**09-Dec-2021**
		Sampled By:	**Noel Becker**
Client Reference:	**Stream & Bore Samples**	*Laboratory Activity Dates:*	**09-Dec-2021 - 17-Dec-2021**
Purchase Order:	**Not Supplied**	*Quote Reference :*	**5453**

Please note: Waikaka Bore- insufficient sample received, not able to test for TOC and Bromide.

Sample Details		WATERS	WATERS
Lab Sample ID:		**211209-159-1**	**211209-159-2**
Client Sample ID:			
Sample Date/Time		09/12/2021 10:13	09/12/2021 10:14
Description:		Waikaka Pump Bore	Waikaka Stream
Chemistry Detailed			
Anions			
Bromide	mg/L	-	0.019
General Testing			
Conductivity (at 25 °C)	µS/cm	220	85
Nitrate Nitrogen (as N)	mg/L	<0.01	0.32
pH (at room temp c. 20 °C)	pH unit	6.56	7.18
Turbidity	NTU	23	6.4
Metals			
Total Metals by ICP-MS—Trace (Default Digest)			
Arsenic (Total)	mg/L	0.0068	0.00053
Boron (Total)	mg/L	<0.005	<0.005
Cadmium (Total)	mg/L	<0.00005	<0.00005
Calcium (Total)	mg/L	10	5.5
Chromium (Total)	mg/L	0.00065	0.00054
Cobalt (Total)	mg/L	0.00011	0.00021
Copper (Total)	mg/L	0.00055	0.00081
Iron (Total)	mg/L	4.4	0.79
Lead (Total)	mg/L	0.00071	0.00012
Magnesium (Total)	mg/L	5.5	2.1
Manganese (Total)	mg/L	0.2	0.024
Mercury (Total)	mg/L	<0.00005	<0.00005
Potassium (Total)	mg/L	1.2	0.72
Organics			
Total Organic Carbon by Non-dispersive infrared detection			
Total Organic Carbon	mg/L	-	2.7
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100mL	<10	640

*Results marked with * are not accredited to International Accreditation New Zealand. A dash indicates no test performed.*

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ilac-MRA
ACCREDITED IANZ TESTING LABORATORY

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions				
Bromide	APHA (online edition) 4110 B	0.005 mg/L	2	Auckland
General Testing				
Conductivity (at 25 °C) by Electrode	APHA (online edition) 2510 B	2 µS/cm	All	Invercargill
Nitrate Nitrogen (as N) by Colorimetry/Discrete Analyser	Nitrate-N Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.010 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.1 NTU	All	Invercargill
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	APHA (online edition) 3125 B by ICPMS	0.00010 mg/L	All	Auckland
Boron (Total)	APHA (online edition) 3125 B by ICPMS	0.005 mg/L	All	Auckland
Cadmium (Total)	APHA (online edition) 3125 B by ICPMS	0.00005 mg/L	All	Auckland
Calcium (Total)	APHA (online edition) 3125 B by ICPMS	0.010 mg/L	All	Auckland
Chromium (Total)	APHA (online edition) 3125 B by ICPMS	0.0005 mg/L	All	Auckland
Cobalt (Total)	APHA (online edition) 3125 B by ICPMS	0.00003 mg/L	All	Auckland
Copper (Total)	APHA (online edition) 3125 B by ICPMS	0.0002 mg/L	All	Auckland
Iron (Total)	APHA (online edition) 3125 B by ICPMS	0.002 mg/L	All	Auckland
Lead (Total)	APHA (online edition) 3125 B by ICPMS	0.00010 mg/L	All	Auckland
Magnesium (Total)	APHA (online edition) 3125 B by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	APHA (online edition) 3125 B by ICPMS	0.0005 mg/L	All	Auckland
Mercury (Total)	APHA (online edition) 3125 B by ICPMS	0.00005 mg/L	All	Auckland
Potassium (Total)	APHA (online edition) 3125 B by ICPMS	0.05 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	2	Auckland
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100mL	All	Invercargill
Preparations				
Digest for Total Metals in Liquids	APHA 3030E Modified (4:1 Nitric:Hydrochloric Acid: 95°C 2 hours)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		2	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Compliance and Projects Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

Peter Boniface
KTP Signatory

APPENDIX F LIMITATIONS

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MANAGEMENT

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MEMORANDUM

Recipient:	Noel Becker – Waikaka Gold Mines Limited
From:	Paul Weber – Mine Waste Management
Date:	6 September 2022
Cc:	Carlos Hillman (MWM)
Document Number:	J-NZ0194-002-M-Rev0
Document Title:	Waikaka Column Leach Test Results

INTRODUCTION

Mine Waste Management Ltd (MWM) has provided this memorandum to Waikaka Gold Mines Limited (WGM) to summarise the results of the column leach test. The column leach test was undertaken to understand the Potential Contaminants of Concern (PCOC) associated with acid and metalliferous drainage (AMD) at the proposed Waikaka Valley Project located to the northeast of Gore, Southland. This assessment was undertaken to provide guidance on water quality monitoring requirements.

BACKGROUND

WGM has completed an exploration programme involving air core drilling and bulk sampling for alluvial gold. This exploration programme is designed to support a Feasibility Study (FS). MWM was engaged by WGM to provide environmental geochemistry support for the FS. MWM assessed the potential for AMD and the results were provided in report "Assessment of Environmental Effects – Acid and Metalliferous Drainage, Waikaka Gold Mine" (MWM, 2022).

The bottom of drill hole WX0097 40-41 ended in the Gore Lignite Measures (GLM), with the ore zone sample containing 0.4 m of GLM. This sample is considered a reasonable material to understand the PCOC that could be released to water from the GLM, which have been classified as potentially acid forming (PAF) with a Net Acid Producing Potential (NAPP) of 3.3 kg H_2SO_4/t demonstrating a low capacity to generate acidity and a maximum potential acidity (MPA) of 4.5 kg H_2SO_4/t (Table 1).

Table 1. ABA analysis for leach column sample.

SAMPLE ID	$pH_{1:2}$	TS	MPA	ANC	NAPP	NPR	AMIRA AMD CLASS	PRICE AMD CLASS
	pH units	wt% S		kg H_2SO_4/t		-	-	-
WX0097 40-41	5.9	0.147	4.5	1.2	3.3	0.267	PAF	PAF

pH1:2 - Paste pH; TS – Total Sulfur; MPA – Maximum Potential Acidity; ANC – Acid Neutralisation Capacity; NAPP – Net Acid Production Potential; NPR – Neutralisation Potential Ratio

The geochemical signature that can be generated from a material type can be inferred from acid base accounting (ABA) characterisation data. For sample WX0097 40-41 is can be assumed that acidic drainage is likely. However, it does not provide an indication of other PCOC that may be present in drainage waters. Hence column leach testing was undertaken.

OBJECTIVES

The objective of this memorandum is to determine the PCOC for mine impacted waters where GLM are disturbed. This would provide an indication of the water quality monitoring requirements for the project for resource consenting purposes.

METHODOLOGY

One sample from the drillhole WX0097 at 40 - 41 m was selected for the free draining column leach test. Free draining column leach tests are used to provide information on material reactivity and the leaching behaviour of materials under optimum oxidising conditions. This process is achieved by applying a weekly rinse cycle and a monthly flush cycle, which is analysed for PCOC as per industry guidance (AMIRA, 2002). Heat lamps were used to ensure drying of the sample between wetting cycles.

Typically, 2.0 to 2.5 kg of crushed rock, tailings or sediment is required for the test (AMIRA, 2002). However, due to limited sample availability only 400 g of material was available. Hence, the following approach was applied:

- The sample size was enough to give a bed depth of ~40 – 50 mm in a 110 mm Buchner funnel;
- The sample material was crushed to ~5 mm;
- Deionised water was applied at a rate 800 mL/kg equivalent for the flush cycle (i.e., 160 mL) as minimal leachate was collected using the AMIRA (2002) application rate of 400 mL/kg; and
- The test was operated for 3 months (3 cycles) to confirm the PCOC

COLUMN LEACH TEST RESULTS

Water Quality Analysis

Water quality data (Table 2) was assessed against the 95% ANZG (2018) water quality criteria, which included hardness modification adjustments to the trigger value. These data were normalised to derive the metal ecotox quotient (MEQ). A MEQ is used to identify PCOC that are elevated with respect to water quality compliance limits or trigger values (Weber and Olds, 2016). The MEQ value is determined by dividing the measured concentration by the compliance limit/trigger value. MEQ values greater than 1 indicate parameters which exceed water quality guidelines. Conversely, MEQ values less than 1 are below compliance limits or trigger values. Full laboratory certificates can be found in Attachment A. Timeseries graphs showing analytes compared to the ANZG, 2018 Default Guideline Values (DGVs) are shown in Attachment B.

Table 2. Column Leachate Analysis.

PARAMETER	DGVs 95% (ANZG, 2018)	MONTH 1	MONTH 2	MONTH 3	MEAN	MEQ#
Leachate volume (mL)	**-**	103	117	117	-	-
pH (pH units)	**-**	3.20	2.85	2.80	-	-
Electrical Conductivity (EC) (µS/cm)	**-**	-	1,778	1,680	1,729	-
Hardness (mg $CaCO_3$/L)	**-**	599	250	172	340	-
Acidity (mg $CaCO_3$/L)		507	745	983	-	**-**
Aluminium (Al)	**0.055**	24	26	32	27.3	**582**
Arsenic (As)	**0.013**	0.09	0.07	0.1	0.09	**7.7**
Boron (B)	**0.94**	0.15	<0.1*	0.1	0.083	0.16
Cadmium (Cd)	**0.0002**	0.0162	0.0096	0.0077	0.01	**1.1**
Calcium (Ca)	**-**	146	62	41	83	-
Chromium (Cr)	**0.001**	0.064	0.156	0.21	0.14	**5.74**
Cobalt (Co)	**0.0014**	12.4	16.4	15.7	14.8	**11,714**
Copper (Cu)	**0.0014**	2.2	2.4	3.1	2.56	**86.8**
Iron (Fe)	**-**	127	200	270	199	-
Lead (Pb)	**0.0034**	0.27	0.147	0.101	0.17	**46.2**
Magnesium (Mg)	**-**	57	23	16.8	32.3	-
Manganese (Mn)	**1.9**	4.8	2.4	1.81	3.00	**2.53**
Mercury (Hg)	**0.0006**	<0.00008	<0.002	<0.00008	0.0004	0.07**
Nickel (Ni)	**0.011**	5.7	2.7	2.2	3.53	**7.92**
Potassium (K)	**-**	9.4	1.4	1.1	3.97	-
Selenium (Se)	**0.011**	0.02	<0.02*	<0.02*	0.01	**1.82**
Sodium (Na)	**-**	18.3	4.4	1.4	8.03	-
Zinc (Zn)	**0.008**	18.6	11.7	10.8	13.7	**33.9**
Sulfate (SO_4)	**-**	959***	860	950	710	-

DGVs are obtained from ANZG (2018) 95% level of protection.
All values are in mg/L unless otherwise specified.
A hyphen (-) indicates no value is given.
Values shaded RED exceed the DGVs.
Guideline values for As(V) were applied instead of As(III) due to an expectation that surfaced waters would be oxic.
Guideline values for Cr(VI) were used.
Guideline values for Al (pH >6.5)
 # - MEQ values are determined from the highest recorded value
< - Given value is below the Laboratory Limit Reporting (LOR).
** ½ the LOR value was used in calculating MEQ value.*
*** - A value of ½ the LOR of 0.0008 mg/L was used to determine the MEQ for Hg (with the <0.002 mg/L being excluded).*
**** - Sulfate calculated from total sulfur analysis with the assumption all sulfur is SO_4*

COLUMN LEACH TEST SUMMARY

Data indicates the GLM sample produced acidic drainage with pH values of 2.8 - 3.2 and acidities of 507 – 983 mg $CaCO_3$/L. Elevated PCOC also occur (Table 2). MEQ indicates that Al, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, and Zn are >1.0 MEQ. Data indicates that the GLM materials have the potential to generate AMD if not properly managed.

Such elevated PCOC concentrations are unlikely at the project given the PAF materials (process residues, silt pond slimes, GLM) represent <10% of the materials that will be mined and that overall the project materials are non-acid forming with an excess of acid-neutralising materials (MWM, 2022). Further work is recommended to understand water quality based on the conceptual site model and flow rates from various materials and mine domains. The data indicates the PCOC that should be analysed as part of any monitoring programme including baseline studies and future potential project effects.

ABA DATA – PROCESS RESIDUE

Four process residue samples were tested after recovery of the pan tails (i.e., after removal of heavy minerals) as it was suggested by WGM that this process could also remove sulfide minerals such as pyrite. The samples were analysed by ABA methodologies including:

- Paste pH/EC;
- Acid neutralisation capacity (ANC);
- Total sulfur content;
- Maximum potential acidity (MPA);
- Net acid producing potential (NAPP); and
- Neutralisation potential ratio (NPR).

An explanation of ABA methodologies can be found in MWM (2022). Results are provided in Table 3; ABA laboratory certificates are provided in Attachment A. The samples were classified using the NAPP (AMIRA, 2002) and the Price (2009) classification schemes.

Results indicate that two samples (BSF-1 and BSJ-2) were NAF based on the AMIRA (2002) and Price (2009) classification schemes having negative NAPP values. The other two samples, BSC-3 and BSG-4 had higher sulfur content that generated positive NAPP values and are classified as PAF. The other two samples, BSC-3 and BSG-4 had higher sulfur content and positive NAPP values and are classified as PAF.

Table 3. ABA analysis - tailing residue.

SAMPLE ID	$pH_{1:2}$	TS	MPA	ANC	NAPP	NPR	AMIRA AMD CLASS	PRICE AMD CLASS
	pH units	wt% S		kg H_2SO_4/t		-	-	-
BSF-1	6.8	0.030	0.91	1.82	-0.9	1.9	NAF	NAF
BSJ-2	7.2	<0.005*	0.077	1.21	-1.1	15.8	NAF	NAF
BSC-3	6.5	0.221	6.8	1.82	4.9	0.3	PAF	PAF
BSG-4	6.3	0.123	3.8	1.21	2.6	0.3	PAF	PAF

*< - Given value is below the LOR; * - infers that ½ the LOR value was used for the MPA calculation*

SUMMARY

Results indicate that after processing some process residues may be classified as NAF and are a low risk for AMD. Some of these materials will be PAF with the ability to generate AMD elevated in acidity and potential contaminants of concern that could include (Al, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, and Zn). These contaminants should be used to guide water quality monitoring programs for baseline studies and the assessment of future potential effects.

Further work is recommended to understand water quality based on the conceptual site model and flow rates from various materials and mine domains.

CLOSING REMARKS

Please do not hesitate to contact Paul Weber at +64 27 294 5181 or paul.weber@minewaste.com.au should you wish to discuss this memorandum in greater detail.

Attachments: Attachment A – Column Leach Test Laboratory Certificates of Analysis
Attachment B – Timeseries Graphs
Attachment C – ABA Data: Process Residues

REFERENCES

AMIRA, 2002. ARD Test Handbook - Project P387A Prediction and Kinetic Control of Acid Mine Drainage. AMIRA International Limited. Melbourne, Australia.

ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian State and Territory Governments. www.waterquality.gov.au/anz-guidelines.

Price, W., 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Mine Environment Neutral Drainage (MEND) Program, Smithers, British Columbia. http://mend-nedem.org/wp-content/uploads/1.20.1_PredictionManual.pdf

MWM, 2022. Assessment of Environmental Effects – Acid and Metalliferous Drainage Waikaka Gold Mine – Rev0. Report J-NZ0194-001-R-Rev0. 14 May 2022,

Weber, P and Olds, W, 2016. Optimised water assessment for the environmental management of mining projects. In: Fergusson, D (ed). Proc. AusIMM NZ Branch 2016 Conference, Wellington, p. 455–466.

ATTACHMENT A - COLUMN LEACH TEST LABORATORY CERTIFICATES OF ANALYSIS

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Certificate of Analysis

Client:	Verum Group Limited	**Lab No:**	2904957 SPv3
Contact:	Rachel Skews	**Date Received:**	04-Mar-2022
	C/- Verum Group Limited	**Date Reported:**	18-May-2022 **(Amended)**
	PO Box 29415	**Quote No:**	116003
	Riccarton	**Order No:**	
	Christchurch 8440	**Client Reference:**	Leachate testing
		Submitted By:	N Newman

Sample Type: Aqueous

Sample Name:		Column 1 28-Feb-2022				
Lab Number:		2904957.1				
Individual Tests						
Dissolved Aluminium	g/m³	24	-	-	-	-
Dissolved Boron	g/m³	0.15	-	-	-	-
Dissolved Calcium	g/m³	146	-	-	-	-
Dissolved Cobalt	g/m³	12.4	-	-	-	-
Dissolved Iron	g/m³	127	-	-	-	-
Dissolved Magnesium	g/m³	57	-	-	-	-
Dissolved Manganese	g/m³	4.8	-	-	-	-
Dissolved Mercury	g/m³	< 0.00008	-	-	-	-
Dissolved Potassium	g/m³	9.4	-	-	-	-
Dissolved Selenium	g/m³	0.02	-	-	-	-
Dissolved Sodium	g/m³	18.3	-	-	-	-
Dissolved Sulphur	g/m³	320	-	-	-	-
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.09	-	-	-	-
Dissolved Cadmium	g/m³	0.0162	-	-	-	-
Dissolved Chromium	g/m³	0.064	-	-	-	-
Dissolved Copper	g/m³	2.2	-	-	-	-
Dissolved Lead	g/m³	0.27	-	-	-	-
Dissolved Nickel	g/m³	5.7	-	-	-	-
Dissolved Zinc	g/m³	18.6	-	-	-	-

Analyst's Comments

Amended Report: This certificate of analysis replaces report '2904957-SPv2' issued on 17-Mar-2022 at 5:21 pm.
Reason for amendment: Dissolved Sulphur has been added.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0010 - 0.02 g/m³	1
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	1
Dissolved Aluminium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.06 g/m³	1
Dissolved Boron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.10 g/m³	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	1.0 g/m^3	1
Dissolved Cobalt	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.004 g/m^3	1
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.4 g/m^3	1
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.4 g/m^3	1
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.010 g/m^3	1
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	1.0 g/m^3	1
Dissolved Selenium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.02 g/m^3	1
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23^{rd} ed. 2017.	0.4 g/m^3	1
Dissolved Sulphur	Filtered sample, ICP-MS, trace level. APHA 3125 B 23^{rd} ed. 2017.	10 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 10-Mar-2022 and 18-May-2022. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Client Services Manager - Environmental

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Certificate of Analysis

Client:	Verum Group Limited	**Lab No:**	2940054 SPv1
Contact:	Rachel Skews	**Date Received:**	31-Mar-2022
	C/- Verum Group Limited	**Date Reported:**	08-Apr-2022
	PO Box 29415	**Quote No:**	116003
	Riccarton	**Order No:**	
	Christchurch 8440	**Client Reference:**	Leachate testing
		Submitted By:	Rachel Skews

Sample Type: Aqueous

Sample Name:		Column 1 30-Mar-2022				
Lab Number:		2940054.1				
Individual Tests						
Sum of Anions	meq/L	18.0	-	-	-	-
Sum of Cations	meq/L	17.2	-	-	-	-
pH	pH Units	2.9	-	-	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	-	-	-	-
Carbonate	g/m^3 at 25°C	< 1.0	-	-	-	-
Bicarbonate	g/m^3 at 25°C	< 1.0	-	-	-	-
Total Hardness	g/m^3 as $CaCO_3$	250	-	-	-	-
Electrical Conductivity (EC)	mS/m	181.1	-	-	-	-
Dissolved Aluminium	g/m^3	26	-	-	-	-
Dissolved Boron	g/m^3	< 0.10	-	-	-	-
Dissolved Calcium	g/m^3	62	-	-	-	-
Dissolved Cobalt	g/m^3	16.4	-	-	-	-
Dissolved Iron	g/m^3	200	-	-	-	-
Dissolved Magnesium	g/m^3	23	-	-	-	-
Dissolved Manganese	g/m^3	2.4	-	-	-	-
Dissolved Mercury	g/m^3	< 0.002	-	-	-	-
Dissolved Potassium	g/m^3	1.4	-	-	-	-
Dissolved Selenium	g/m^3	< 0.02	-	-	-	-
Dissolved Sodium	g/m^3	4.4	-	-	-	-
Chloride	g/m^3	1.3	-	-	-	-
Nitrite-N	g/m^3	0.004	-	-	-	-
Nitrate-N	g/m^3	0.035	-	-	-	-
Nitrate-N + Nitrite-N	g/m^3	0.039	-	-	-	-
Sulphate	g/m^3	860	-	-	-	-
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.07	-	-	-	-
Dissolved Cadmium	g/m^3	0.0096	-	-	-	-
Dissolved Chromium	g/m^3	0.156	-	-	-	-
Dissolved Copper	g/m^3	2.4	-	-	-	-
Dissolved Lead	g/m^3	0.147	-	-	-	-
Dissolved Nickel	g/m^3	2.7	-	-	-	-
Dissolved Zinc	g/m^3	11.7	-	-	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0010 - 0.02 g/m^3	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter. Performed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 23rd ed. 2017.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEquiv/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H^+) also included in calculation if available. APHA 1030 E 23rd ed. 2017.	0.05 meq/L	1
pH	pH meter. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1
Carbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 23rd ed. 2017.	1.0 g/m^3 at 25°C	1
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 23rd ed. 2017.	1.0 g/m^3 at 25°C	1
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	1
Dissolved Aluminium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.06 g/m^3	1
Dissolved Boron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.10 g/m^3	1
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	1.0 g/m^3	1
Dissolved Cobalt	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.004 g/m^3	1
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.010 g/m^3	1
Dissolved Mercury	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.002 g/m^3	1
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	1.0 g/m^3	1
Dissolved Selenium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Chloride	Filtered sample from Christchurch. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1
Nitrite-N	Filtered sample from Christchurch. Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1
Nitrate-N + Nitrite-N	Filtered sample from Christchurch. Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1
Sulphate	Filtered sample from Christchurch. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 01-Apr-2022 and 08-Apr-2022. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

Client:	Verum Group Limited	**Lab No:**	2969918 SPv2
Contact:	Rachel Skews	**Date Received:**	28-Apr-2022
	C/- Verum Group Limited	**Date Reported:**	13-May-2022 **(Amended)**
	PO Box 29415	**Quote No:**	116003
	Riccarton	**Order No:**	
	Christchurch 8440	**Client Reference:**	Leachate testing
		Submitted By:	N Newman

Sample Type: Aqueous

Sample Name:		Column 1 27/4/22 27-Apr-2022				
Lab Number:		2969918.1				
Individual Tests						
Dissolved Aluminium	g/m^3	32	-	-	-	-
Dissolved Boron	g/m^3	0.10	-	-	-	-
Dissolved Calcium	g/m^3	41	-	-	-	-
Dissolved Cobalt	g/m^3	15.7	-	-	-	-
Dissolved Iron	g/m^3	270	-	-	-	-
Dissolved Magnesium	g/m^3	16.8	-	-	-	-
Dissolved Manganese	g/m^3	1.81	-	-	-	-
Dissolved Mercury	g/m^3	< 0.00008	-	-	-	-
Dissolved Potassium	g/m^3	1.1	-	-	-	-
Dissolved Selenium	g/m^3	< 0.02	-	-	-	-
Dissolved Sodium	g/m^3	1.4	-	-	-	-
Sulphate	g/m^3	950	-	-	-	-
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.10	-	-	-	-
Dissolved Cadmium	g/m^3	0.0077	-	-	-	-
Dissolved Chromium	g/m^3	0.21	-	-	-	-
Dissolved Copper	g/m^3	3.1	-	-	-	-
Dissolved Lead	g/m^3	0.101	-	-	-	-
Dissolved Nickel	g/m^3	2.2	-	-	-	-
Dissolved Zinc	g/m^3	10.8	-	-	-	-

Analyst's Comments

Amended Report: This certificate of analysis replaces report '2969918-SPv1' issued on 06-May-2022 at 2:30 pm.
Reason for amendment: Sulphate added as per client request.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0010 - 0.02 g/m^3	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	1
Dissolved Aluminium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.06 g/m^3	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Boron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.10 g/m^3	1
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	1.0 g/m^3	1
Dissolved Cobalt	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.004 g/m^3	1
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.010 g/m^3	1
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	1.0 g/m^3	1
Dissolved Selenium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.4 g/m^3	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

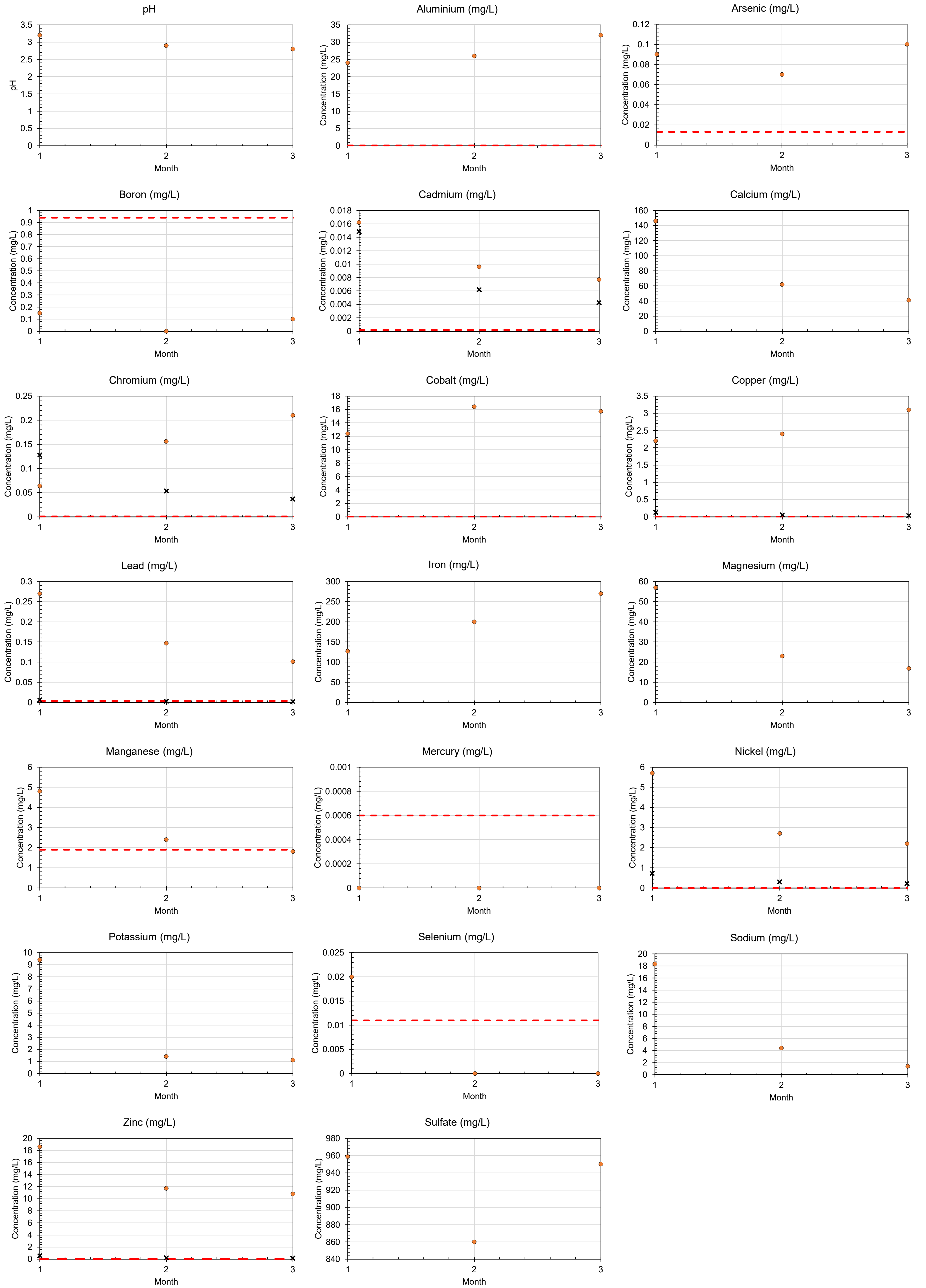
Testing was completed between 04-May-2022 and 13-May-2022. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

ATTACHMENT B – TIMESERIES GRAPHS



Notes:
Guideline values for As(V) were applied instead of As(III) due to an oxic environment being present.
Guideline values for Cr(VI) were used. No guideline values for Cr(III) exist.
Guideline values for Al (pH >6.5) were used as the level of species protection (%) for Al (pH <6.5) are unknown.

Analyte Concentration
ANZG (2018) Default Guideline Trigger values (95% Level of Protection)
Hardness Modified Guideline Value

ATTACHMENT C – ABA DATA: PROCESS RESIDUES

WAIKAKA GOLD MINES LIMITED

5 April 2022

Paul Weber
Mine Waste Management
Christchurch

Paul

Re: Bulk Sample Rejects samples, Waikaka

Please find enclosed 4 sand samples, being plant processing rejects from each of the following bulk samples.

BSC3
BSE1
BSG4
BSJ2

Samples were taken by spear at the completion of processing from the sediment built up along the tailings channel.
If for any reason the labels are rubbed off the outside of the bags, there is another length of flagging tape in each bag with the label number on it.

Regards

Noel

Noel Becker
Waikaka Gold Mines Ltd

Registered Office: Ashton Wheelans Limited, Level 2, 83 Victoria Street, Christchurch, 8013 , New Zealand
Tel: +64 3 366 7154 **Email:** admin@waikaiagold.co.nz
Mine Office: 1616 Riversdale-Waikaia Road, Freshford, RD7, Gore 9777 **Tel:** +64 3 202 7529

Verum Group

REPORT OF ANALYSIS

Customer: Mine Waste Management

Date Received: 28-Apr-22

Description: Rock samples supplied by client

Customer Reference:		BSF-1	BSJ-2	BSC-3	BSG-4
Verum Group Ltd Reference:		22/366-1	22/366-2	22/366-3	22/366-4
Weight received (kg)		2.5	3.8	3.0	1.0
Analysis					
Paste pH		6.8	7.2	6.5	6.3
Conductivity	uS/cm	258	61	1140	1330
ANC	kg H2SO4/t	1.82	1.21	1.82	1.21
ANC	%CaCO3	0.19	0.12	0.19	0.12
Sulphur - Total	%w	0.030	<0.005	0.221	0.123

Signature:

Mike Young

National Labortory Manager

Date of Issue: 17-May-22

Re-issued with correction to sample identification

THIS REPORT MUST NOT BE QUOTED EXCEPT IN FULL

Distribution:

Mine Waste Management - Paul Weber
Waikaia Gold - Noel Becker